The Caribbean Forester

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TROPICAL FOREST EXPERIMENT STATION
RIO PIEDRAS, PUERTO RICO

VOL. 6, NO. 1 — OCTOBER 1944
VOL. 6, NO. 2 — JANUARY 1945

CONTENTS

Vol. 6, No. 1

Vol. 6, No. 2

Note: Numbers 1 and 2 were combined to save cover stock.

A SILVICULTURAL TECHNIQUE IN TRINIDAD

FOR THE REHABILITATION OF DEGRADED FOREST

John S. Beard
Asst. Conservator of Forests
Trinidad and Tobago

Previous papers in this journal 1/, 2/, 3/, 4/, 5/, have described various silvicultural techniques, practices, and experiences from Trinidad. All of these have dealt with what is, in Trinidad, the major silvicultural activity - the regeneration of high forests. In one locality of Trinidad, however, activities of a somewhat different character have been in progress and there has gradually been evolved experimentally over the past decade a system for the rehabilitation and regeneration of degraded woodlands. The treatment of areas which have been ruined by fire and the shifting cultivator is perhaps one of the biggest forestry problems which exists today in Tropical America, and since a considerable measure of success has been attained in Trinidad, a description of the progress to date may be of help to other workers.

The work has been carried on in the MacNair Ravine Sable Forest Reserve, an irregular block of some 863 acres situated on the northern plain of Trinidad about 15 miles south-east of Port of Spain. It lies five miles to the west of the Arena Forest Reserve.

The original virgin forest in this locality probably remained in undisturbed condition as late as the 1890's. Around the beginning of the present century almost the whole area was sold by the Crown in lots of from 5 to 20 acres for agricultural settlement, mainly to East Indians; only a few small blocks of land being retained by the Crown. As in the case of a regrettably high percentage of past land sales in Trinidad, the soil was subsequently found to be infertile and totally unsuited to permanent peasant agriculture. The original forest on the holdings was burnt into charcoal, food crops were planted and unsuccessful attempts were made to establish cacao. Following this a regime of shifting cultivation began, the holdings being periodically cut over for firewood and crops of corn planted without,

---

1/ Cater, J. C. Notes on *Calophyllum lucidum* Benth. Caribbean Forester, 2:1. 1940.

2/ ____________ The formation of teak plantations in Trinidad with the assistance of peasant contractors. Caribbean Forester, 2:4. 1941.

3/ Brooks, R. L. The regeneration of mixed rain forest in Trinidad. Caribbean Forester, 2:4. 1941.

4/ ____________ Notes on pure teak plantations in Trinidad. Caribbean Forester, 3:1. 1941.

5/ Beard, J. S. Summary of silvicultural experience with cedar, *Cedrela mexicana* Roem. in Trinidad. Caribbean Forester, 3:3. 1942.

of course, the application of any form of fertilizer. Frequent periodic fires swept through the area and eventually very many of the holdings were totally abandoned and became forfeited to the Crown for non-payment of taxes.

In 1930 attention was drawn to the hardship caused to the peasantry in the County of Caroni by the shortage of forest produce, since almost all land in the county had been sold and little forest remained. Accordingly it was decided to form a Forest Reserve at MacNair Ravine Sable out of any remaining blocks of Crown Land and the forfeited holdings. Between 1931 and 1933 the proposed Reserve was surveyed and demarcated and it was finally constituted in 1934.

Description of the Reserve

The following is a full description of the Reserve:

Topography

The land in the northern half is somewhat flat, consisting of alluvial terraces of Pleistocene age dissected by V-shaped ravines. In the southern half the Miocene formation (sands and clays) is exposed and the land is undulating. The elevation throughout varies between 50 and 200 feet above sea level. The flat parts are poorly drained and tend to become swampy in the rainy season.

Soils

The following descriptions of the soil types was furnished by Dr. E. M. Chenery, Government Soil Chemist:

Piarco Sand.-A light, greyish, loose sand, underlain at a depth of one to two feet by an exceedingly compact impermeable and non-shrinking red and white mottled clay or clay-loam. The transition between the horizons is abrupt. This soil is associated with the flat country in the north of the Reserve. The ground surface is markedly hogwallowed.

Las Lomas Loam.-An orange to red and white mottled loam, somewhat stiff and impermeable. This is associated with rather more undulating land than the Piarco Sand, but there is an intermediate zone between them where the two types alternate in catena, Piarco occupying the flat tops of ridges and Las Lomas the slopes.

Talparo Clay.-A very heavy, almost pure clay of shrinking type, generally brilliantly red-mottled in the upper three feet, merging into a whitish clay below. Two phases are distinguished here, the red-weathered phase and the red-mottled phase, the red colour being less pronounced in the latter than in the former and presumably indicating a lesser degree of acidity and faulty aeration.

Calcareous Clay.-A small patch of greenish-yellow calcareous clay is found on the Toby-Hercules Trace.

Arena Sand.— A deep, loose, free-draining sand of grey colour. Two phases are distinguished, a flat phase and a slope phase, depending on the nature of the topography. The boundaries shown between this type and the Talparo Clay should not be too literally interpreted since the actual boundaries are obscure and there is an intermediate catena zone with sand capping ridges and clay outcropping on slopes.

With the exception of the calcareous clay which occupies a very restricted area, all these soils are derived from sedimentary rocks which are deficient in essential plant nutrients and are therefore unsuited to present systems of peasant agriculture.

Rainfall

Rainfall records have been kept in the Reserve for 8 years (1935-1942) and the following are the averages for this period:

Inches of Rain per Month

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Tota
3.38	1.33	1.27	2.90	5.73	8.33	9.86	10.51	8.36	6.01	8.92	7.89	74.4

The year is divided into a dry season from January to April and a rainy season from May to December.

Communications

There is a metalled road one mile from the north end of the Reserve and another two miles from the south end. The Reserve itself is traversed by a number of natural soil cart roads, which connect with the metalled roads.

Utilization of Produce

The local population is an agricultural one, mainly cane farmers of both East and West Indian extraction. The villages of Chaguanas, Longdenville and Cunupia, and the settlements of Madras and Las Lomas are within easy reach. There is a considerable demand for charcoal, fuelwood, roundwood house posts, rods, rafters, thatch for roofing, etc., in fact difficulty is experienced in obtaining wood of any kind. Placed as it is, in a district where all available land has long since been alienated and deforested, the MacNair Ravine Sable Reserve is ideally situated for the disposal of all forest products capable of being grown in the locality. In addition the MacNair Zone is within 20 miles of Port of Spain.

Original Vegetation

Up to the 1890's the vegetation of this area must have rested quite undisturbed. Predominantly the forest must have belonged to the formation evergreen seasonal forest[6] but the rainfall of the locality is very nearly marginal for that type, so that on the driest sites, namely the tops of hard clay ridges, there seems to have been a local change to semi-evergreen seasonal forest. The latter consisted of a Peltogyne association and the former of a Carapa-Eschweilera association which was divisible into a Sabal phase on the drier, milder clays and a Maximiliana phase on sands, loams and wet, acid clays. The alternation of these types was determined broadly by moisture relations, that is, by the mutual interaction of rainfall, topography and the physical character of the soil and was not directly related to any one of these factors taken singly. In general, Carapa-Eschweilera-Maximiliana forest occupied the most moist sites, Peltogyne forest the driest, with Carapa-Eschweilera-Sabal intermediate.

The principal components of the above forest types would have been as follows;

Carapa-Eschweilera-Maximiliana. (Crappo-guatecare-cocorite)

- Aniba panurensis
- Aniba trinitatis
- Sterculia caribaea
- Carapa guianensis
- Eschweilera subglandulosa
- Pachira insignis
- Pentaclethra macroloba
- Diospyros ierensis
- Licania biglandulosa
- Warszewiczia coccinea
- Maximiliana elegans

Carapa-Eschweilera-Sabal. (Crappo-guatecare-carat)

- Carapa guianensis
- Pachira insignis
- Eschweilera subglandulosa
- Crudia obliqua
- Sterculia caribaea
- Pentaclethra macroloba
- Trichilia oblanceolata
- Guarea trichilioides
- Sabal sp.
- Brownea latifolia
- Swartzia pinnata

Peltogyne. (Purpleheart)

- Peltogyne porphyrocardia
- Mouriri marshallii
- Eschweilera subglandulosa
- Vitex capitata
- Pouteria minutiflora
- Trichilia oblanceolata
- Hura crepitans
- Copaifera officinalis
- Sabal sp.
- Coccoloba spp.
- Myrtaceae spp.

Management

When the Reserve was constituted in 1934, the forest growth throughout was in a very degraded condition. The whole northern portion, now Compartments 1 to 8, consisted of abandoned agricultural land, where frequent fires, choppings and croppings had completely exhausted the soil, and

---

6/ Beard, J. S. Climax vegetation in tropical America. Ecology, 25:2. 1944 was covered with a low, worthless bush under 20 feet high, much of it being coppice. It was laced with lianes and razor grass (Scleria) and contained few valuable species, but had a great abundance of the cocorite palm, Maximiliana elegans. The southern portion (Compartments 9 to 13) consisted of former Crown Lands, which had never been cultivated but which had been intensively logged and burned over and were widely ruinate.

Silvicultural operations were started in the reserve area in 1931. The immediate object of management was the improvement of the growing stock so that it could at least form a good pole crop capable of yielding small roundwood and firewood. The ultimate object was the creation of a normal forest capable of supplying timber.

The most obvious procedure was to clear away the bush and plant an entirely new tree crop. On such degraded areas, however, growth of the planted trees is always slow and weeds, particularly razor grass, present a serious problem. Unless an especially fast-growing species can be utilized, plantations are both costly and difficult to establish. Teak, which has been so successful in Trinidad, and is a fast growing tree, was not tried in this particular area since the bulk of the soils suffer from impeded subsoil drainage, a factor which is inimical to the species. Some planting work with other species, mainly native, was done from 1931-1933, but was not subsequently continued.

In 1931 and 1932 seeds of Carapa guianensis and Pentaclethra macroloba were sown on grassy, degraded soil. After a very slow start a healthy pole crop some 20 to 30 feet in height resulted by 1942.

In 1932 fifteen species of Eucalyptus were tried but results have been very poor and none can be called a success. In 1933 an acre was planted with Terminalia obovata at a spacing of 8 x 8 feet. By 1942 the trees were on the average 25 feet in height with the tallest 40 feet.

In the early years growth of the planted stock in all these trials was extremely slow. A very degraded area had been chosen of low bush full of grass and Cordia cylindrostachya and when this was cleared the radiation from the soil appeared so intense that the leaves of the young trees were literally scorched. After some years when the young tree became established and began to cover the soil growth was fairly rapid, but at first the seedlings of these species which under natural conditions come up in the moist, equable environment of a forest floor were quite unable to withstand the severity of full exposure. Attention may be invited to the experiments at Arena Reserve described by R. L. Brooks 7/, where the range of temperature was found to be twice as great in the open as under forest, the evaporating ability of the air three to five times as great, and the degree of insolation twelve times as great. Destruction of tree cover causes the microenvironment to deteriorate to a degree which is hard to realize.

7/ Duthie, D.W., Hardy, F. and Rodríguez, G. Soil investigations in the Arena Forest Reserve, Trinidad. Summarized by R. L. Brooks. Imp. For. Inst. Paper No. 6, Oxford. 1937.

From 1932 natural methods were tried and proved so successful that they were extended for the treatment of the whole Reserve under Working Plans. The first working plan was in force for the five-year period 1933-37 and was superseded by a second for 1938-42. A third plan is in force at the present time and will run until 1947. The theory behind the operations is the simple proposition that "nature is a great healer". In secondary vegetation, if it is protected from further interference, the climax automatically begins to develop sometimes very slowly, but frequently at a not inconsiderable rate. Rather than to adopt elaborate and expensive planting methods, therefore, it may be preferable to let nature do the work offering her only certain assistance with the object of hastening progress and influencing the composition of the natural crop. All work was at first experimental. The initial working plan constituted an Improvement Working Circle divided into five annual coupes varying in size from 140 to 206 acres. Each coupe was subjected in turn to improvement fellings, for which the working plan provided the following general prescriptions:

a. Cutting vines and razor grass.
b. Reducing excess coppice shoots on stools of species of value.
c. Encouraging young natural seedlings and saplings of valuable species by reducing competition.
d. Eradicating palms.

The detailed treatment of each annual coupe was laid down in an Annual Plan, following the foregoing principles, but based further on a detailed examination of the coupe and on experience gained in previous coupes. At this stage the cutting of vines and razor grass was the most important operation, since these were loading the crown of the trees, restricting and deforming growth. Cutting them allowed the tree crop to go ahead. Maximiliana palms were at first poisoned but it was found cheaper and more effective to cut them down.

Under the second working plan the same annual coupes were again treated. Operations had as their object the encouragement of existing and the introduction of fresh natural regeneration and the development of only one pollard or coppice shoot per stump, and were as follows:

a. Cutting of surplus pollard and coppice shoots of valuable species, retaining the best in each case.

b. Thinning and cleaning of other species among the crop to a degree which would assist the development of existing natural regeneration and the appearance of more while still maintaining sufficient of an upper canopy to keep down the growth of grass and vines.

During the first cycle, all the work was done by direct labour and there was very little outturn of produce. Some small poles and rods and odd remnants of timber were sold. During the second cycle a large quantity of pole-size wood was available and the bulk of the work was done by charcoal burners. First, the coupe was inspected by the Forest Ranger in charge, who marked thinnings and coppice shoots etc. for removal. These poles were then cut by charcoal burners (or in some cases by firewood merchants) who paid a small royalty on the wood. The coalburners stacked the wood on the spot and burned it into charcoal. There was such a strong demand for wood products in this locality and for charcoal in Port of Spain which is not far away, that almost every available stick of wood was sold. After the coalburners had finished work, direct labour was employed to tidy up and to cut lianes and fell palms.

As an example, the following are the details of the actual work carried out in one compartment, No. 3:

1933.- The compartment was lightly underbrushed: vines and razor grass were cut. No thinning of excess coppice and pollard shoots was done.

1938.- Excess coppice and pollard shoots, and stems of worthless species interfering with valuable regeneration were marked and were felled by charcoal burners. Razor grass and vines were then cut and the area generally tidied up.

1941.- Razor grass and vines were again cut and odd poles interfering with young growth were removed.

1942.- To meet a local demand for poles and firewood further unwanted poles were marked and felled and removed by purchasers.

Under the current working plan the same policy is continued since "past results have shown that an excellent crop of natural regeneration has been and is being produced under the shelterwood system". Under the working plan, Compartments 1, 2, 3, and 5 are regarded as "regenerated", that is to say they are considered fully stocked with a young pole crop of valuable species. During the current five year period it is confidently expected that all the remainder of the Reserve, except compartments 9 and 10 and a few acres in 6 and 8, will progress to the status of "regenerated". Compartments 9 and 10 contain some clay soils where regeneration has been slow to appear and the portions of 6 and 8 were covered with an excessively degraded bush that had been repeatedly burned and has been slow to recover.

In the regenerated compartments, only thinnings are now being carried out. The Forest Ranger marks poles for removal, treating one compartment each year, and they are cut by purchasers. In order to get access to the produce, the cutters slash what still remains of the razor grass and vines, which is a helpful operation and so these compartments are now, after only ten years, already at a profit-making stage.

In the remainder (except 9, 10 and parts 6 and 8) the improvement operations of the last period are being repeated with the aid, as before, of charcoal burners. In the unpromising Compartments 9 and 10 and portions of 6 and 8 the choice lies between further waiting for recovery of the vegetation and resort to artificial means. The latter has been decided upon for the portions of Compartments 6 and 8, totalling 55 acres, which are to be planted up mainly with *Terminalia obovata*, with some *Gmelina arborea*, Tabebuia pentaphylla (these two are exotics) and Calophyllum lucidum. There is still confidence that natural methods would regenerate these areas in the long run, but as they consist of small blocks in the midst of more advanced growth and as it is intended to produce more or less even-aged crops, the planting is being resorted to for evening up the compartments. In Compartments 9 and 10 some research has been prescribed to shed light on the non-appearance of regeneration.

In carrying out thinnings and cleanings it is recognized that seedling growth is preferable to coppice or pollard and the former is always favoured. During the initial rotation, however, it has been decided to utilize the latter where necessary, for the rapid production of a young pole crop (later to become a timber crop) of mixed valuable species. The following are considered "valuable":

- Byrsonima spicata
- Calophyllum lucidum
- Carapa guianensis
- Cedrela mexicana
- Copaifera officinalis
- Didymopanax morototoni
- Eschweilera subglandulosa
- Hieronyma caribaea
- Hymenaea courbaril
- Nectandra and Ocotea spp.
- Manilkara bidentata
- Peltogyne porphyrocardia
- Platymiscium trinitatis
- Tabebuia serratifolia
- Terminalia obovata
- Virola surinamensis
- Vitex capitata
- Vitex divaricata

Economics

A conspicuous feature of the operations at MacNair Ravine Sable Reserve has been the extremely low cost relative to results obtained. Table 1 summarizes for each compartment the expenditure and revenue to date in terms of dollars per acre. The currency unit is the British West Indian dollar which corresponds to 4s. 2d. sterling and is equivalent at the present official rate of exchange to U. S. $1.17. Rates paid to labour for daily work have been as follows:

Year	Males	Females
	$	$
1931-36	0.35-0.45	0.35
1936	0.40-0.50	0.35-0.40
1937	0.45-0.55	0.40-0.45
1938-40	0.50-0.60	0.45
1941	0.72	0.50
1943	1.06	0.78

These rates are not entirely relevant to costing since much of the work was often done by contract.

Figures are summarized in Table 1 by cycles, each compartment being treated in turn and (usually) once only in each cycle. Sales of produce took place only in the year of treatment. Thinnings and cleanings in

Table 1.—Net Cost of Improvement Operations in Dollars per Acre
(Costo Neto en Dólares por Acre de las Operaciones de Mejora)

Compt.	Area	1st. Cycle, 1933-37 (le . Ciclo, 1933-37)			2nd. Cycle, 1938-42 (2do. Ciclo, 1938-42)			Thinnings & Cleanings 1941-42 (Aclareos y Limpias, 1941-42)			Total Net Cost to date (Costo hasta la fecha)
		Exp. (Gastos)	Rev. (Imp.)	Net Cost (Costo Neto)	Exp. (Gastos)	Rev. (Imp.)	Net Cost (Costo Neto)	Exp. (Gastos)	Rev. (Imp.)	Net Cost (Costo Neto)	
	Acres	$	$	$	$	$	$	$	$	$	$
1b	34.8	2.00	-	2.00	3.81	2.64	1.19	3.55	1.92	1.63	5.32
2	29.0	2.17	-	2.17	3.19	1.78	1.41	.06	.13	.07	3.51
3	139.5	2.00	-	2.00	2.49	2.54	.05	4.42	.73	3.69	5.64
4	36.5	2.54	.17	2.37	3.50	3.87	.37	-	-	-	2.00
5	46.5	2.16	.27	1.89	2.60	2.31	.29	-	-	-	2.18
6	83.5	2.17	.12	2.05	3.09	1.07	2.02	-	.01	.01	4.06
7	50.0	2.20	.67	1.53	1.68	1.37	.31	.45	.79	.34	1.50
8	70.8	2.01	.02	1.99	3.04	2.08	.96	-	-	-	2.95
9	51.5	2.19	.09	2.10	6.01	1.70	4.31	-	-	-	6.41
10	65.4	2.20	-	2.20	10.30	4.06	6.24	-	-	-	8.44
11	85.5	2.20	-	2.20	*	*	*				
12	62.0	2.00	-	2.00	10.40	4.95	5.45	-	-	-	7.45
13	77.5	2.20	-	2.20	7.58	4.70	2.88	-	-	-	5.08
										(Promedio) Average	4.83

* Not completed
(Sin terminar)

1941-42 refer to additional work done in a few compartments in response to a special local demand for produce. The outturn consists largely of cordwood, sold as firewood or for burning into charcoal, at the rate of 60 cents per cord of 128 stacked cubic feet. Increasing numbers of small poles are being sold and fetch from 8 to 12 cents each.

The work at MacNair has always been very strictly related to costs and the intensity of work done has been regulated so as not to exceed a certain fixed net expenditure. At first the aim was do such work as would involve a net expenditure of not over $2.00 per acre per cycle. With increasing labour costs, particularly towards the end of the second cycle (Cpts. 9-13) this basic figure has had to be raised but still remains reasonably low. It would of course be possible to do much more intensive work and thus accelerate regeneration, but speed for its own sake is no object. Also, increasing haste increases costs in something like geometric progression. To halve the regeneration period would probably multiply costs four times. The aim of these operations is to produce a timber crop on degraded land at low cost by utilizing nature's own slow but sure processes.

In Trinidad, it costs about $25 per acre, net, to establish teak plantations and about $30 to $40 for rapid establishment of young mixed stands of native species under shelterwood by mixed artificial and natural regeneration. Compartments 1, 2, 3, and 5 are already considered established at MacNair and their average net cost has been $4.70 per acre.

Nature of the Present Crop

The present crop at MacNair shows some interesting variations and rewards detailed consideration on an ecological basis. Great modifications in the original forest had already taken place by 1932 and further changes have occurred since then in response to natural succession and the silvicultural operations. The present crop is, therefore, an expression both of history and the environment. It may conveniently be considered in detail by compartments: (see Fig. 1).

Compartment 1a

Area approximately 15.5 acres. Piarco sand. This is filled partly by plantation, partly by experiment plots and partly by untreated lastro (secondary bush). The plantation (4.5 acres) was formed in 1931-32 by sowing and planting _Pentaclethra macroloba_, _Carapa guianensis_ and _Calophyllum lucidum_ on degraded grassy land. The crop now consists of healthy poles some 30 to 35 feet in height. The soil has been considerably improved and carries a good layer of humus.

Compartments 1b, 2, 3, and 5

Area approximately 250 acres. Piarco sand. The crop consists of a low light shelterwood formed principally of coppice and pollard shoots mainly of Terminalia obovata in association with _Didymopanax morototoni_, _Cordia_ spp., _Pentaclethra macroloba_, _Parinari campestris_, _Byrsonima spicata_ and Maximiliana elegans. Accessory species are Pisonia eggergiana, Amaioua corymbosa, Protium guianense, Coccoloba latifolia, Rollinia mucosa and Melastomaceae. There is much razor grass but little herbaceous ground cover. Below the shelterwood is a well-established crop of mixed natural regeneration of Manilkara bidentata, Carapa guianensis, Vitex divaricata, Calophyllum lucidum, Eschweilera subglandulosa, Didymopanax morototoni, Nectandra surinamensis, Terminalia obovata, Tabebuia serratifolia, Byrsonima spicata and Hieronyma caribaea - Eschweilera subglandulosa and Terminalia obovata being much the commonest species. The regeneration varies from small plants under 5 feet in height to poles 4 to 5 feet in girth, with an average stocking of 262 young trees per acre or a spacing of about 14 feet apart.

Compartments 4, 6a, 6c, 6e, 7a, and 8a

Area approximately 190 acres. Piarco sand, Talparo clay, red-weathered phase, and mixed Las Lomas loam and Piarco sand. The crop here is of essentially the same composition as described above, except that Pithecolobium jupunba and Byrsonima spicata vie for dominance with Terminalia obovata and that the regeneration, while present is too small to be considered established, the whole crop being smaller.

Compartments 6b, 6d, 8b, and 8c

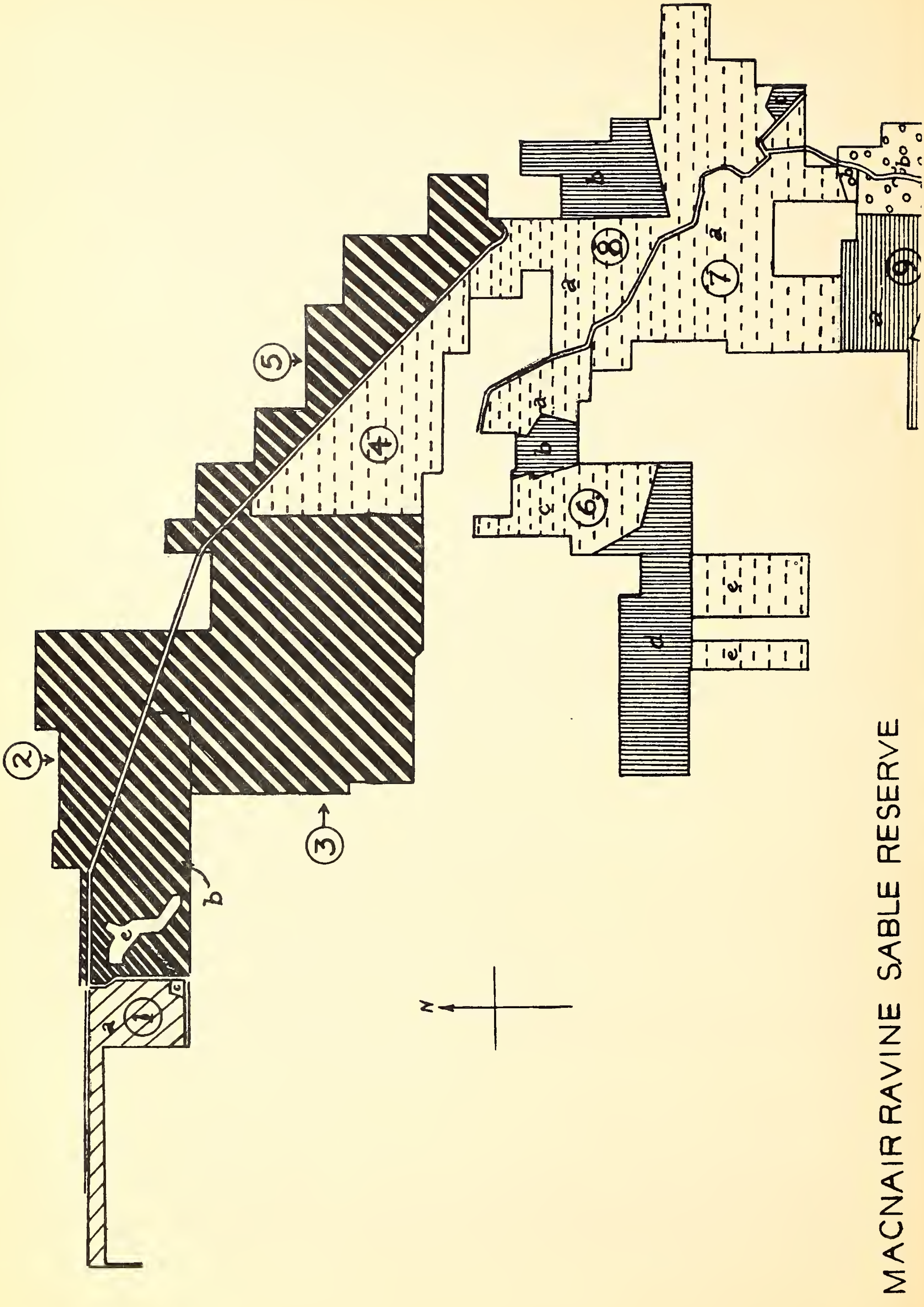
Area approximately 55 acres. The crop while showing affinities to the above, is a poor lastro (secondary bush) showing the effect of recent fires and consists chiefly of Cecropia peltata, Cordia cylindrostachya, Coccoloba latifolia, Pentaclethra macroloba, Terminalia obovata, Cordia spp., Laetia procera, Amaioua corymbosa and Ficus sp. No regeneration can be considered as effectively present.

Compartments 9a, and 10a

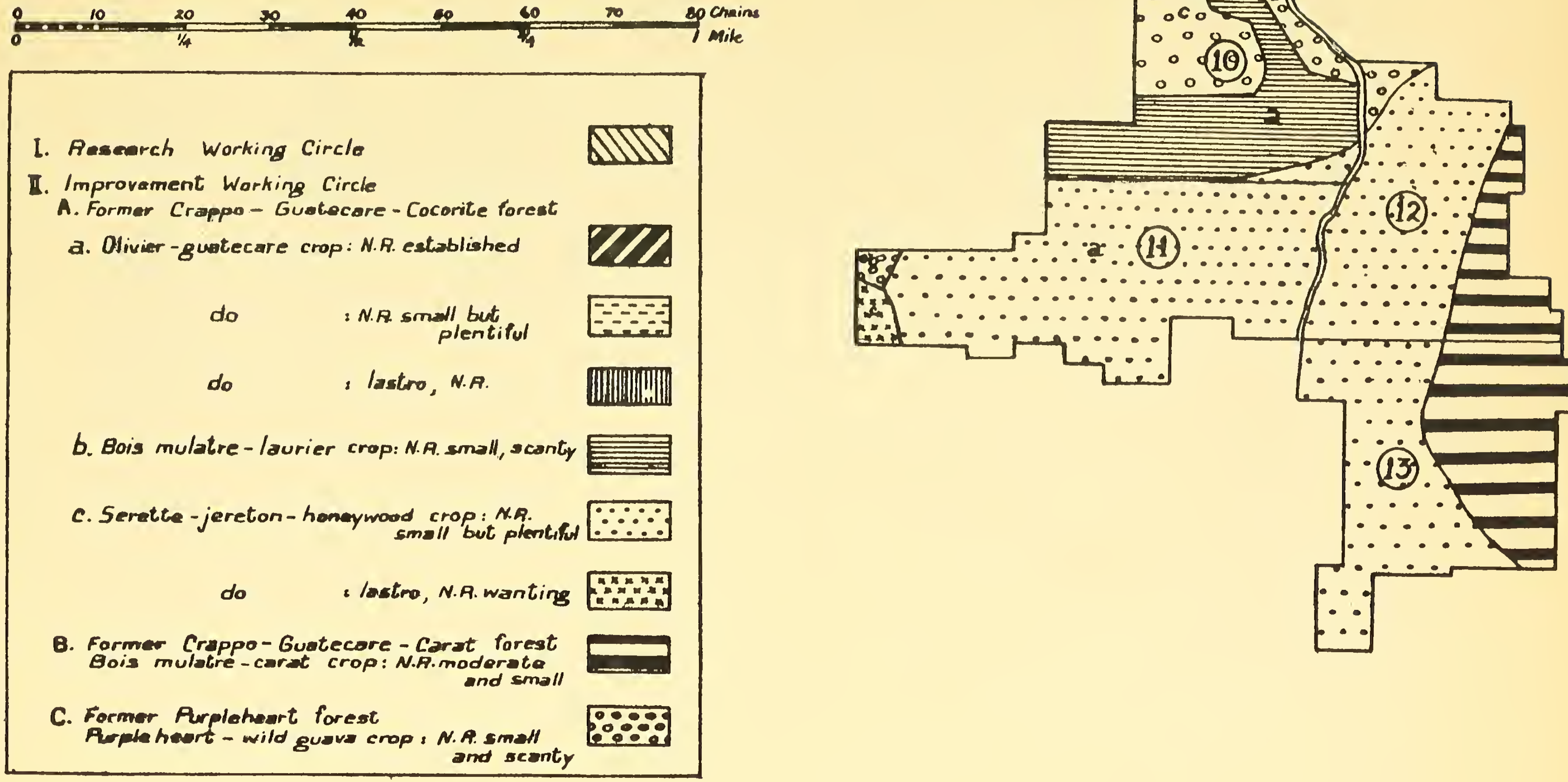
Area approximately 72 acres. Arena sand, steep phase, Talparo clay, red-weathered phase, Las Lomas loam, and mixed Las Lomas loam and Piarco sand. A tall and open shelterwood of Pentaclethra macroloba, Nectandra and Ocotea, Carapa guianensis, Inga spp., Duguetia lucida, Pachira insignis, Tabebuia stenocalyx, Sterculia caribaea, Spondias mombin, Ormosia monosperma, Parinari campestris etc., with accessory species Rudgea freemani, Brownea latifolia, Aegiphila integrifolia, Diospyros ierenensis and Myrtaceae spp. and a very dense ground cover of Heliconia spp. and similar herbaceous plants. There is no razor grass. Regeneration is not very plentiful but includes Cedrela mexicana, Vitex divaricata, Eschweilera subglandulosa, Aniba panurensis, Nectandra martinicensis and Tabebuia serratifolia, too small to be considered established.

Compartments 7b, 9b, 9c, 10b, 10c, 11b, and 12b

Area approximately 50 acres. Talparo clay, red-weathered phase, Las Lomas loam, and Arena sand, steep phase, and Calcareous clay. These areas were formerly the Peltogyne porphyrocardia type of forest. The crop consists of high, open shelterwood containing overmature Peltogyne porphyrocardia, Spondias mombin, Copaifera officinalis, Mouriri marshallii, Vitex


MACNAIR RAVINE SABLE RESERVE
N
1
2
3
4
5
6
7
8
9

STOCK-MANAGEMENT MAP



capitata, Eschweilera subglandulosa and Albizzia caribaea, over a fairly thick understory of Coccoloba latifolia, Myrtaceae spp., Warszewiczia coccinea, Brownea latifolia, Coccoloba fallax, Mouriri rhizophoraefolia and Erythrina pallida. There is little or no ground vegetation. Regeneration is not plentiful but includes Manilkara bidentata, Cedrela mexicana, Vitex capitata, Eschweilera subglandulosa, Didymopanax morototoni, Hymenaea courbaril, Terminalia obovata, Tabebuia serratifolia and Platymiscium trinitatis, too small to be considered established.

Compartments 11a and western Portions 12a and 13

Area approximately 158 acres. Arena sand, steep phase, Talparo clay, red-weathered phase, and Arena sand, flat phase. Developed mainly upon the Arena sand, the crop here is strongly reminiscent of Arena Reserve and responds in the same way to silvicultural treatment. The crop consists of a light shelterwood of poles up to 5 feet in girth and 60 feet high containing Byrsonima spicata, Didymopanax morototoni, Pentaclethra macroloba, Alchornea glandulosa, Nectandra surinamensis, Terminalia obovata and Pera arborea. Ryania speciosa is a conspicous undershrub and there is little or no ground vegetation except for occasional Ischnosiphon arouma. Razor grass is absent. Exceedingly copous natural regeneration has come in of Byrsonima spicata, Didymopanax morototoni, Tabebuia serratifolia, Hieronyma caribaea, Nectandra and Ocotea, Eschweilera subglandulosa and Vitex spp., but is as yet too small to be considered established.

Compartment 11c

Area approximately 2.77 acres. Arena sand, steep phase, and Talparo clay, red-weathered phase. A secondary bush ("lastro") type of the preceding, without much regeneration.

Compartments 12a, and 13 (eastern portions)

Area approximately 60 acres. Talparo clay, red-mottled phase. This area which was formerly the Carapa-Eschweilera-Sabal type of forest has not been placed in separate sub-compartments since the boundary is not a distinct one on the ground and since the type of regeneration is the same as on adjoining areas though less plentiful. The crop consists of a light shelterwood in which Pentaclethra macroloba predominates together with Pachira insignis, Carapa guianensis, Laetia procera, Nectandra and Ocotea, Sterculia caribaea, Tabebuia serratifolia and Warszewiczia coccinea. Regeneration is moderately plentiful and consists of the same species as in Compartments 11a and the adjoining areas of 12a and 13.

Compartments 1e

Area approximately 2.5 acres, unproductive. This is a swamp containing Symphonia globulifera and Virola surinamensis and has not been treated silviculturally.

Classification of Regeneration Crops

It will be clear from the above description that the present crops differ rather more widely from one another than did the original vegetation types. Characteristic crops can be traced as descending from the original purpleheart (Peltogyne porphyrocardia) (Compts. 7b etc.) and crappo-guatecare-carat (Carapa-Eschweilera-Sabal) (Eastern 12a and 13) types, characterized on Fig. 1 as the purpleheart-wild guava (Peltogyne-Myrtaceae) and bois mulatre-carat (Pentaclethra-Sabal) crops respectively. Present crops originating from a crappo-guatecare-cocorite (Carapa-Eschweilera-Maximiliana) association have been moulded by history and environment into three quite distinct crop-types: the olivier-guatecare (Terminalia-Eschweilera) crops of Compartments 1-8, the bois mulatre-laurier (Pentaclethra-Nectandra) crop of Compartments 9a and 10a and the serrette-jereton-honeywood (Byrsonima-Didymopanax-Alchornea) crop of Compartments 11a and western 12a and 13. The first of these, marked by the dominance of olivier (Terminalia obovata), occurs on the flat and hogwallowed or gently sloping land of the Piarco Sand and Piarco-Las Lomas catena in the north of the reserve, where quite a characteristic flora has developed, doubtless influenced by the shifting cultivation and burning the area has undergone. Regeneration mainly of olivier (Terminalia obovata) and guatecare (Eschweilera subglandulosa) coppice, is plentiful and the most advanced young crops are to be found here. The bois mulatre-laurier (Pentaclethra-Nectandra) crop is found on moist Las Lomas and Talparo Clay sites in the center of the Reserve. A dense herbaceous ground-layer is characteristic, and may well be partly responsible for the relative lack of regeneration. The serrette-jereton-honeywood (Byrsonima-Didymopanax-Alchornea) crop is associated with the Arena Sand, free draining and without much ground vegetation. Natural regeneration of good species comes in very readily under shelterwood here and even in the pre-existing secondary pole crop there are many natural groups of well formed serrette (Byrsonima spicata) and jereton (Didymopanax morototoni).

One of the most important considerations is that regeneration of desired species comes in readily on sands - very well on free draining sands, fairly well on poorly drained types - but only to a limited extent on clays. The reason for this is not at present known. Liability to dry out and to waterlog are no doubt important factors, and also the nature of the ground vegetation.

Statistics

Table 2 summarizes the natural regeneration up to 1 feet girth disclosed by enumeration surveys in which strips 10 feet wide were enumerated on the sides of lines cut in each compartment.

Discussion

The salient point of the silvicultural results, which is confirmed by experience elsewhere in Trinidad, is that natural regeneration occurs very readily on sandy soils - or on soils which at least are sandy in the upper horizon - but relatively weakly on clays, particularly heavy clays.

The species which regenerate are different on these two soil groups and this in spite of the fact that the original forest type of both sand and clay may have been identical. On sandy soils a timber forest usually grows back somewhat rapidly, but on clays there is a lengthy stage where the worthless Cecropia, Ochroma, Vismia, and Guazuma are the chief tree species and the ground is thickly covered with Heliconia and other herbaceous vegetation. Research is indicated into the reasons for this difference in behaviour, which are not at present known. It is probable that the heavy, impermeable clays hold up too much water at the surface and cause the seed to rot, but it is equally possible that much mortality occurs in the seedling stage.

A factor equally important to regeneration is the seed dispersal mechanism of the different trees. Those which spring up most readily are, naturally, those whose seeds are easily distributed. Among the "valuable" species at MacNair, Terminalia, Tabebuia and Cedrela have winged seeds widely dispersed by wind and the seed of Byrsonima, Didymopanax, Hieronyma and Lauraceae are distributed by birds and bats. These species regenerate much more copiously than the remainder in the list of "valuables" which have relatively large and heavy seeds without any natural dispersal mechanism.

It is also necessary to consider the particular niche in succession which a species occupies. Some are the natural pioneers of bare land, others belong to a secondary stage when high forest is being recreated and yet others belong only to the climax association and are the last to appear. There is usually a rough correlation between seed dispersal and place in succession, those of the first stage being the most readily distributed and vice-versa. Generally also the members of the first stage are without value and the most valuable timbers are to be found in the final and climax stage. It will, clearly, be considerably easier to regenerate species whose niche is in an early stage of succession. Nobody in the West Indies should have any trouble in producing a pure stand of Cecropia peltata, but such pioneers are not always desirable. It is generally the best principle in natural regeneration operations to select as a compromise species of reasonably good timber appearing at a reasonably early stage, thus striking a balance between quality and time. In Trinidad, Byrsonima spicata, Didymopanax morototoni, Hieronyma caribaea, Tabebuia serratifolia and Terminalia obovata regenerate readily and are fast growing in their early stages: one is a first quality hardwood, three are medium quality hardwoods and one a medium quality softwood. These are relied upon to provide the principal portion of the crop and such admixture of other more valuable species as will appear is carefully fostered.

The rate at which the recreative process in degraded forest protected and treated by improvement operations takes place will depend in most cases upon the degree of initial degradation. Land that has been intensively burned and over-cropped for many years will recover more slowly to start with than an area less greatly disturbed. In Trinidad there has been no experience in the treatment of eroded land. At MacNair the ground is generally somewhat flat and no appreciable erosion appeared to have taken place. The soil was basically poor in mineral nutrients and had been

Table 2.—Natural Regeneration up to 1 foot Girth
(Regeneración Natural hasta 1 pie de Circumferencia)

Compt.	Height in Feet (Altura en Pies)				Total	Length of line (Largo de la línea)	Number per Acre (Número por Acre)		Equivalent Spacing in feet square (Espaciamiento equivalente en pies cuadrados)	
	5' & less (5' o menos)	5' 1" -10'	10' 1" -15'	15' 1" & over (15' 1" o más)			Total	Over 5' (Más de 5')	Total	Over 5' (Más de 5')
	No. (Núm.)	No. (Núm.)	No. (Núm.)	No. (Núm.)	No. (Núm.)	Chains (Cadenas)	No. (Núm.)	No. (Núm.)		
1b	11	17	17	13	58	8.00	239	194	13.5	15.0
2	28	42	30	29	129	15.25	279	219	12.5	14.1
3	42	66	54	46	208	32.50	211	169	14.4	16.0
4	52	28	22	37	139	19.65	233	146	13.7	17.3
5	25	17	26	22	90	13.50	220	159	14.1	16.6
6	5	5	7	11	28	7.35	126	103	18.6	20.6
7	21	15	27	37	100	18.75	176	139	15.7	17.7
8	51	20	22	19	112	18.00	205	112	14.6	19.7
9	79	16	23	31	149	22.00	223	105	14.0	20.4
10	155	25	16	36	232	27.00	284	94	12.4	21.5
11	53	20	34	24	131	16.30	265	158	12.8	16.6
12	71	25	41	41	178	19.00	309	186	12.0	15.3
13	146	32	37	45	260	28.00	306	134	12.0	18.0

exhausted of its humus, but the effect of the approach of bedrock to the surface which is usually associated with eroded lands was not present.

During the present year it is hoped to repeat these operations experimentally in some of the Windward and Leeward Islands. Here there are two main types of site to be treated: dry, eroded hillsides in the lowlands, covered with poor, deciduous bush and with little soil remaining, and secondary woodland in wet mountain areas that have suffered from the shifting cultivator. In the former case there are indications that once the lands are closed and protected rapid invasion by Tabebuia pallida and Swietenia mahagoni can be expected. In the mountains, secondary woodlands usually contain naturally a high proportion of Simaruba amara and various species of Lauraceae, a proportion which it should be practicable to increase. All of these species are fast-growing (for their site) and of considerable timber value.

The particular advantage of natural methods for the treatment of degraded woodlands is the absolute certainty of obtaining results of some kind. One is encouraging natural processes all the time and at the very least at the end of a period of years the formerly degraded area will carry a much better growth than at the beginning, even if not fully stocked with valuable species: and the expenditure will have been small. On really degraded sites ecological conditions have become so adverse and balances so upset that artificial methods may be demanding the impossible, demanding of the planted stock a tolerance which it cannot hope to possess. There is no certainty in artificial regeneration under such circumstances. It is invariable costly and if it fails the last state may well be worse than the first, due to the additional interference tendings have necessitated. The additional time required by natural methods is surely of no consequence in forestry where rotations run to 60, 80, 100, or more years, and in any case the experience at MacNair has shown that this time lag is by no means as great as is generally supposed. Tropical forestry, in nearly every country in which it has been proctised (and Trinidad is no exception), has suffered in its youth from a disease that has been called "planting measles", a fixed idea that it was necessary to start forming plantations at great speed all over the place, often without any previous research. After the wastage of much money the programme is revised in favour of less costly, more natural methods based on careful experiment.

(Traducción del artículo anterior)

UNA TECNICA SILVICULTURAL DE LA ISLA DE TRINIDAD

PARA LA REHABILITACION DE BOSQUES DEGRADADOS

En disertaciones que aparecieron previamente en esta revista se describieron varias técnicas, prácticas y experiencias silviculturales usadas en Trinidad. Todas han tenido que ver con lo que constituye la actividad silvícola primordial en esa isla; la regeneración de los montes altos. Sin embargo, en una localidad en Trinidad se están llevando a cabo actividades de índole algo distinta y durante la década pasada se ha ido desarrollando gradual y experimentalmente un sistema para la rehabilitación y regeneración de los montes degradados. Uno de los problemas dasonómicos de más alto alcance hoy día en la América tropical consiste en el tratamiento adecuado de las áreas que han sido arruinadas por el fuego y la agricultura nomádica. Debido al hecho de que se ha alcanzado considerable éxito en la solución de este problema en Trinidad, la descripción del progreso obtenido hasta la fecha puede servir de ayuda a los demás investigadores.

El trabajo se llevó a cabo en la Reserva Forestal "MacNair Ravine Sable", una masa arbolada, irregular, de cerca de 863 acres, situada en la meseta norte de Trinidad aproximadamente a 15 millas al sudeste de Puerto España y 5 millas al oeste de la Reserva Forestal Arena.

La selva virgen que existía originalmente en esa localidad se conservó inalterada probablemente hasta fines del siglo pasado. A principios de este siglo casi todo el área fué vendido a la Corona en lotes de 5 a 20 acres para colonización agrícola de los indios orientales principalmente y la Corona sólo retuvo algunos macizos forestales pequeños. Como ha pasado en un gran porcentaje de las adquisiciones de tierras en Trinidad resultaba, desgraciadamente, que el terreno era infértil y totalmente incapacitado para el cultivo agrario permanente. Los terratenientes convirtieron el bosque original en carbón, luego sembraron cultivos agrícolas y trataron de cosechar cacao, aunque sin éxito. Después de ésto comenzó un régimen de cultivos nomádicos o de conuco por el cual se talaban las parcelas periódicamente para obtener carbón y luego se sembraba maíz sin aplicar abono alguno. Incendios en períodos frecuentes arrasaban el área y eventualmente muchas de las parcelas fueron totalmente abandonadas y pasaron otra vez a poder de la Corona, embargadas por falta de pago de las contribuciones.

En el 1930 se llamó la atención hacia las penalidades sufridas por los campesinos del condado de Caroni debido a la escasez de productos forestales, ya que casi todas las tierras del condado habían sido vendidas y quedaban muy pocos bosques. Por lo tanto se decidió establecer una reserva forestal en MacNair Ravine Sable con los macizos forestales que aún pertenecían a la Corona, junto con las parcelas embargadas. Entre el 1931 y el 1933 se hizo un reconocimiento y demarcación de la proyectada reserva forestal, que fué finalmente constituída en el 1934.

Descripción de la Reserva

A continuación aparece una descripción completa de la Reserva:

Topografía

La tierra en la mitad norte de la isla es algo llana y consiste de bancales aluviales de la Edad Pleistocena seccionados por hondonadas en forma de V. En la mitad sur la formación miocénica (arenas y arcillas) es bien perceptible y el terreno es de relieve ondulante. A través de toda la isla la elevación varía entre los 50 y 200 pies sobre el nivel del mar. Los sitios llanos tienen drenaje deficiente y tienden a empantanarse en la estación lluviosa.

Suelos

Las siguientes descripciones de los tipos edáficos fueron suministrados por el Dr. E. M. Chenery, Químico de Suelos del Gobierno de Trinidad.

Arena Piarco.— Arena liviana, grisácea y de contextura suelta, con un subsuelo arcilloso o arcilloso-lómico, compacto, impermeable, moteado de rojo y blanco y situado a 1 ó 2 pies de profundidad. La transición entre un horizonte y otro es abrupta. Este suelo está asociado con la llanura norte de la Reserva. La superficie del terreno es marcadamente hoyosa.

Suelo Lómico Las Lomas.— Suelo lómico moteado de anaranjado a rojo y blanco, algo tenaz e impermeable. Está asociado con terrenos más ondulantes que los de Arena Piarco pero hay una zona intermedia en que los dos tipos de suelos se alternan en cadena, con Piarco en las cimas llanas y Las Lomas en las laderas.

Arcilla Talparo.—Arcilla casi pura, muy pesada y generalmente de color rojo moteado brillante en los primeros tres pies de profundidad, tornándose albariza más abajo. Pueden distinguirse dos fases: la rojiza y la rojo-moteada. El color es menos pronunciado en la segunda lo que indica probablemente menor grado de acidez y aeración defectuosa.

Arcilla Calcárea.—En el Toby-Hercules Trace se encuentra un pequeño trecho de arcilla calcárea de color amarillo-verdoso.

Arena Sand.— Esta arena es profunda, suelta, de drenaje libre y de color gris. Se puede dividir en dos fases: una fase lisa y una pendiente, dependiendo de la naturaleza de la topografía. Los límites entre este tipo de arena y la arcilla Talparo no están bien delimitados ya que existe una zona intermedia en cadena, con las cimas de las lomas cubiertas de arena y las laderas cubiertas de arcilla.

Con excepción de la arcilla calcárea, que ocupa un área muy limitada, todos estos suelos se derivan de rocas sedimentarias deficientes en los nutrimentos esenciales a las plantas y, por lo tanto, no están capacitadas para los actuales sistemas de producción agrícola.

Precipitación

Por espacio de 8 años (1935-42) se ha llevado un registro de la precipitación en la Reserva y a continuación expresamos los promedios mensuales para ese período. (Véase la página 3)

La división climatérica del año es como sigue: estación seca, comprendida desde enero hasta abril y la estación lluviosa desde mayo hasta diciembre.

Sistema de Comunicaciones

El sistema de comunicaciones consiste de: una carretera afirmada que se extiende a una milla de la extremidad norte de la Reserva y otra a dos millas de la extremidad sur. Varios caminos para carretas atraviesan la Reserva y van a unirse a las carreteras afirmadas.

Utilización de los Productos

La población local es eminentemente agrícola, cultivando con especialidad la caña, y de descendencia india, tanto oriental como occidental. Las aldeas de Chaguanas, Longdenville y Cunupia y los poblados de Madras y Las Lomas están bastante cerca de la Reserva. Existe una considerable demanda de carbón, leña, zocos, varas y cañas para techar, etc., más bien puede decirse que es difícil obtener cualquier clase de madera. Por lo tanto la Reserva MacNair Ravine Sable, al estar situada en un distrito donde los terrenos disponibles han sido desforestados y malversados, se halla en condiciones ideales para disponer de los productos que en ella puedan cosecharse. Además, la zona MacNair está a 20 millas de Puerto España.

Vegetación Primitiva

Hasta fines del siglo pasado la vegetación de este área se había conservado prácticamente inalterada. Debió predominar la formación ecológica conocida como bosque estacional perennifolio, pero la precipitación de la localidad es casi marginal para este tipo, de manera que en los sitios más secos, o sea en las cimas de las colinas de suelo arcilloso duro, parece que hubo un cambio local a bosque estacional semiperennifolio. Este último bosque consistía de una asociación Peltogyne y el primero de una asociación Carapa-Eschweilera, que podía dividirse en una fase Sabal manifiesta en los suelos arcillosos más secos y ligeros y una fase Maximiliana en las arenas, suelos lómicos y en las arcillas ácidas y húmedas. La alternancia de estos tipos dependía de las condiciones de humedad conjuntas, es decir, de la acción recíproca mútua de la precipitación, topografía y naturaleza física del suelo, pero no estaba directamente relacionada con ninguno de estos factores por separado. En general, los bosques de la asociación Carapa-Eschweilera-Maximiliana ocupaban los sitios más húmedos; los bosques de la asociación Peltogyne los sitios más secos y la asociación Carapa-Eschweilera-Sabal aparecía en las zonas de humedad intermedia.

Las principales esencias forestales comprendidas en los tipos forestales arriba expresados debieron ser como sigue:

Carapa-Eschweilera-Maximiliana (Crapo-guatecaro-cocurito). (Véase la lista de especies en la página 4).

Carapa-Eschweilera-Sabal (Crapo-guatecaro-carat). (Véase la lista de especies en la página 4).

Peltogyne (palo morado). (Véase la lista de especies en la página 4).

Ordenación Dasocrática

Cuando se constituyó la Reserva en el 1934, la vegetación forestal acusaba un alto grado de degradación en todos sitios. Toda la parte norte, que hoy comprende los compartimientos del 1 al 8, consistía de terrenos agrícolas abandonados, en los que fuegos, podas y cultivos frecuentes habían desgastado el suelo por completo, de tal manera que ahora sólo estaba cubierto de una maleza baja, de menos de 20 pies de altura, sin valor y constituída en su mayoría de resalvos. Lianas y yerba cortadera (Scleria) entrelazaban el matorral, que contenía pocas especies valiosas pero gran abundancia de palmas cocurito, Maximiliana elegans. La parte sur (Compartimientos del 9 al 13) consistía de los terrenos que habían sido propiedad de la Corona, los que nunca se habían cultivado pero sí talado y quemado intensamente redundando en el estado ruinoso actual.

En el 1931 se comenzaron las operaciones silviculturales en el área de la Reserva. El objetivo inmediato del plan dasocrático era el de mejorar la masa forestal existente de manera que fuera capaz de rendir por lo menos postes pequeños y leña. El objetivo final era crear un bosque normal capaz de suplir madera.

El procedimiento más obvio era eliminar la maleza y sembrar árboles de nuevo. Sin embargo, en las áreas degradadas el crecimiento de los árboles es siempre lento y las malas yerbas, en particular la yerba cortadera constituye un problema grave. Las plantaciones resultan costosas y difíciles de establecer a menos que no se pueda utilizar una especie de crecimiento rápido. No se ensayó con la teca, a pesar de que además de ser un árbol de crecimiento rápido, ha sido utilizado con éxito en Trinidad, debido al hecho de que es hostil a los suelos que aquí predominan, los cuales sufren de obstaculización en el avenamiento del subsuelo. Del 1931 al 1933 se llevó a cabo la siembra de otras especies principalmente nativas pero esta práctica no se continuó en lo sucesivo.

En 1931 y 1932 se sembraron semillas de Carapa guianensis y Pentaclethra macroloba en suelo gramíneo degradado. Después de una iniciación lenta, para el 1942 se había desarrollado un latizal de 20 a 30 pies de altura.

En el 1932 se ensayó con 15 especies diferentes de Eucalyptus pero los resultados han sido tan poco promisorios que ninguno puede calificarse como un éxito. En 1933 se sembró un acre de Terminalia obovata con un espaciamiento de 8 x 8 pies y por el año 1942 estos árboles tenían una altura promedio de 25 pies y el más alto medía 40 pies.

En los primeros años el crecimiento de las especies sembradas en los diversos ensayos fué extremadamente lento. Se había escogido un área muy degradada, de matorral bajo lleno de yerbas y de Cordia cylindrostachya, y cuando éstas fueron eliminadas la radiación solar fué tan intensa que las hojas de los arbolitos fueron literalmente quemadas. Después de algunos años, cuando los arbolitos arraigaron y empezaron a cubrir el suelo, el crecimiento fué bastante rápido; pero al principio, los plantones de estas especies que bajo condiciones naturales crecen en el medio estacional húmedo y uniforme que forma la cubierta forestal no pudieron sobrellevar la severidad de una exposición completa al sol. El lector debe referirse a los experimentos llevados a cabo en la Reserva Arena, descritos por R. L. Brooks en los cuales se encontró que el índice térmico era el doble en los claros que bajo la cubierta forestal, la evaporación del aire era de 3 a 5 veces mayor, y el grado de exposición al sol era 12 veces mayor. La destrucción de la cubierta arbórea trae como resultado una deterioración inimaginable del micro-ambiente.

Desde el 1932 se ensayaron métodos naturales y dieron tan buen resultado que este tratamiento se extendió a toda la Reserva bajo Planes de Trabajo. El primer plan de trabajo estaba en vigor por el lustro de 1933-37 y fué continuado por un segundo plan de 1938-42. Hoy día está en vigor un tercer plan que termina en 1947. La teoría sobre la que descansan estas operaciones es la simple proposición de que "la naturaleza es una gran sanadora". Si se protege la vegetación secundaria contra interferencias subsiguientes, automáticamente se empezaría a desarrollar la clímax, a veces más despacio pero frecuentemente a razón no inconsiderable. Por lo tanto en vez de adoptar métodos de siembra elaborados y costosos sería preferible dejar que la naturaleza actuara, aportando sólo cierta ayuda que acelerara el progreso y ejerciera influencia sobre la composición natural de la cosecha. Al principio todo el trabajo fué experimental. El plan de trabajo inicial estaba formado por un Ciclo de Trabajo de Mejoramiento dividido en cinco cortas anuales que cubrían de 140 a 206 acres. A su vez cada corta era sometida a cortas de mejora, para las cuales el plan de trabajo proveía las siguientes prescripciones generales:

a. Cortar los bejucos y yerba cortadera.
b. Reducir el número de resalvos en las cepas de especies valiosas.
c. Alentar el desarrollo de los brinzales y latizales de especies valiosas reduciendo la competencia.
d. Erradicar las palmas.

El tratamiento detallado de cada corta anual fué especificado en un Plan Anual, siguiendo los principios arriba expuestos pero basados en un examen detallado de la corta y en las experiencias adquiridas en las cortas previamente efectuadas. En el estado inicial el corte de bejucos y yerba cortadera era la operación más importante pues evitaba que éstos sobrecargaran las copas de los árboles restringiendo y deformando su desarrollo.

Su eliminación permitía que la cosecha progresara. A las palmas Maximiliana se las envenenaba al principio pero se determinó que era más económico y más eficiente cortarlas.

Bajo el segundo plan de trabajo se volvían a tratar las mismas zonas de corta. Las operaciones tenían como objetivo alentar la regeneración natural existente, encarrilar nueva regeneración natural y desarrollar un sólo resalvo de cepa por tocón y podrían describirse como sigue:

a. Cortando los resalvos y brotes en demasía de las especies valiosas, reteniendo el mejor en cada caso.
b. Aclarando y limpiando las otras especies del cultivo a tal grado que ayudase al desarrollo de la vegetación natural existente y a la aparición de nueva vegetación, pero conservando siempre una copa forestal suficiente que mantuviese a raya las yerbas y bejucos.

Durante el primer ciclo, todo el trabajo se llevó a cabo sin contrato de trabajo y se obtuvo pocos productos. Se vendieron algunos postes pequeños, varas y remanentes de madera. Durante el segundo ciclo se pudo obtener una gran cantidad de madera del tamaño de postes y la mayoría del trabajo fué efectuado por carboneros. La corta a efectuarse fué inspeccionada primero por el Oficial Forestal a cargo, quién señaló lo que debía cortarse y aclararse. Después los carboneros (y a veces los traficantes en carbón) cortaban los postes luego de pagar una pequeña suma por estas utilidades. Los carboneros apilaban la leña in situ y la quemaban para producir carbón. Había una demanda tan grande de productos madereros en esta localidad y de carbón en Puerto España (que está cerca de allí) que se vendió la más mínima vara de madera disponible. Al terminar los carboneros, los trabajadores limpiaron los sitios y cortaron las lianas y las palmas.

Para dar un ejemplo del trabajo logrado presentaremos en detalle el que se efectuó en un compartimiento - el número 3.

1933.— El compartimiento fué ligeramente desmalezado: se eliminaron los bejucos y yerba cortadera. No se cortaron los resalvos y brotes en exceso en una misma cepa.

1938.— Se marcaron y los carboneros apearon los resalvos y brotes en exceso en las copas y los tallos de especies sin valor que interferían con la regeneración de las especies valiosas. Se cortaron los bejucos y yerba cortadera y el área se ordenó un poco.

1941.— Se cortó otra vez la yerba cortadera y los bejucos y se removieron los árboles sueltos que interferían con la vegetación joven.

1942.— Para suplir la demanda de postes y leña se marcaron y apearon otros fustes indeseables que fueron acarreados por los compradores.

Bajo el plan de trabajo actual, se ha continuado la misma política ya que "los resultados previos han indicado que se produjo y se está produciendo una excelente cosecha de regeneración natural bajo el sistema de cortas de abrigo". Bajo el plan de trabajo, los compartimientos 1, 2, 3, y 5 se consideran como "regenerados", es decir completamente provistos de una cosecha de postes de especies valiosas. Durante el presente período de cinco años se confía que el resto de la Reserva, con excepción de los compartimientos 9 y 10 y algunos acres en los compartimientos 6 y 8 progresarán hasta el estado de "regenerados". Los compartimientos 9 y 10 contienen algunos suelos arcillosos donde la regeneración tardó en aparecer y las porciones del 6 y 8 estaban cubiertas por una maleza excesivamente degradada que había sido quemada repetidamente y que ha recuperado con suma lentitud.

En los compartimientos ya regenerados, sólo se efectúan aclareos. El Técnico Forestal marca los postes que han de removerse, tratando un compartimiento cada año y luego los compradores se encargan de cortarlos. Para ganar acceso a los árboles los compradores cortan la yerba cortadera y los bejucos, operación que resulta beneficiosa al monte y podemos decir entonces que estos compartimientos han llegado ya al estado ganancioso al cabo de sólo diez años.

En el resto de los compartimientos (excepto el 9, 10 y parte del 6 y 8) las operaciones de mejora del último período se están repitiendo con la ayuda de los carboneros. En los poco promisorios compartimientos 9 y 10 y en las porciones del 6 y 8 debemos elegir entre esperar más aún porque recupere la vegetación natural o recurrir a medios artificiales. Este último recurso ha sido aceptado para los compartimientos 6 y 8 que suman 55 acres y en los cuales habrá de sembrarse principalmente *Terminalia obovata*, con alguna *Gmelina arborea*, *Tabebuia pentaphylla* (exóticas las dos) y *Calophyllum lucidum*. Se confía aún en que a la larga la reproducción natural habrá de regenerar estas áreas, pero como consisten de pequeños bloques en medio de vegetación en un grado más avanzado de crecimiento y como se intenta producir cosechas más o menos coetáneas, se ha recurrido a la siembra para igualar más los compartimientos. En los compartimientos 9 y 10 se ha prescrito que se investigue la ausencia de regeneración natural.

Al llevar a cabo los aclareos y limpias se determinó que es preferible que se desarrollen los brinzales a los brotes o resalvos y por lo tanto siempre se favorecen los primeros. Sin embargo, se decidió que durante el turno inicial se podían utilizar los resalvos donde fuera necesario, para producir rápidamente una cosecha de postes (que luego se tornaría en cosecha de madera) de especies valiosas mixtas. Las especies que se consideran "valiosas" aparecen en la página 8.

Economía

Un rasgo conspicuo de las operaciones efectuadas en la Reserva MacNair Ravine Sable ha sido su costo extremadamente bajo en relación con los resultados obtenidos. La Tabla núm. 1 sintetiza los gastos y rentas de cada compartimiento hasta la fecha, en dólares por acre. La unidad monetaria es el dólar de las Indias Occidentales Británicas, que corresponde a 4s. 2d. esterlinas y que en la presente valuación del intercambio monetario equivale a $1.17, dinero americano. Los jornales pagados a los trabajadores aparecen enumerados en la página 8. Estos jornales no son enteramente indicios del costo ya que la mayor parte del trabajo se hizo bajo contrato.

Las cifras que aparecen en la Tabla 1 en la página 9 están distribuídas en ciclos, cada compartimiento se ha tratado en orden cronológico y (casi siempre) sólo una vez en cada ciclo. Las ventas del producto se efectuaron sólo durante el año en que tuvo lugar el tratamiento. Los aclareos y limpias del 1941-42 se refieren a trabajo adicional que se hizo en algunos compartimientos como resultado de una demanda local especial de productos forestales. Los productos consistieron en su mayoría de leña apilada que se vendió como tal o para hacer carbón a razón de 60 centavos por cuerda (cord) de 128 pies cúbicos apilados. Cada día se vende mayor número de pequeños postes de 8 a 12 centavos cada uno.

El trabajo en MacNair ha estado siempre estrechamente relacionado con su costo y la intensidad del trabajo ha estado regulada de tal manera que no exceda ciertos gastos fijos estipulados de antemano. Al principio los gastos no podían exceder de $2.00 por acre por ciclo. Pero con la creciente alza en los jornales, particularmente hacia fines del segundo ciclo (compts. 9-13) esta cifra básica tuvo que aumentarse pero hoy día todavía se conserva razonablemente baja. Sería posible, desde luego, hacer trabajos más intensivos y así acelerar la regeneración pero la rapidez de por sí no es objetivo. Además, la aceleración causa el aumento del costo en escala geométrica. Al reducir en el doble el período de regeneración habría que multiplicar por cuatro el costo. El objetivo de estas operaciones es producir a bajo costo una cosecha forestal en las tierras degradadas utilizando los procesos lentos pero seguros de la naturaleza.

En Trinidad, el establecer una plantación de teca cuesta cerca de $25 por acre y el establecimiento de rodales jóvenes mixtos de especies nativas, bajo el sistema de cortas de abrigo con regeneración artificial y natural mixtas, cerca de $30 a $40. Los compartimientos 1, 2, 3, y 5 ya se consideran establecidos en MacNair y su costo promedio neto ha sido $4.70 por acre.

Naturaleza de la Cosecha Actual

En MacNair la cosecha actual ofrece algunas variaciones interesantes y merece ser considerada detalladamente desde el punto de vista ecológico. Ya para el 1932 habían surgido grandes modificaciones en el bosque original y desde entonces han ocurrido cambios posteriores como resultado de la sucesión natural y la acción de las operaciones silviculturales. La cosecha actual es, por lo tanto, una expresión tanto de la historia como del medio ambiente. La consideraremos en detalle, por compartimientos: (Véanse las páginas 12 y 13)

Compartimiento 1a

De aproximadamente 15.5 acres. Arena Piarco. Este compartimiento está parcialmente ocupado por una plantación, cuarteles experimentales y lastro (maleza secundaria) sin tratar. La plantación (4.5 acres) fué formada en 1931-32 por siembra y trasplante de Pentaclethra macroloba, Carapa guianensis y Calophyllum lucidum en terrenos herbáceos degradados. Hoy día la cosecha consiste de postes sanos de 30 a 35 pies de altura. El suelo se ha mejorado considerablemente y contiene una buena capa humífera.

Compartimientos 1b, 2, 3 y 5

De aproximadamente 250 acres. Arena Piarco. La cosecha consiste de un techo forestal bajo, formados principalmente por brotes y resalvos de Terminalia obovata en su mayoría, asociados con Didymopanax morototoni, Cordia sp., Pentaclethra macroloba, Parinari campestris, Byrsonima spicata y Maximiliana elegans. Las especies accesorias son Pisonia eggersiana, Amaioua corymbosa, Protium guianense, Coccoloba latifolia, Rollinia mucosa y Melastomaceae. Hay mucha yerba cortadera pero poca cubierta herbácea en el suelo. Debajo de los árboles padres existe una cosecha bien establecida de vegetación natural de Manilkara bidentata, Carapa guianensis, Vitex divaricata, Calophyllum lucidum, Eschweilera subglandulosa, Didymopanax morototoni, Nectandra surinamensis, Terminalia obovata, Tabebuia serratifolia, Byrsonima spicata, siendo Hieronyma caribaea-Eschweilera subglandulosa y Terminalia obovata las especies más comunes. La regeneración varía entre pequeños plantones de menos de 5 pies de altura hasta postes de 4 pies a 5 pies de circunferencia con un promedio de 262 árboles jóvenes por acre o sea un espaciamiento de 14 pies.

Compartimientos 4, 6a, 6c, 6e, 7a y 8a

De aproximadamente 190 acres. Arena Piarco. Arcilla Talparo de la fase rojiza y una mezcla de suelo Lómico Las Lomas y Arena Piarco. La cosecha aquí es esencialmente de la misma composición que la descrita anteriormente excepto que el Pithecollobium jupunba y Byrsonima spicata compiten con Terminalia obovata por la dominancia y en que la regeneración natural aunque presente es muy exigua para considerarse establecida.

Compartimientos 6b, 6d, 8b y 8c

De aproximadamente 55 acres. La cosecha, aunque demuestra ciertas afinidades con la anterior es un lastro (maleza secundaria) pobre, marcada por los fuegos recientes y consiste principalmente de Cecropia peltata, Cordia cylindrostachya, Coccoloba latifolia, Pentaclethra macroloba, Terminalia obovata, Cordia sp., Laetia procera, Amaioua corymbosa y Ficus sp. Ninguna regeneración puede considerarse como efectivamente presente.

Compartimientos 9a y 10a

De aproximadamente 72 acres. Arena Sand de la fase pendiente, Arcilla Talparo fase rojiza, suelo Lómico Las Lomas y una mezcla de suelo

Lómico Las Lomas y Arena Piarco. Una serie de árboles padres altos y abiertos de Pentaclethra macroloba, Nectandra y Ocotea, Carapa guianensis, Inga sp., Duguetia lucida, Pachira insignis, Tabebuia stenocalyx, Sterculia caribaea, Spondias mombin, Ormosia monosperma, Parinari campestris etc., con las siguientes especies accesorias: Rudgea freemani, Brownea latifolia, Aegiphila integrifolia, Diospyros ierensis y Myrtaceae sp. y el suelo con una cubierta muy densa de Heliconia sp. y otras plantas herbáceas similares. No hay yerba cortadera. La regeneración no es muy abundante pero incluye Cedrela mexicana, Vitex divaricata, Eschweilera subglandulosa, Aniba panurensis, Nectandra martinicensis, y Tabebuia serratifolia, muy pequeñas aún para poder considerarse establecidas.

Compartimientos 7b, 9b, 9c, 10b, 10c, 11b y 12b

De aproximadamente 50 acres. Arcilla Talparo fase rojiza, suelo Lómico Las Lomas, Arena Sand, fase pendiente y arcilla calcárea. Estas áreas eran previamente del tipo de bosques Peltogyne porphyrocardia. La cosecha consiste de árboles padres altos, abiertos, con árboles supermaduros de Peltogyne porphyrocardia, Spondias mombin, Copaifera officinalis, Mouriri marshallii, Vitex capitata, Eschweilera subglandulosa y Albizzia caribaea, sobre un piso bajo bastante denso de Coccoloba latifolia, Myrtaceae sp., Warszewiczia coccinea, Brownea latifolia, Coccoloba fallax, Mouriri rhizophoraefolia y Erythrina pallida. Hay poca o ninguna vegetación superficial. La regeneración no es abundante pero incluye Manilkara bidentata, Cedrela mexicana, Vitex capitata, Eschweilera subglandulosa, Didymopanax morototoni, Hymenaea courbaril, Terminalia obovata, Tabebuia serratifolia y Platymiscium trinitatis, muy pequeños para considerarse establecidos.

Compartimientos 11a, y la parte oeste del 12a y 13

De aproximadamente 158 acres. Arena Sand, fase pendiente, arcilla Talparo, fase rojiza y arena Sand, fase plana. Desarrollada principalmente en arena Sand, la cosecha aquí tiene reminiscencias de la Reserva Arena y responde igualmente al tratamiento silvicultural. La cosecha consiste de postes de árboles padres de 5 pies de circunferencia y 60 pies de altura y contiene Byrsonima spicata, Didymopanax morototoni, Pentaclethra macroloba, Alchornea glandulosa, Nectandra surinamensis, Terminalia obovata y Pera arborea. Ryania speciosa es un arbusto conspicuo del piso bajo y en la superficie del suelo existe poca o ninguna vegetación con excepción de Ischnosiphon arouma que aparece ocasionalmente. No hay yerba cortadera. Ha surgido una vegetación natural excesivamente copiosa de Byrsonima spicata, Didymopanax morototoni, Tabebuia serratifolia, Hieronyma caribaea, Nectandra y Ocotea, Eschweilera subglandulosa y Vitex spp., pero todavía está muy pequeña para considerarse establecida.

Compartimiento 11c

De aproximadamente 2.77 acres. De arena Sand, fase pendiente y arcilla Talparo fase rojiza. Tipo de maleza secundaria ("lastro") igual al anterior, con poca regeneración.

Compartimientos 12a y 13 (parte este)

De aproximadamente 60 acres. Arcilla Talparo, fase rojo-moteada. Este área, que primitivamente era del tipo de bosque Carapa-Eschweilera-Sabal no ha sido separado en sub-compartimientos ya que sus límites no están bien delineados y porque el tipo de regeneración es el mismo de las áreas adyacentes aunque menos abundante. La cosecha consiste de árboles padres dispersos en los que predomina Pentaclethra macroloba junto con Pachira insignis, Carapa guianensis, Laetia procera, Nectandra y Ocotea, Sterculia caribaea, Tabebuia serratifolia, y Warszewiczia coccinea. La regeneración es moderadamente abundante y consiste de las mismas especies que el compartimiento 11a y las áreas adyacentes de 12a y 13.

Compartimiento 1e

De aproximadamente 2.5 acres, improductivo. Este es un pantano que contiene Symphonia globulifera y Virola surinamensis y no ha sido tratado silviculturalmente.

Clasificación de las Cosechas de Regeneración

De las descripciones arriba expuestas es evidente que las cosechas actuales difieren más unas de las otras que los tipos de vegetación original. Las cosechas características pueden trazarse como descendiendo de los tipos palo rojo (Peltogyne porphyrocardia) (Compts. 7b etc.) y crapo-guatecaro-carat (Carapa-Eschweilera-Sabal) (parte este del 12a y 13) los que aparecen en el mapa como cosechas palo rojo-guava silvestre (Peltogyne-Myrtaceae) y bois mulatre-carat (Pentaclethra-Sabal) respectivamente. Las cosechas actuales que se originaron de la asociación crapo-guatecaro-cocurito (Carapa-Eschweilera-Maximiliana) han sido moldeadas por el tiempo y el ambiente en 3 tipos de cosechas diferentes: aceitunillo-guatecaro (Terminalia-Eschweilera) en los compartimientos 1-8; el bois mulatre-laurel (Pentaclethra-Nectandra) en los compartimientos 9a y 10a, y el serrette-jereton-honeywood (Byrsonima-Didymopanax-Alchornea) en el compartimiento 11a y en la parte oeste del 12a y 13. La primera de éstas en la que domina el aceitunillo (Terminalia obovata) se encuentra en las tierras lisas y en las ligeramente pendientes en la cadena de arena Piarco - Las Lomas en el norte de la Reserva donde se ha desarrollado una flora característica debido quizás a la influencia de la agricultura nomádica y las quemas. La regeneración, que consiste principalmente de brotes de aceitunilla (Terminalia obovata) y guatecaro (Eschweilera subglandulosa) es abundante y es aquí donde se encuentran las cosechas jóvenes más avanzadas. El bois mulatre-laurel (Pentaclethra-Nectandra) se encuentra en los medios estacionales húmedos en que prevalecen las arcillas Las Lomas y Talparo en el centro de la Reserva. Una vegetación superficial herbácea densa es característica de esos sitios y es responsable, en parte, de la falta relativa de regeneración natural. La cosecha serrette-jereton-honeywood (Byrsonima-Didymopanax-Alchornea) está asociada con la Arena Sand, drenaje libre y escasez de vegetación superficial. En estos sitios la regeneración natural de las especies buenas empieza fácilmente bajo la sombra de los árboles padres y aún en la cosecha secundaria preexistente de postes hay muchos grupos naturales bien formados de serrette (Byrsonima spicata) y jeretón (Didymopanax morototoni).

Una de las consideraciones más importantes es que la regeneración de las especies deseadas es buena en las arenas - muy buena en las arenas de drenaje libre - bastante buena en los tipos de arena de drenaje pobre - pero sólo hasta cierto límite en las arcillas. Hasta la fecha no se conoce la razón de ese comportamiento pero no cabe duda de que la tendencia a secarse y a anegarse, así como la naturaleza de la vegetación superficial son factores importantes.

Estadísticas

La Tabla 2, (pág. 17) que aparece en este trabajo es un resumen de la regeneración natural hasta 1 pie de circunferencia, obtenida por medio de reconocimientos aritméticos en los que se demarcó una faja de 10 pies de ancho en cada compartimiento.

Discusión

El punto saliente en los resultados silviculturales, confirmado por la experiencia en el resto de la isla de Trinidad, estriba en que la regeneración natural prevalece bastante bien en los suelos arenosos o en los suelos que tengan arenoso por lo menos el primer horizonte pero es relativamente pobre en los suelos arcillosos particularmente en los pesados. Las especies que regeneran en estos 2 grupos edáficos son diferentes aún a pesar del hecho de que el tipo forestal original, tanto de la arena como de la arcilla, pudo haber sido idéntico. En los suelos arenosos el bosque maderero vuelve casi siempre con alguna rapidez, pero en las arcillas hay un período largo en que las indeseables Cecropia, Ochroma, Vismia y Guazuma son las especies principales y el suelo está densamente cubierto de Heliconia y demás vegetación herbácea. Es preciso investigar las razones para esta diversidad de comportamientos ya que aún se desconocen. Es posible que las arcillas, pesadas e impermeables acumulen mucha agua en la superficie lo cual hace que se pudran las semillas pero también es posible que la mortalidad ocurra en el estado de brinzal.

Un factor igualmente importante en la regeneración es el mecanismo de diseminación de los diferentes árboles. Los que más se extienden son sin duda aquellos cuyas semillas se distribuyen con facilidad. Entre las especies "valiosas" de MacNair, Terminalia, Tabebuia y Cedrela poseen semillas aladas fáciles de diseminar por medio del viento y las semillas de Byrsonima, Didymopanax, Hieronyma y Lauraceae son distribuídas por los pájaros y murciélagos. Estas especies regeneran mucho más copiosamente que las demás de la lista de especies "valiosas" que tienen semillas relativamente grandes y pesadas sin mecanismo alguno de diseminación natural.

Es necesario considerar también el lugar que ocupa cada especie en la sucesión. Algunas son colonizadoras de tierras baldías, otras pertenecen al estado secundario, cuando el monte alto está volviéndose a crear y sin embargo otras pertenecen sólo a la asociación clímax y son por lo tanto las últimas en aparecer. Existe casi siempre una ligera correlación entre la diseminación y el lugar ocupado en la sucesión; aquellas que mejor se diseminan aparecen en la primera serie y viceversa. Generalmente, los miembros de la primera serie ecológica son especies sin valor y las maderas más valiosas se encuentran en la serie final y clímax. Se ve claramente que es considerablemente más fácil regenerar las especies que ocupan el primer lugar en esta escala de sucesión. En las Indias Occidentales nadie debe tener dificultad en producir un rodal puro de Cecropia peltata, pero tales colonizadores no son siempre deseables. Generalmente, el mejor principio en las operaciones de regeneración natural es seleccionar una especie intermedia de madera razonablemente buena, que aparezca en una de las primeras series, sentando así un balance entre calidad y tiempo. En Trinidad, Byrsonima spicata, Didymopanax morototoni, Hieronyma caribaea, Tabebuia serratifolia y Terminalia obovata regeneran con facilidad y son de crecimiento rápido en sus primeras etapas: uno es una madera dura de primera calidad, tres son maderas duras de mediana calidad y el otro es una madera blanda de mediana calidad. Se cuenta con estas especies para proveer la parte principal de la cosecha y la mezcla de otras especies más valiosas se fomenta cuidadosamente según va apareciendo.

El compás en que se efectúan los procesos de renacimiento en los bosques degradados al ser protegidos y tratados por medio de operaciones de mejora depende en la mayoría de los casos del grado inicial de degradación. Las tierras que han sido quemadas y cultivadas intensamente por espacio de muchos años recobrarán con más lentitud que aquellas que han sido menos alteradas. En Trinidad no se ha practicado el tratamiento de tierras erosionadas. Como en MacNair la superficie es generalmente algo lisa no parece haber sufrido apreciables efectos debido a la erosión. El suelo era básicamente pobre en nutrimentos minerales y estaba desprovisto de su capa humífera pero el efecto de acercamiento de la roca madre a la superficie, que es el indicio asociado con las tierras erosionadas, no ha tenido lugar allí.

Se espera que en este año estas operaciones se repitan experimentalmente en las Islas Inglesas de Barlovento y Sotavento. Los dos tipos principales de medios estacionales que han de tratarse allí son: laderas secas y erosionadas de la bajura, cubiertas de maleza pobre, decidua y de suelo escaso, y en segundo lugar los bosques secundarios en las montañas húmedas que han sufrido los efectos de la agricultura nomádica. En el primer caso hay indicios de que una vez las tierras estén cerradas y protegidas es de esperarse la rápida invasión de Tabebuia pallida y de Swietenia mahagoni. En las montañas, los bosques secundarios por naturaleza contienen una proporción alta de Simaruba amara y varias especies de Lauráceas, proporción que prácticamente sería posible aumentar. Todas estas especies son de crecimiento rápido y de considerable valor maderero.

La ventaja peculiar de los métodos naturales para el crecimiento de bosques degradados es la absoluta certeza que se tiene de obtener resultados de alguna índole. Se fomentan los procesos naturales todo el tiempo y al final de algunos años el área antes degradada si no está completamente provista de especies de valor tendrá por lo menos mejor vegetación que al principio y los gastos habrán sido exiguos. En los sitios realmente degradados las condiciones ecológicas se han tornado tan adversas y tan fuera de balance que el utilizar los métodos artificiales sería pedir lo imposible ya que requiere del material sembrado una tolerancia que no puede esperarse que posea. En estas circunstancias no hay certeza en cuanto a la regeneración artificial. Es invariablemente muy costosa y si fracasa el resultado final puede que sea aún peor que el inicial, debido a la interferencia adicional que esos cuidados conllevan. El tiempo extra que requieren los métodos naturales no es de grandes consecuencias en la dasonomía, donde los turnos de explotación alcanzan 60, 80, 100 y aún más años, y de todos modos, la experiencia demostró que este retraso no es, de ninguna manera, tan grande como se cree generalmente. En casi todas las naciones (y Trinidad no es ninguna excepción) en que ha sido practicada, la dasonomía tropical ha sufrido en sus comienzos la enfermedad que ha sido llamada "fiebre de siembra", la idea fija de que es necesario empezar formando plantaciones con gran rapidez por todo el área dada, a menudo sin estar precedidas por ninguna investigación preliminar. Después de haber desperdiciado mucho dinero se ha revisado el programa en favor de métodos menos costosos y más naturales basados en experimentación cuidadosa.

Résumé

Le traitement des surfaces forestières qui ont été ruinées par le feu et l'agriculture nomade et incessante est peut-être aujourd'hui un des problèmes forestiers plus importants de l'Amerique Tropicale. Jusqu'à present les efforts faits pour résoudre ces problèmes ont eu des résultats couronnées du succès.

Les travaux que l'auteur y fait rapport ont été poursuivi à Trinidad dans la Réserve MacNair Ravine Sable sur une superficie dont la forêt a été souvant défrichée et brûlée depuis 1890. Les résultats prouvaient que le sol n'y était pas approprié pour l'agriculture. La végétation primitive était sempervirente, croissant dans un sol dont la roche-mère était principalement sédimentaire et en recevant une précipitation annuelle de 75 pouces. Les trois associations principaux des types forestiers sont enumerées à la page 4.

La régénération artificielle était très difficile d'atteindre et comme la croissance des jeunes arbres plantés était très lente dans leurs premières années on employa la régénération naturelle qui y réussit. On avait partagé la superficie de la forêt en 5 parcelles de coupe travaillant chaque année dans une d'elles. Pendant la première coupe on enleva les vignes sauvages, les herbes mauvaises, les palmiers et les pousses excessives dans une même souche parmi les essences de qualité supérieure. Ainsi, les jeunes arbres d'essences précieuses ont été encouragés en réduisant la competence. Une mesure forestière semblable a été poursuivi dans les coupes les plus récentes. Les essences de qualité supérieure qui ont été favorisées figurent à la page 8 du texte en anglais.

Ce méthode d'amélioration des forêts degradées n'est pas aussi rapide que d'autres mais il peut être accompli à bas prix. Les quatre compartiments dejà établis ont coûté seulement $4.70 l'acre.

L'avantage spécifique de la régénération naturelle pour mettre en valeur les forêts degradées est la véritable certitude d'en obtenir des résultats de quelque sorte. Encourageant toujours les procédés naturels, la surface autrefois degradée atteindra au moins et depuis plusieurs années un repeuplement meilleur quand même les essences y compris ne seront toutes de qualité supérieure, les dépenses auront été assez économiques. Dans les endroits completement denudés les conditions écologiques deviennent si adverses et l'équilibre aussi bouleversé que la règénération artificielle est tout à fait imposible car aucune essence possède la tolérance et les exigences necessaires pour y réussir. Donc, dans ces circonstances on n'est jamais sûr des résultats de la régénération artificielle. En outre il est invariablement très coûteux et dans le cas où elle ne puisse pas établir le peuplement, l'état atteint serait au pis à cause de l'interference additionnelle des opérations culturales. Les méthodes artificielles ont besoin de plus de temps mais cela ne fait rien car la rotation prend ou moins 60, 80, 100 ou plus d'années et les épreuves dans MacNair ont montré que le temps necessaire pour le repeuplement naturel n'est aussi long qu'on s'imagine. Les sciences forestières dans presque tous les pays des tropiques (et Trinidad ne fait pas l'exception) ont souffert dans leurs premières années d'une maladie connue sous le nom de "fièvre de coupe", c'est-à-dire l'idée fixe qu'il était necessaire d'établir des peuplements avec rapidité et aussitôt que possible sans faire des recherches préliminaires des conditions spécifiques. L'orientation moderne se tourne vers les méthodes naturelles, moins coûteux et basées sur l'expérimentation sylvicole.

———oOo———

PERU FORESTAL

Recientemente llegó a nuestras manos el primer número de Colonias y Foresta, órgano de la Dirección de Asuntos Orientales, Colonización y Terrenos de Oriente, del Ministerio de Agricultura del Perú. Damos nuestros parabienes a la Dirección por las prometedoras perspectivas de esta revista y por su presentación y contenido. Los resultados de la coordinación del esfuerzo administrativo y técnico encauzado hacia la colonización y aprovechamiento racional de las reservas forestales del Perú aportan una contribución educacional a toda la América tropical.

Colonias y Foresta constituye un buen comienzo de tan loable propósito. El "Caribbean Forester" le desea una fructífera labor a la revista hermana.

THE FIRST YEAR IN THE CAMBALACHE EXPERIMENTAL FOREST

Frank H. Wadsworth, Forester
Tropical Forest Experiment Station
Puerto Rico

A memorandum of understanding was signed by the Executive Director of the Puerto Rico Land Authority and the Acting Chief, Forest Service, U. S. Department of Agriculture on April 7, 1943, putting on record the desire of these two agencies to cooperate in the development of the best silvicultural policies and techniques to be used in the management of the forest of the dry limestone region along the north coast. Specifically, the Land Authority made available to the Tropical Forest Experiment Station a tract of non-agricultural land for research on forest problems common to thousands of acres of other lands owned or soon to be bought by the Authority. In return the Tropical Forest Experiment Station pledged its willingness to make available to the Authority, at the earliest possible date, all findings which would lead to improved forest management practices on Authority forest lands.

The Forest

The tract set aside, called the Cambalache Experimental Forest, is in Colonia Walcott, in the Municipality of Arecibo, and contains a total of 616 acres. The highest elevation is 165 feet above sea level, and precipitation averages approximately 50 inches annually. The topography is rough, consisting of steep limestone hills separated by very narrow valleys. The soil is chiefly of the Tanamá series, shallow to moderately deep. The forest has been cut over in the past, but at present a young stand typical of other forests in this region, covers most of the tract. The largest tree diameters are 25 to 30 inches, but almost all of the trees are less than 10 inches. The tallest trees are 60 feet in height. The forest contains a wide variety of tree species, possibly 200 in all. Many of those now present do not grow to a large size and will disappear as the forest develops.

Forest Protection

The first requisite of forest management is protection from destructive agencies. The Cambalache Forest fortunately had received adequate protection from both trespass and fire by Central Cambalache immediately prior to its sale to the Authority. The fire hazard was readily apparent, however, on dry brushy hillsides where the forest had been repeatedly burned off years ago. Also it was known that trespass in this region, because of the scarcity of forest products, was a serious problem. The need for continuous protection was obvious.

During September 1943 a guard was employed to patrol the forest boundaries and to regulate forest use. He has since spent 64 per cent of his time directly on patrolling the area. It was found that trespass had become frequent during the period in which the land was in litigation, and it was necessary to advise the people in the vicinity as to the objectives of the forest and the need for complete control over cutting. This alone did not stop all trespass, but when the policy of making available without charge all dead material for fuel became generally known, the attitude changed.

The next step was to locate the boundaries with certainty, to clear cut the lines, and to fence them. This work was completed during the year with Emergency labor.

One fire swept into the forest from outside during the year and burned approximately two acres of brush. Warnings have been issued to all families living in the vicinity, and no other fires have occurred despite a much drier season following this fire.

In order to mark the boundaries permanently, some 6,000 seedlings of Australian pine, Casuarina equisetifolia, were planted between the fence posts. Unfortunately the planting was almost a total loss as a result of dry weather. Replantings will be made in better weather, as the advantages of such a fence row, which will stand out against the native vegetation and permanently support the fence, are obvious.

Forest Research

A reconnaissance of the forest showed it to be well adapted for research in silvics, regeneration, and silviculture. Accordingly the forest was divided into three areas as follows:

1. An area of 35 acres was set aside to be left permanently without disturbance to provide an opportunity to study the development of the natural forest and for comparison with different treatments in other parts of the forest. This area is well inside the boundaries so that it is protected from unauthorized disturbance.

2. An area of 120 acres was set aside for studies of forest regeneration. Here the forest will be altered in any way necessary to test various methods of planting and establishing new and better tree species. However, cutting will be done in such a way that the soil will always be adequately protected. This area is also centrally located for better protection.

3. A remaining area of 461 acres is to be used for studies of cutting, thinning, and pruning, and to be operated as a forest working circle under sustained yield management.

Studies of silvics and regeneration were started during the year. Results to date are here presented.

Silvics

Silvical research has consisted of study of all of the forest from the valleys to the tops of the hills. It has included estimation of stand density and determination of forest composition.

1. The natural forest on the limestone hills, even where it has been cut over repeatedly, contains a much higher representation of valuable tree species than had been expected. Such species as úcar, Bucida buceras, capá blanco, Petitia domingensis, ortegón, Coccolobis laurifolia, roble, Tabebuia pallida, péndula, Citharexylum fruticosum, and maga, Montezuma speciosissima are common.

2. All forest cover on the limestone hills of this region is very valuable, regardless of species present, because of its role in protecting the very shallow soil from erosion. Deforested hills very soon are completely devoid of soil and of no value for agriculture, and reforestation is then very difficult.

3. The denser natural forests on the hills are generally in need of improvement cuttings to thin them out, to remove inferior trees, and to kill vines. Such cuttings must be light even though removal of all undesirable trees is not possible at present because of the danger of exposure of the soil. The balance of the inferior trees can be removed later when a better forest has developed naturally.

Regeneration

Regeneration research has dealt with a number of valuable tree species which grow naturally in similar environments. If found well adapted these might be planted elsewhere on bare hills or some of them under the shade of inferior trees which can be removed when the planted trees become well established. The results during the year were affected by the severe drought, and some s tudies will need replication.

1. The outstanding finding in regeneration is the need for small local tree nurseries for forest plantings in such a dry climate. Trees taken from Rio Piedras immediately after heavy rains at Cambalache arrived after much of the moisture had already evaporated from the soil. From a nearby nursery this delay could have been avoided.

2. Cóbana negra, Stahlia monosperma, a tree producing a strong durable wood and native to the south coast failed in experimental plantings. Although the drought probably had some effect direct seeding appears to be more practical than planting.

3. Cojóbana, Piptadenia peregrina, a tree which appears to be adapted for planting on bare slopes where a cover is needed, has

proven drought resistant. In a planting made in January survival has been high despite the record drought.

4. Dominican mahogany, Swietenia mahogani, plantings have been successful in an open valley. A planting made during dry weather has a survival of 84 per cent following 6 months of drought. Mulching with dead grass about the roots was apparently helpful. Direct seeding of this species has shown much promise and may in future studies prove a much more practical method of establishment than planting.

5. Ucar, Bucida buceras, one of the most valuable trees in the forest, has been very difficult to propagate because of very low seed viability. During the year better seed was located and although final results from an experimental planting made during dry weather are not yet available, indications are that this species is well adapted for planting in this region. This may become one of the chief species used in reforestation of the dry limestone hills.

6. Bayahonda, Neltuma juliflora, a rapid-growing tree which produces excellent posts and fuelwood on the dry southcoast, has proven resistant to the very dry conditions prevailing during this year. Growth of young planted seedlings started almost immediately, and survival is high.

7. Chilean mesquite, Neltuma chilensis, planted in the forest for its first test in Puerto Rico has proven to be as drought-resistant as the native species.

8. Guayacán, Guayacum officinale, failed, when direct seeded under partial shade, possibly due to the perishability of the seed during the drought. Further trials with this valuable species will be made in better weather.

Forest Management and Utilization

Of the total area of the forest 461 acres, or 75 per cent, are being managed primarily for wood production. This area is divided into 5 compartments, each to be improved during successive years, thus making a continuous cycle of cutting, returning to each compartment at 5-year intervals.

The first cutting is to remove trees of poor form or of inferior species, giving more growing space to better trees, yet leaving a forest cover in all parts of the stand to protect the soil and to keep the environment suitable for the development of young trees under the shade.

The timber to be cut is sold on the stump using standard Forest Service stumpage prices which are set deliberately low to expedite the removal of inferior trees which are valuable only for fuel. The forest guard has been given training in silviculture to the extent that he knows which trees should be marked. These trees are blazed and marked with a crayon at a point below where they will be cut. When a large area has been marked the guard makes it known that material is available, and sales are made. To date 20 acres have been so marked. Before removing the products from the forest the buyer must deposit a money order in the Experimental Forest trust fund for the value of the material. During the first year $94.40 have been brought in from such sales to 22 different individuals living in the vicinity. This money, in accordance with the terms of the memorandum, will all be spent toward the improvement of the forest, chiefly by hiring local labor for improvement work.

These 461 acres also contain a large accumulation of dead timber which is being made available free to the families living nearby. The only requisite is that the guard be permitted to measure and tally the wood so taken. During the 10 months of record 2,090 bundles of dead wood were carried out, totalling 35 cords. This free wood was used for fuel by 172 families including some 860 persons. Many of these people came as far as 3 kilometers to get fuel. The supply of dead material is by no means exhausted, and it is intended that this policy be continued, as the good will of the nearby families is worth many times the value of the dead wood, which might otherwise rot.

To facilitate the harvesting of forest products a network of old trails has been reopened, using emergency labor. Also the principal road through the forest is being repaired to make it passable for trucks.

The presence of small tracts of agricultural land between the hills provides an excellent opportunity for close study of a combination of woodlot forestry and agriculture. Four sites have been chosen for homesteads and permission has been received from the Authority to rent to four families 5 acres for agriculture and pasture. Houses will be constructed of forest materials and rental will be paid in the form of forest work. In addition to the income from crops these families will have an opportunity to cut and prepare forest products at a profit to themselves.

(Traducción del artículo anterior)

PRIMER ANIVERSARIO DEL BOSQUE EXPERIMENTAL DE CAMBALACHE

El 7 de abril de 1943 el Director Ejecutivo de la Autoridad de Tierras de Puerto Rico y el Jefe Interino del Servicio Forestal del Departamento de Agricultura de los Estados Unidos firmaron un memorándum en que consta el deseo de estas dos agencias de cooperar en el delineamiento de mejores prácticas y técnicas silvícolas que han de utilizarse en la ordenación de los bosques de la zona caliza seca a lo largo de la costa norte Específicamente, la Autoridad de Tierras puso a la disposición de la Estación de Experimentación Forestal Tropical un trecho boscoso de tierra no cultivable para investigar sobre la solución de los problemas forestales que son comunes a los 1,000 acres de tierra en esas mismas condiciones que posee o ha de poseer esta Autoridad. En cambio, la Estación de

Experimentación Forestal Tropical prometió suministrar todos los hallazgos técnicos que conduzcan a mejores prácticas de ordenación de bosques en las tierras forestales de la Autoridad.

El Bosque

El trecho asignado, que se conoce con el nombre de Bosque Experimental Cambalache, está situado en la Colonia Walcott, del municipio de Arecibo y consta de un total de 616 acres. La elevación máxima es de 165 pies sobre el nivel del mar y la precipitación pluvial promedio es de aproximadamente 50 pulgadas anuales. La topografía es accidentada, consistiendo de colinas calizas inclinadas y separadas por valles muy estrechos. El suelo es principalmente de la serie Tanamá, de superficial a moderadamente profundo. El bosque fué talado en el pasado y hoy día un rodal joven, típico de los demás bosques de la región, cubre casi todo el trecho. Los diámetros más grandes son de 25 a 30 pulgadas, pero casi todos los árboles tienen menos de 10 pulgadas de diámetro. Los árboles más grandes tienen 60 pies de altura. El bosque contiene una gran variedad de especies forestales; puede decirse alrededor de 200 por todas. Muchas de las especies no crecen mucho y habrán de desaparecer según vaya creciendo el bosque.

Protección Forestal

El primer requisito de ordenación forestal es la protección contra agentes destructores. Afortunadamente, el Bosque Cambalache recibió siempre protección adecuada contra los transgresores y el fuego, gracias a la Central Cambalache que era el propietario anterior a la Autoridad de Tierras. Sin embargo, el peligro de fuego era plenamente visible en aquellas colinas secas y arbustivas donde el bosque había sido destruído por el fuego años atrás. También se sabía que debido a la escasez de productos forestales en esta región, la transgresión era un problema grave. Por lo tanto era obvia la necesidad de protección continua.

En septiembre de 1943 se contrataron los servicios de un guarda que había de patrullar los linderos forestales y regular la utilización del bosque. Desde entonces él ha empleado el 64 por ciento de su tiempo en patrullar el área. Se averiguó que las transgresiones habían aumentado durante el tiempo en que el terreno estuvo en litigio y fué necesario avisarle a la gente en las inmediaciones cuales eran los objetivos del bosque y la necesidad de restringir la corta. Esto sólo no fué suficiente para poner coto a todas las transgreciones, pero cuando la gente tuvo conocimiento de la norma de donar todo el material muerto que podía servir para leña, cambiaron de actitud.

El próximo paso fué el de localizar los límites con exactitud, limpiar y poner empalizadas en las guardarrayas. Este trabajo se efectuó ese año, con trabajadores del Programa de Emergencia de Guerra.

En el año, un fuego que comenzó fuera del bosque quemó cerca de 2 acres de maleza. Se amonestó a todas las familias que vivían cerca del bosque y en lo sucesivo, aún en épocas más secas, no hubo ningún otro caso de fuego.

Para establecer permanentemente las guardarrayas se sembraron 6,000 arbolitos de pino australiano, Casuarina equisetifolia, a lo largo de las empalizadas pero, desgraciadamente, debido a la sequía se murieron casi todos. Se aprovechará una época lluviosa futura para volver a sembrarlos ya que un seto vivo permanente como el que proporciona el pino es de ventajas obvias.

Investigación Forestal

El reconocimiento general del bosque indicó que se adaptaba bien para cualquier estudio de ecología forestal, regeneración y selvicultura. Por lo tanto, el bosque se dividió en las siguientes tres áreas:

1. Un área de 35 acres, que no habría de tocarse para nada, en la cual se estudiaría el desarrollo natural del bosque y que serviría de índice de comparación para los otros tratamientos a que fuera sometido el resto del bosque. Este área está situado bastante al centro del bosque para evitar cualquier alteración desautorizada.

2. Otra área de 120 acres se separó para estudios de regeneración forestal. Este área se podrá alterar en cualquier forma, para probar los distintos métodos de siembra y para propagar nuevas y mejores especies arbóreas. Sin embargo, se efectuarán cortas de tal manera que el suelo esté adecuadamente protegido. También se centralizó este área para mejor protección.

3. Las 461 acres y restantes se utilizarán para estudios de corte, aclareo y poda y se tratará como una unidad de aprovechamiento forestal de rendimiento continuo.

Los estudios de ecología forestal y de regeneración fueron comenzados durante el año. Los resultados aparecen a continuación.

Ecología Forestal

La investigación ecológica consistió del estudio de todo el bosque desde los valles hasta la cima de las colinas. Se incluyó la determinación de la densidad de los rodales y la composición forestal.

1. La vegetación natural de las colinas calizas aún donde habían sido taladas varias veces, estaba representada por especies más valiosas de lo que se suponía. Tales especies como úcar, Bucida buceras, capá blanco, Petitia domingensis, ortegón, Coccolobis laurifolia, roble, Tabebuia pallida, péndula, Citharexylum fruticosum, and maga, Montezuma speciosissima eran corrientes allí.

2. Aún sin tomar en cuenta las especies presentes, la cubierta forestal de las colinas calizas de esta región es muy valiosa debido al importante papel que desempeña protegiendo el suelo

tan superficial de los efectos de la erosión. Las colinas desprovistas de árboles pierden por completo la fertilidad de su suelo y su valor agrícola y por lo tanto el embosquecimiento se hace sumamente difícil.

3. El bosque en las colinas por naturaleza más denso necesita en general, cortas de mejora para aclararlos, extraer los árboles inferiores y eliminar la maleza. Estas cortas deben ser de poca intensidad ya que no es posible remover todos los árboles indeseables por el peligro de dejar el suelo al descubierto. El resto de los árboles inferiores puede cortarse luego cuando ya se haya desarrollado naturalmente un bosque mejor.

Regeneración

La regeneración experimental se llevó a cabo con varias especies valiosas que crecen naturalmente en medio ambientes similares. Si se adaptan bien a estas condiciones, podrán sembrarse también en las colinas desnudas o algunas de ellas pueden sembrarse bajo la sombra de especies inferiores que pueden irse cortando según los arbolitos de mejor clase se vayan estableciendo. Los resultados de los experimentos efectuados el año pasado han sido afectados por la sequía sin precedentes y algunos tendrán que ser repetidos.

1. El hecho más sobresaliente en cuanto a regeneración es la necesidad de viveros forestales en esa localidad debido al clima tan seco. Los arbolitos que se llevaron de Rio Piedras inmediatamente después de haber llovido copiosamente en Cambalache llegaron después que ya se había evaporado mucha de la humedad del suelo. Esta tardanza pudo haberse evitado si existiera un vivero en las cercanías.

2. La cóbana negra, Stahlia monosperma, que es un árbol nativo de la costa sur y que produce madera dura y durable fracasó en las plantaciones experimentales que se hicieron en los claros naturales del bosque. A pesar de que el problema de la sequía sin precedentes de este año tuvo algo que ver con estos resultados, la siembra directa parece ser más práctica que la plantación.

3. La cojóbana, Piptadenia peregrina, árbol que parece adaptarse a las colinas desnudas donde se necesita una cubierta forestal ha demostrado que resiste la sequía. En una siembra que se efectuó en enero la supervivencia ha sido alta a pesar de la falta de lluvia.

4. Una siembra de caoba dominicana, Swietenia mahagoni, ha tenido éxito en uno de los valles. Una plantación que se estableció durante el período seco ha tenido una supervivencia de 84 por ciento después de 6 meses de sequía. El cubrir la raíz de los arbolitos con paja mojada dió buenos resultados. La siembra directa de esta especie parece ser más efectiva y en estudios

futuros se probará si es éste un método más práctico de establecer las plantaciones.

5. Ucar, Bucida buceras, es uno de los árboles más valiosos de este bosque pero es muy difícil de propagar debido a la poca viabilidad de sus semillas. En este año se consiguió mejor semilla y a pesar de que no se conocen aún los resultados finales de la siembra experimental que se hizo durante el tiempo seco todo parece indicar que esta especie se adapta bien a esta región. Esta especie será la que predominará en el embosquecimiento de las colinas de la zona caliza seca.

6. Bayahonda, Neltuma juliflora, es un árbol de crecimiento rápido que produce excelentes postes y leña en la costa seca del sur y ha demostrado ser resistente a las condiciones extremas de sequía que persistieron este año. El crecimiento de los arbolitos empezó casi inmediatamente después de la siembra y la supervivencia ha sido alta.

7. Pudo probarse que el mesquite chileno, Neltuma chilensis, que se sembró aquí por primera vez en Puerto Rico era tan resistente a la sequía como la especie nativa.

8. El guayacán, Guayacum officinale, no dió resultado cuando se sembró directamente en el campo bajo sombra parcial debido posiblemente a que la semilla no pudo soportar la sequía. Se harán más pruebas con esta valiosa especie cuando haya mejor tiempo.

Aprovechamiento y Utilización Forestal

El 75 por ciento del área total de bosque, o sean 461 acres se están utilizando primordialmente para la producción de madera. Este área se ha dividido en 5 compartimientos cada uno de los cuales será mejorado sucesivamente, a razón de 1 por año, lo cual constituye un ciclo de corta ya que al cortar el último se regresará al primero formando un intervalo de 5 años entre cada una de las cortas por compartimiento.

En la primera corta se removerán los árboles de mala forma o de especies inferiores, dándole así más espacio a los árboles mejores pero dejando el techo forestal en todos sitios, para proteger el suelo y conservar el medio ambiente adecuado al crecimiento de los árboles jóvenes que suben bajo la sombra.

La madera que ha de cortarse se vende cuando el árbol está aún en pie, a base de los precios tipo del Servicio Forestal, que se estipulan bajos deliberadamente, para estimular la remoción de los árboles inferiores que sólo sirven para leña. El guarda forestal ha recibido el entrenamiento necesario en selvicultura para poder seleccionar los árboles que deben señalarse. Estos árboles se marcan y señalan con creyón más abajo de donde van a cortarse. Después de marcar un área grande el guarda anuncia que el material está disponible y entonces se procede a efectuar las ventas. Antes de acarrear los productos del bosque el comprador debe depositar un giro postal por el valor de la compra en el Fondo de Bosques Experimentales. Durante el primer año se obtuvieron $94.40 de ventas efectuadas a 22 personas que vivían en las inmediaciones. Este dinero, de acuerdo con lo estipulado en el convenio, se utilizará para mejorar el bosque, empleando obreros locales para tales trabajos.

Estas 461 acres también contienen madera seca que se ha venido distribuyendo gratis entre las familias que viven cerca. El único requisito es que el guarda debe medir y apuntar la madera antes de que la saquen del bosque. Durante los 10 meses comprendidos en el informe se sacaron 2,090 haces de leña o sean 35 cords. Esta leña fué usada por 860 personas en 172 familias. Mucha de esta gente tuvo que recorrer 3 kilómetros para obtener la leña. Aún no se ha terminado la provisión de leña y nosotros continuaremos con esta norma ya que la buena voluntad de estos vecinos vale mucho más que la leña que de otra manera se pudriría en el bosque.

Para facilitar la cosecha de productos forestales se ha vuelto a abrir la red de antiguos caminos, con trabajadores del Programa de Emergencia de Guerra. Se está reparando también la carretera principal que atraviesa el bosque para facilitar el paso de los camiones.

La presencia de pequeños trechos de tierra cultivable entre las colinas provee una excelente oportunidad para un estudio concienzudo de la combinación de arbolado y agricultura. Se seleccionaron cuatro sitios para parcelas y se logró el permiso de la Autoridad para arrendarle a cuatro familias cinco acres a cada una para cultivar y pastorear. Las casas se construirán con los productos forestales y la renta será cobrada en trabajo forestal en el bosque. Además de recibir los ingresos agrícolas estas familias tendrán la oportunidad de cortar y preparar productos forestales para su propio provecho.

Résumé

La Forêt d'Essai Cambalache est une surface forestière qui s'etend sur une aire de 616 acres sur des collines calcaires dans la côte du nord de l'île de Puerto Rico. Elle fut établie en 1943 pour faire des études sur la régénération et l'aménagement forestier. La moyenne annuelle des précipitations atmosphériques y est de 50 pouces et la forêt représente d'une manière typique la végétation qui prédomine dans ce région côtière sèche, plate et de grande étendue. La forêt avait été souvent coupé mais elle conserve plusieurs essences de qualité superieure.

Comme la forêt est placée au centre d'une région densement peuplée la première tâche à être entrepris était sa protection contre les transgressions par des mesures faisables. On employa un garde forestier chargé de veiller à la conservation de la surface, on débroussailla les limites et palissada tout autour de la forêt. Les familles voisines pouvaient enlever seulement le bois mort ou sec, mesure qui avait beaucoup réduit les transgressions. Pendant les premiers 10 mois 172 familles ont été fournies avec bois de chauffage par ce source.

La forêt fut partagée en 3 parties:

1. 35 acres qui devaient rester inalterés pour y faire des études ecologiques.

2. 120 acres dans lesquels on devait étudier la régénération et

3. 461 acres qu'on laissa pour étudier expérimentalement l'aménagement basé sur des rendements soutenus.

Les études sur la structure et composition de la forêt ont montré qu'elle possèdait plusieurs essences de haute qualité qu'on n'en avait pensé. Ce couverture herbacée, sur des collines à pente rapide et sol peu profond, sans faire aucun cas de la composition. est d'une importance essentielle pour la conservation du sol dans ceux lieux. Les peuplements plus denses ont besoin des éclaircies et des coupes d'amélioration pour reduire l'écartement et éliminer les arbres de qualité inférieure.

Malgré la sécheresse prédominant cette année les plantations experimentaux de Neltuma juliflora, N. chilensis et Piptadenia peregrina ont eu du succès mais celles de Stahlia monosperma et Guayacum officinale n'ont pas réussit mais on les traitera durant la saison humide la prochaine année sur une petite èchelle. Bucida buseras très commun dans la région est très difficile à propager au moyen de semis, alors on éssaya en transplantant des sauvageons. Cela n'avait pas réussit dû probablement aux conditions climatiques peu satisfaisantes. L'ensemencement direct de Swietenia mahagoni avait eu du succès et comme on devait la planter avec motte dans l'avenir on employera probablement l'ensemencement direct.

Pour faire les investigations sur les 461 acres dediées à l'aménagement avec rendement soutenu on avait partagé la surface en 5 compartiments travaillant chaque année dans un d'eux. Les travaux viennent de commencer dans le premier compartiment. Les arbres inferieurs et defectueux seront coupés pour être employés comme poteaux, bois à cerceaux et bois de feu. Après avoir vendu tout le bois mûr on enlèvera les arbres pas desirables, les vignes sauvages et d'autres mauvaises herbes.

FOREST ASSOCIATIONS OF BRITISH HONDURAS, II

J. H. Nelson Smith
Assistant Conservator of Forests
British Honduras

FOREWORD
(By N. S. Stevenson, Former Conservator of Forests, British Honduras)

Recognition of the fundamental characteristics of varying types of vegetation is a part of the essential basis of the work of forest officers and others concerned with the use of soil, but tropical plant ecology is still in its infancy, methods of approach are numerous, the data collected are too often incomplete and there is no simple book of words to guide the worker in the field or forest. How then does one begin? How can one be certain that one's own work is intelligible to others and how can the value of other people's work be assessed or the possibilities of its application elsewhere be gauged?

In 1938 the late Dr. J. Burtt Davey of the Imperial Forestry Institute at Oxford indicated a solution, which can be briefly summarized as "systematic" record of data in complete and unbiased detail according to a uniform plan. He urged the use of a questionnaire requiring negative as well as positive answers, and his proposal was examined, amplified and simplified by other competent British ecologists, Messrs. Richards, Tansley, and Watt, in the Imperial Forestry Institute Paper No. 19 entitled "The recording of structure, life form and flora of tropical forest communities as a basis for their classification".

This method was welcomed in British Honduras where we have to our sorrow already explored the pitfalls into which incomplete data, vague generalization or the ignoring of inconvenient facts can lead one, so much so that during the visit of Mr. Bevan to the Colony we seized the opportunity of discussing with him the value of publishing the association descriptions we had already collected in accordance with the Imperial Forestry Institute plan. We decided that it might well be of value in the Caribbean area to publish such descriptions leaving out any discussion of succession, and refraining from the use of general type terms such as "deciduous forest" or "high rain forest" until we were certain just where the associations described fit in.

In the association descriptions we have submitted to the Caribbean Forester for publication it may be that similar forest types are continually described as different associations but we believe that when the whole array of associations from the whole Caribbean Tropical American area is examined and analyzed, then and then only will a clear understanding of the basic vegetation types and their constituent associations be obtained.

The descriptions, to which this note is a brief introduction, were made by Mr. J. H. Nelson Smith in an area examined in 1939 by Mr. C. F. Charter in a reconnaisance soil survey. The area lies from 5 to 10 miles north of the head of the Stann Creek valley in the northern karst region of the Colony. It is a fairly level plain ranging from 200 to 400 feet in altitude and containing numerous steep limestone hills up to 400 feet in height. Several north flowing streams cross the area and have their source in the central massif which adjoins the area on the south. Alluvium derived from the weathering of the slates, sandstone, quartzites and grano-diorites of the massif, borders the streams in strips of varying widths. Plots in the neighbourhood of Charter's soil pits were marked out with chain and compass and were usually three chains in length by half a chain in width.

This area was divided up into half chain square sections. The various strata were enumerated section by section except in cases where the field and shrub layers were so dense that they were enumerated in one or two sections only. The subordinate and canopy species were counted throughout the plots. After enumeration a profile drawing to scale was made of all species over 15 feet in height. Larger plots would have been desirable but the time available did not permit.

Mr. Nelson Smith has suggested that plots 10 chains by 1/2 chain, with cruising lines for major species running at right angles to the long axis might be a more suitable size for detailed examination but the size of plot depends largely on the type of vegetation studied and the time at the disposal of the investigator.

The area lies to the north of the main mass of hills and its climate is believed to be intermediate between Belize, Cayo, and Stann Creek. It is probably not as hot as Agstat, Stann Creek, or Cayo, nor as wet as the Stann Creek valley stations.

HABITAT

Temperature

Temperature extremes are as shown in Table 1.

Table 1.- Temperature Extremes for Three Stations in British Honduras (Límites de Temperatura para Tres Estaciones en Honduras Británica)

Station (Estación)	Mean Temperature (Temperatura media)				Absolute (Absoluta)	
	Hottest Month (Mes más caliente)		Coldest Month (Mes más frío)			
	Month (Mes)	Temp.	Month (Mes)	Temp.	Maximum (Máxima)	Minimum (Mínima)
		°F		°F	°F	°F
Belize	August	86.9	January	67.8	95	50
Cayo	May	91.4	March	63.8	98	49
Stann Creek Agstat	May	90.5	Dec.	66.0	97	52

Precipitation

Monthly precipitation is as shown in Table 2.

Table 2.— Monthly Precipitation for Three Stations in British Honduras. (Precipitación Mensual en las Tres Estaciones Experimentales de Honduras Británica)

Month (Mes)	Belize 29-year average (Promedio de 29 años) Inches (Pulgadas)	Cayo 23-year average (Promedio de 23 años) Inches (Pulgadas)	Stann Creek Agstat 8-year average (Promedio de 8 años) Inches (Pulgadas)
January	7.17	5.29	6.61
February	2.49	2.01	2.83
March	1.77	.44	1.90
April	2.25	1.62	3.30
May	5.70	8.86	8.92
June	8.82	8.70	9.40
July	6.78	7.26	12.91
August	6.55	6.38	9.70
September	9.39	7.06	13.39
October	12.81	7.80	13.56
November	9.44	5.36	6.38
December	7.20	5.00	7.00
Total	80.38	66.78	95.90

At Belize the average number of days each year without rain is 184; at Cayo, 240; and at Stann Creek Agstat, 172. The dry season, including only months in which mean monthly rainfall does not exceed 4 inches, is from February to April at all three stations. Seasonal extremes are as shown in Table 3.

Table 3.— Seasonal Precipitation Extremes for Three Stations in British Honduras. (Precipitaciones Extremas Según la Estación Climática en las Tres Estaciones de Honduras Británica)

Station (Estación)	Dry Season (Estación seca)		Wet Season (Estación húmeda)	
	Driest (Más seca)	Wettest (Más húmeda)	Driest (Más seca)	Wettest (Más húmeda)
	Inches (Pulgadas)	Inches (Pulgadas)	Inches (Pulgadas)	Inches (Pulgadas)
Belize	2.07	14.33	39.93	128.01
Cayo	1.11	11.90	33.01	153.62
Stann Creek Agstat	2.28	11.73	66.46	119.31

Wind

It is probable that the winds over this area are modified by the high hill mass to the south and the numerous limestone hills on the east and west. The general prevailing direction of the wind is East, with average velocity about 12 miles per hour. Maximum velocities rarely exceed 36 miles per hour and records of sixteen years indicate that only 15 per cent of the maximum velocities recorded exceeded this figure.

The Colony, particularly the northern portion, is occasionally subjected to tropical hurricanes, which bring high wind velocities and heavy rainfall. The records apart from those of the capital are incomplete, and of eight hurricanes recorded in the last 150 years, seven have damaged Belize. During the winter months northers often with moderately high wind velocities and rather low temperatures occur. These winds are steady, often for a period of days, while the maximum velocities of the east and southeast winds are usually squalls only.

The winds at Belize during the period 1924-36, as recorded by a standard anemometer 45.7 feet above ground, are as shown in Table 4.

Table 4.—Wind Records for Belize, British Honduras. (Registro de los Vientos Prevalecientes en Belize, Honduras Británica)

Month (Mes)	Prevailing wind speed (Velocidad del viento)	Prevailing wind direction (Dirección)			Maximum velocity (Velocidad) máxima)	Most common direction of max. velocities (Dirección más común de las velocidades máximas)
		NW	E	SE		
	MPH	%	%	%	MPH	
January	11.6	50	19	19	48	SE
February	12.2	23	50	27	42	NW & ESE
March	13.8	8	61	31	36	SE
April	13.8	15	35	50	48	SE
May	13.5	8	61	31	48	E
June	14.3	-	100	-	48	E
July	14.1	-	92	18	48	E
August	12.1	-	100	-	60	E
September	11.0	-	85	15	150	E
October	9.0	34	54	-	36	NE
November	8.8	89	-	-	36	NE
December	10.7	61	23	8	36	NW & E

The winds at Cayo, 60 miles inland, appear to be influenced by the local topography. The town lies at the lower northern end of the gorge of the Makal branch of Belize River which here runs from southeast to north, and the hills to the south appear to screen the town from winds from that direction, while the southwest-northeast hills to the north may also influence. Wind velocities at Cayo, estimated on the Beaufort scale are as shown in Table 5.

Table 5.—Wind Records for Cayo, British Honduras. (Registro de la Velocidad del Viento en Cayo, Honduras Británica)

Month (Mes)	Most Common Direction (Dirección más común)	Mean Velocity (Velocidad promedio) MPH
January	NE	6.0
February	NE	6.2
March	NE	11.2
April	NE	8.9
May	E	8.2
June	E	12.8
July	E	8.8
August	E	8.5
September	NE	?
October	NE	5.0
November	W	3.2
December	NE	3.5
Annual		7.5

Soil and Subsoil

Beneath seven of the plots the rock is believed to be white limestone of the Rio Dulce beds. The other five plots are on rock of metamorphic origin, slates, quartzites, etc. The soil varies from a heavy clay to a light silty loam with stones in some places. No humus is present. Leaf litter is generally sparse and the rate of disappearance fairly rapid. The soil varies with topography from 4 inches to 5 feet in depth with the subsoil well to poorly drained. Roots generally penetrate to 3 feet. Erosion is nil, runoff is slight, and drainage is generally free.

History of the Area

There is little information on this subject, and no signs of old cultivation were observed.

Biotic Factors

For the past 50 to 100 years mahogany exploitation has been carried out spasmodically, and at the present time there exists a fairly extensive system of "truck passes" throughout the area. This has resulted in a certain opening of the canopy in localised areas which are never extensive, and although such influence must necessarily have a definite effect on the structure of the vegetation it is considered to be negligible in the plot described.

There has been no widespread grazing. Animals employed on mahogany workings are grazed at the creek sides, and suitable palms and a limited variety of hardwoods of which Brosimum is the principal species are utilized for feeding purposes. This results in a certain opening of the vegetation over very small localized areas.

The effect of grazing or trampling by wild animals appears to be limited. Warrie pigs in herds of 50 or more roam the district and undoubtedly cause some destruction of the regeneration. The soil may be completely exposed and upturned over areas of one square chain or more in extent, but the effect on the vegetation as a whole must be considered small.

Termite nests are common throughout the district. They are usually oval in shape and seldom exceed three feet in height. Some form of support such as dead stumps or trunks of trees are utilized in building the nests. Subterranean termites are not uncommon but little is known of their habits. There is apparently little or no damage done to living vegetation as the termites appear to restrict themselves to dead timber and assist in the breaking down of fallen trees, branches,etc.

Wee wee ants, which live in the ground, are common and use living vegetation for their fungal "gardens." There is little information as to the extent of damage in uncultivated forests but it is known that these ants may cause serious defoliation in mahogany plantations and on citrus trees.

There was no sign of burning.

HIGH FOREST - ORBIGNYA-VIALIUM-VIROLA ASSOCIATION 1/

All 12 plots in this association were located in what is known as the Dry Creek Area near the eastern boundary of the Cayo District and in the Manatee area in the southwest corner of the Belize district.

Size and Nature of Plots Sampled

Eleven plots were 1/2 by 3 chains, the twelfth 1/2 by 4 chains, and all were divided into 1/2-chain squares. Palms and hardwoods more than 6 feet in height were enumerated separately by strata. Species of less than 6 feet in height were enumerated on parts of each plot with the exception of Selaginella which, where very abundant, was counted on only small sample areas within the plots.

The altitude of the plots ranges from 160 to 220 feet above sea level. Most of the plots were sheltered only three being slightly exposed. Aspect varied, with most of the plots facing east or northeast. All sites were nearly level.

1/ This description is based on data collected from 12 sample plots as summarized at the Tropical Forest Experiment Station, whereas the former article was based upon but one plot.

Structure and Composition

Structure

The canopy is generally closed. Occasional openings are usually due to the presence of emergents over the general canopy level or to windfalls. About 15 per cent (range 5 to 30 per cent) of the vegetation below the canopy level receives direct sunlight.

The spacing of emergents varies widely and there is a tendency toward grouping, with trees spaced as close as 20 feet in the groups and with the groups 200 to 600 feet apart. Spacing of canopy trees is generally regular at an average distance of 20 feet (range 10 to 60 feet). Variations are due to occasional dense groups of emergents or the presence of dense stands of Orbignya cohune. The trees of the subordinate layer are generally spaced 5 to 15 feet apart but may be grouped irregularly where Orbignya cohune is abundant or may occur as scattered individuals as much as 35 feet apart. Shrubs are spaced from 3 to 10 feet apart or in exceptional areas as much as 18 feet apart.

Apparently mature trees do not generally exceed 30 inches in diameter. The large trees in the plots have the following diameters:

	Diameter in inches
Pterocarpus hayesii	18
Calophyllum brasiliense	10
Symphonia globulifera	17
Erythroxylon sp.	12
Dialium guianense	14
Terminalia sp.	24
Pithecolobium sp.	28
Ceiba pentandra	48
Virola koschnyi	16
Spondias mombin	16
Guarea excelsa	19

The clarity of stratification varies greatly. The emergent stratum is generally clearly defined and is between 60 and 100 feet in height, although in one plot with a low canopy it starts at 45 feet. The canopy is easily distinguished from the emergents but generally not easily from the subordinate layer. This canopy occurs at about 50 feet, varying considerably from plot to plot (30 to 75 feet). The subordinate layer, at about 20 feet (range 10 to 35 feet) is variable both in composition and density. The presence of Orbignya cohune greatly affects the representation of hardwoods in this layer. In some plots this layer was open and composed of compact-crowned trees. The shrub layer, from 6 to 18 feet in height, is characterized by a heavy stand of Rinorea sp. and is denser than the subordinate layer except beneath palm stands. The upper field layer, 3 to

6 feet tall, is characterized by Heliconia aurantiaca and the lower field layer, 1 to 3 feet tall, is more dense and contains an abundant growth of Selaginella umbrosa.

Physiognomy and Life Form

Lianas are common to abundant, ascending to the tops of the emergents and causing some congestion in the canopy. Climbers are common and ascend to 50 feet in the upper part of the canopy. They are not confined to any one zone. Tillandsia sp. fairly common in the canopy and on emergents, is most abundant at the 30 to 50 feet level. The types noted are as follows:

1. Indeterminate small spade-shaped leaf tie tie on canopy, subordinate trees, and shrubs.

2. Indeterminate large spade-shaped leaf tie tie on emergents and canopy trees.

3. Indeterminate medium spade-shaped leaf tie tie occasional on emergents and canopy trees to 60 feet.

4. Indeterminate large heart-shaped leaf tie tie on emergents and canopy.

5. Basket tie tie on canopy.

6. Bellyfull tie tie on Orbignya cohune.

7. Vanilla-type creeper on canopy and subordinate trees and shrubs.

8. Tillandsia sp. on emergents.

9. Orchids occasional on emergents, canopy and subordinate trees.

10. Ferns from subordinates to emergents, no tree ferns found.

11. Mosses on most trees.

12. Matapalos rare, in canopy.

Trees with plant buttresses average about 15 per acre, and include:

Dialium guianensis
Virola koschnyi
Nectandra sp.
Pithecolobium sp.
Terminalia sp.
Pterocarpus hayesii
Ceiba pentandra
Sloanea sp.
Brosimum sp.

Relatively few trees have stilt roots, an average of about 8 per acre. The species included are:

Pourouma aspera
Symphonia globulifera
Piper sp.
Cecropia sp.

Pneumatophores, thorns, cauliflory, and succulent leaves and stems are absent. Numerous palms and the rattan Desmoncus are present. The palms include: Orbignya cohune, Chamaedorea sp., Synechanthus sp., and Geonoma sp.

Possibly half of the emergents are deciduous although this varied widely between plots. The canopy is almost entirely evergreen. Leaf fall takes place in January and February and new leaves are produced in March.

The types and sizes of leaves are shown in the Table 6.

Table 6.—Leaf Types and Sizes in High Forest Plots. (Tipos y Tamaños de las Hojas en los Arboles de Monte Alto)

Species (Especie)	Type (Tipo)	Number of leaflets (Número de foliolas)	Size[1] (Tamaño) Leaves (Hojas)	Size[1] (Tamaño) Leaflets (Foliolas)
Virola koschnyi	Simple		Mesophyll	
Calophyllum brasiliense	Simple		Mesophyll	
Guarea excelsa	Pinnate	5-7	Macrophyll	Mesophyll
Licania hypoleuca	Simple		Mesophyll	
Voschysia sp.	Simple		Mesophyll	
Lucuma sp.	Simple		Macrophyll	
Sloanea sp.	Simple		Macrophyll	
Rinorea sp.	Simple		Macrophyll	
Rheedia edulis	Simple		Mesophyll	
Dialium guianense	Pinnate	5-7	Mesophyll	Microphyll
Simaruba glauca	Pinnate	to 30	Mesophyll	Microphyll
Inga sp.	Pinnate	5-8	Macrophyll	Mesophyll
Pterocarpus hayesii	Pinnate	5-8	Macrophyll	Mesophyll
Protium copal	Pinnate	5-7	Macrophyll	Mesophyll
Mouriria sp.	Simple		Microphyll	
All palms	Pinnate	Numerous		
Terminalia sp.	Simple		Microphyll	
Aspidosperma megalocarpon	Simple		Mesophyll	
Brosimum sp.	Simple		Mesophyll	
Piper sp.	Simple		Mesophyll	
Guettarda sp.	Simple		Macrophyll	
Miconia sp.	Simple		Macrophyll	
Acacia sp.	Pinnate			Leptophyll

1/ Raunkiaer's leaf size classes.

Table 6.— Continued

Species (Especie)	Type (Tipo)	Number of leaflets (Número de foliolas)	Size (Tamaño)	
			Leaves (Hojas)	Leaflets (Foliolas)
Symphonia globulifera	Simple		Mesophyll	
Cupania sp.	Pinnate	5-7	Macrophyll	Mesophyll
Nectandra sp.	Simple		Mesophyll	
Achras sp.	Simple		Mesophyll	
Pithecolobium sp.	Bipinnate		Mesophyll	Microphyll
Ceiba pentandra	Palmate	7	Macrophyll	Mesophyll
Spondias mombin	Pinnate		Mesophyll	Microphyll
Stemmademia donnell-smithii	Simple		Mesophyll	
Zanthoxylum sp.	Simple		Mesophyll	
Guazuma ulmifolia	Simple		Mesophyll	
Podocarpus sp.	Simple		Microphyll	
Pseudalmedia sp.	Simple		Mesophyll	
Coccoloba sp.	Simple		Macrophyll	
Andira sp.	Pinnate	7-13	Mesophyll	Microphyll
Calocarpum sp.	Pinnate		Macrophyll	
Guarea guara	Pinnate	5	Macrophyll	Mesophyll

The field and ground layers are variable in their life forms. In two plots there was an abundance of small hardwood seedlings and numerous palms. Tall herbs and ferns were generally absent. Selaginella umbrosa was abundant, with as many as 850,000 individuals per acre in one plot. No annual plants were noted, and there is apparently no seasonal dying down of the field and ground layers.

Reproduction

Dialium guianense produces abundant seed in small one-seeded globose fruits which do not open and are said to be a favorite fruit of animals. No vegetative reproduction was noted.

The distribution of seedbearers, saplings, and seedlings of the principal species in the 12 plots combined is as shown in Table 7.

Table 7.— Seedbearers, Saplings, and Seedlings in High Forest, by Species. (Portagranos, Latizales y Brinzales por Especie en el Monte Alto)

Species (Especie)	Seedbearers (Portagranos)	Saplings (Latizales)	Seedlings (Brinzales)
Calophyllum braziliense	8	25	284
Virola sp.	9	6	37
Licania hipoleuca	11	29	71

Table 7.— Continued

Species (Especie)	Seedbearers (Portagranos)	Saplings (Latizales)	Seedlings (Brinzales)
Melastomaceae sp.	26	52	99
Sloanea berteriana	8	28	17
Protium copal	19	28	138
Mouriria sp.	10	9	16
Dialium guianensis	8	1	6
Erythroxylon sp.	2	-	-
Ceiba pentandra	4	-	-
Lucuma sp.	11	42	69
Rheedia edulis	7	18	150
Rinorea sp.	129	150	266
Spondias mombin	7	-	4
Aspidosperma megalocarpon	4	8	7
Nectandra sp.	2	-	1
Pourouma aspera	5	9	216
Pithecolobium sp.	2	2	160
Stemmademia donnell-smithii	9	5	5
Pterocarpus hayesii	2	-	9
Symphonia globulifera	4	2	13
Inga sp.	3	2	13
Simaruba glauca	7	3	1
Miconia sp.	9	16	25
Achras zapote	1	-	-
Guarea sp.	12	14	65
Guarea guarea	11	3	46
Guarea excelsa	4	2	12

Floristic Composition

The emergent layer averages 15 trees per acre, ranging from 6 to 49 in the plots, but varies widely. The most prominent species are:

Dialium guianense
Virola koschnyi
Orbignya cohune
Pterocarpus hayesii
Calophyllum brasiliense
Symphonia globulifera
Simaruba glauca
Pourouma aspera
Inga sp.
Pithecolobium sp.
Ceiba pentandra
Spondias mombin
Terminalia amazonia
Pseudolmedia sp.
Cordia sp.

The canopy averages 130 hardwoods per acre varying from 92 to 263, and 25 palms varying from 6 to 136 per acre, including:

Calophyllum brasiliense
Pourouma aspera
Virola brachycarpa
Orbignya cohune

Rheedia edulis
Lucuma sp.
Symphonia globulifera
Miconia sp.
Protium copal
Licania hypoleuca
Simaruba glauca
Guarea sp.
Inga sp.
Mouriria sp.
Cecropia sp.
Euterpe panamensis
Xylopia sp.
Cupania sp.
Melastomaceae spp.
Podocarpus guatemalensis
Pithecolobium sp.
Nectandra sp.
Achras zapote
Aspidosperma megalocarpon
Spondias mombin
Stemmadenia donnell-smithii
Sloanea sp.
Guarea excelsa
Cassipourea podantha
Coccoloba sp.
Persea sp.

The subordinate layer is composed of an average of 242 hardwoods per acre, varying from 76 to 800, and 172 palms, ranging from 13 to 719 per acre, including:

Crysophila argentea
Protium copal
Cupania sp.
Voschysia sp.
Sloanea sp.
Eugenia capub
Chamaedorea sp.
Rinorea sp.
Brosimum alicastrum
Miconia sp.
Persea s p.
Sabal sp.
Geonoma glauca
Piper sp.

The shrub layer is composed of an average of 530 hardwoods per acre, varying from 275 to 1000, and 423 palms, ranging from 0 to 1,956 per acre, including:

Synechanthus sp.
Crysophila argentea
Rinorea sp.
Brosimum alicastrum
Geonoma glauca
Alsophila mysorides
Cephaelis sp.
Piper sp.
Anona squamosa
Carica dolichensis
Miconia sp.
Protium copal
Lucuma belizensis
Bactris sp.
Mouriria sp.
Chamaedorea sp.
Synechanthus sp.
Guarea sp.

The upper field layer is a stratum of hardwood seedlings averaging 571 to the acre and varying from 440 to 1280 with small palms averaging 198 to the acre, varying from 171 to 1660, together with *Heliconia aurantiaca*, which is fairly abundant averaging 695, and ranging from 306 to 5656, including the following species:

Chamaedorea sp.
Bactris sp.
Rinorea sp.
Lucuma belizensis
Synechanthus sp.
Heliconia aurantiaca
Piper sp.
Miconia sp.

Geonoma glauca
Cephaelis tormentosa
Stemmadenia donnell-smithii
Schizolobium parahybum
Protium copal
Crysophila argentea
Erythrina sp.

The lower field layer contains an average of 1,450 hardwoods per acre, with the range from 620 to 8000; an average of 606 palms, ranging from 620 to 2,633; and an average of 73,890 ferns, ranging from 104 to 448,000 per acre including:

Selaginella umbrosa
Chamaedorea sp.
Geonoma glauca
Rinorea sp.
Protium copal
Cephaelis sp.
Bactris sp.
Eugenia sp.
Synechanthus sp.
Piper sp.
Miconia sp.
Mouriria sp.
Stemmadenia sp.
Cephaelis tormentosa
Calocarpum mimosum
Anona squamosa

The general appearance of the forest is seen in Figures 1 to 3.

A list of species with common names appears below.

Scientific Name (Nombre Científico)	Common Name (Nombre Común)
Achras zapote	Sapodilla macho
Alsophila mysorides	
Andira sp.	Cabbage bark
Annona squamosa	Wild Custard Apple
Aspidosperma megalocarpon	My lady
Bactris sp.	Hone
Brosimum alicastrum	
Carica dolichensis	Wild Pawpaw
Cassipourea podantha	Water wood
Calocarpum sp.	
Calophyllum brasiliense	Santa María
Cecropia sp.	Trumpet
Ceiba pentandra	Cotton
Cephaelis sp.	African root
Cephaelis tormentosa	
Chamaedorea sp.	Pacaya
Coccoloba sp.	Wild grape
Cordia sp.	Jackwood
Crysophila argentea	Give and take
Cupania sp.	Grande betty
Desmoncus sp.	Rattan
Dialium guianensis	Ironwood
Erythrina sp.	Tiger wood
Erythroxylon sp.	Redwood
Eugenia sp.	Cacho venado
Eugenia capub	Walk naked
Euterpe panamensis	Mountain cabbage

Fig. 1.—A Typical Profile in the Orbignya-Dialium-Virola Association, B.H. Plot 23
(Croquis de un Perfil Típico de la Asociación Orbignya-Dialium-Virola, H.B. Lote 23)

Key to Species. (Clave)

1.	Aspidosperma megalocarpon	11.	Coccoloba sp.
2.	Erythroxylon sp.	12.	Guettarda sp.
3.	Dialium guianense	13.	Terminalia amazonia
4.	Rinorea sp.	14.	Lucuma belizensis
5.	Eugenia capub	15.	Licania hypoleuca
6.	Lucuma sp.	16.	Virola koschnyi
7.	Brosimum alicastrum	17.	Symphonia globulifera
8.	Cassipourea podantha	18.	Cupania sp.
9.	Sabal mauritiiformis	19.	Miconia sp.
10.	Andira sp.	x	Indeterminate

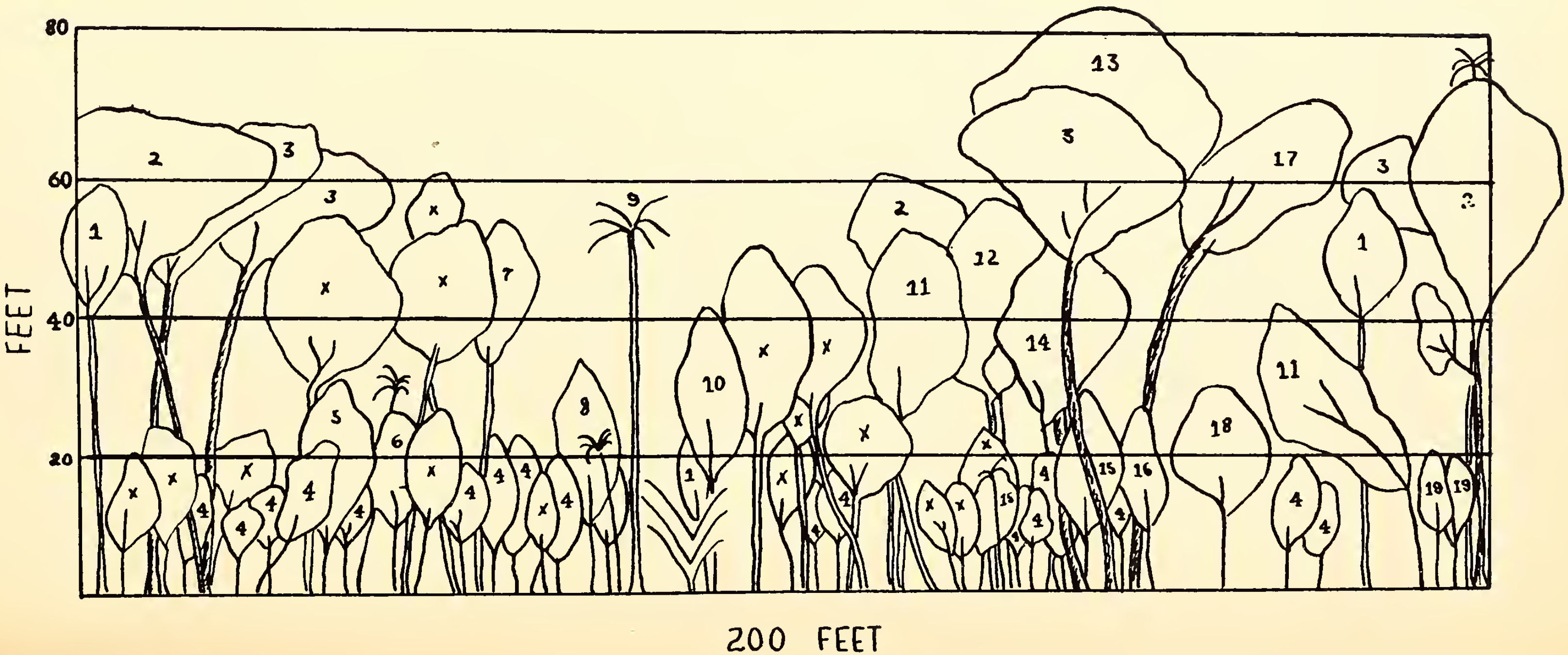


Fig. 2.—A Typical Profile in the Orbignya-Dialium-Virola Association, B.H. Plot 15
(Croquis de un Perfil Típico de la Asociación Orbignya-Dialium-Virola, H.B. Lote 15)

Key to Species. (Clave)

1. Guarea excelsa
2. Aspidosperma megalocarpon
3. Calophyllum brasiliense
4. Guarea sp.
5. Protium copal
6. Dialium guianensis
7. Coccoloba sp.
8. Lucuma sp.
9. Rheedia edulis
10. Pterocarpus hayesii
11. Piper sp.
12. Cecropia sp.
13. Symphonia globulifera
14. Cassipourea podantha
15. Trophis sp.
16. Ceiba pentandra

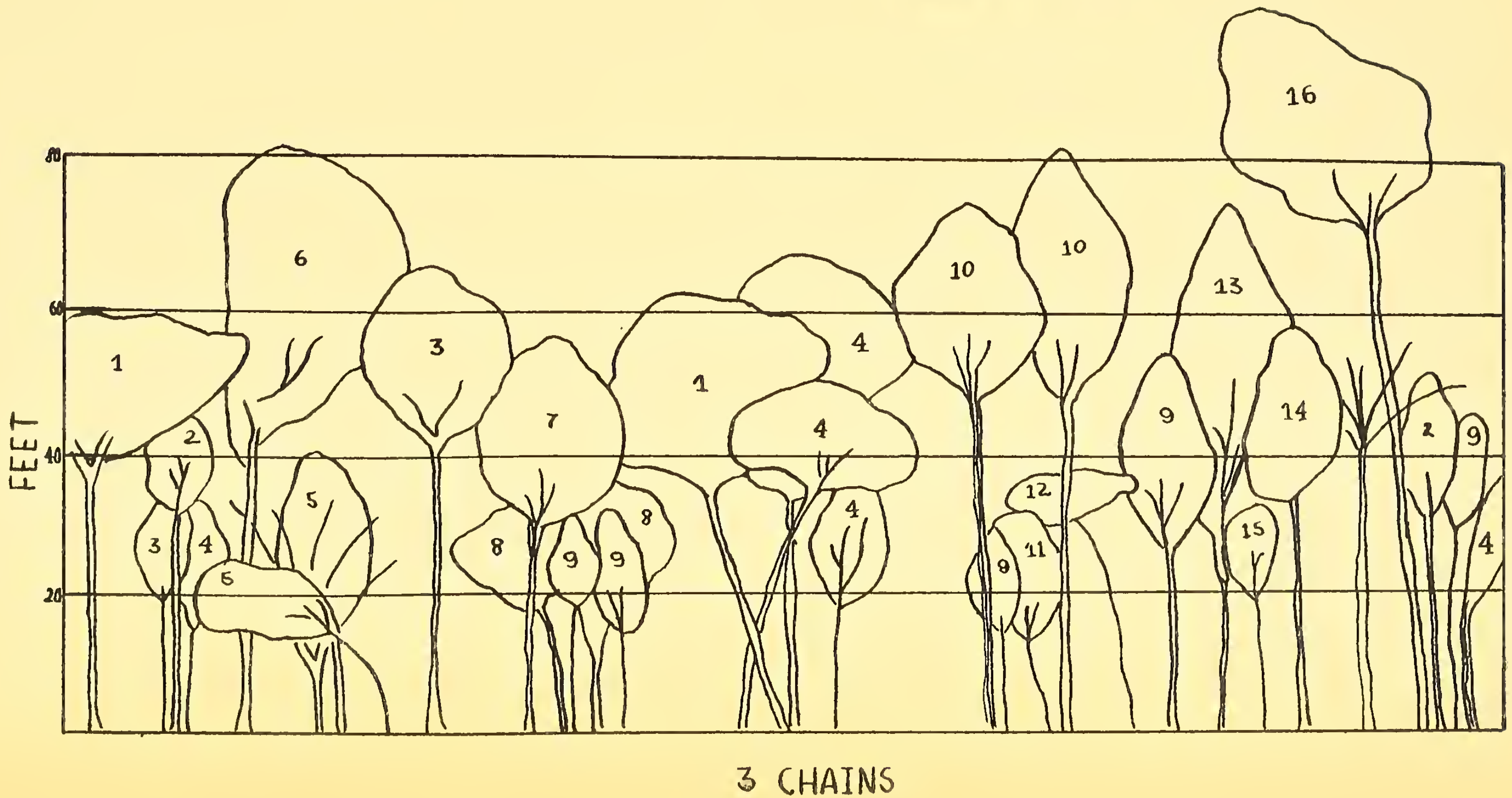
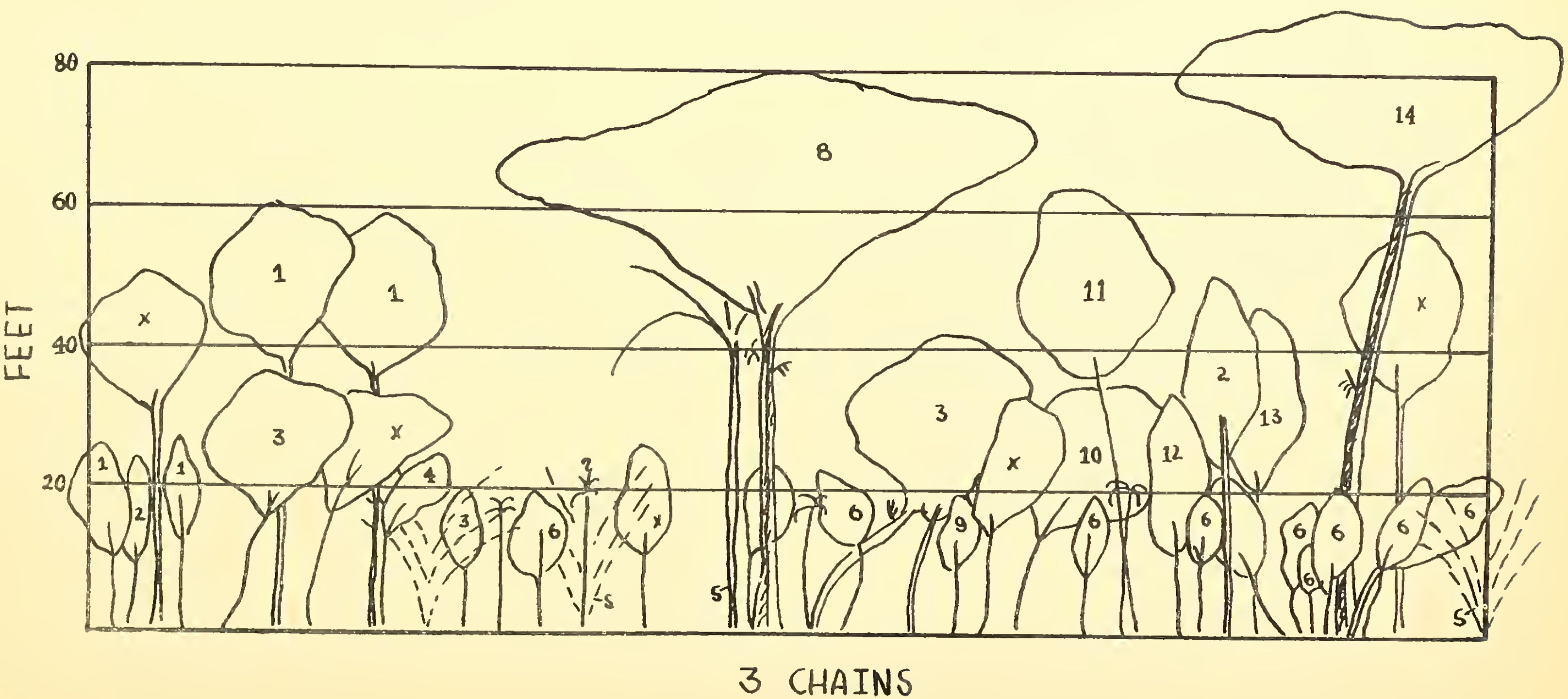


Fig. 3.— A Typical Profile in the Orbignya-Dialium-Virola Association, B.H. Plot 25
(Croquis de un Perfil Típico de la Asociación Orbignya-Dialium-Virola, H.B. Lote 25)

Key to Species. (Clave)

1. Nectandra sp.
2. Aspidosperma megalocarpon
3. Lucuma sp.
4. Protium copal
5. Orbignya cohune
6. Rinorea sp.
7. Crysophila argentea
8. Pithecolobium sp.
9. Dialium guianense
10. Guarea sp.
11. Achras zapote
12. Brosimum alicastrum
13. Pithecolobium sp.
14. Ceiba pentandra
x Indeterminate



Scientific Name (Nombre Científico)	Common Name (Nombre Común)
Geonoma glauca	Capuka
Guarea sp.	White copal, Bastard Cramantee
Guarea excelsa	Cramantee
Guarea guarea	
Guazuma ulmifolia	
Guettarda sp.	Glasswood
Heliconia sp.	Vaha
Heliconia aurantiaca	
Inga sp.	Bribri
Inga sp.	Tama tama
Licania hypoleuca	Pidgeon plum
Lucuma sp.	Mammee ciruela
Lucuma belizensis	Silion
Miconia sp.	Maya
Mouriria sp.	Jug
Nectandra sp.	Timber sweet
Orbignya cohune	
Persea sp.	Wild pear
Piper sp.	Spanish elder
Pithecolobium sp.	Barba Jolote
Pithecolobium sp.	Tamarind
Pithecolobium sp.	John Crow Bead
Pourouma aspera	Mountain Trumpet
Protium copal	Red copal
Pseudolmedia sp.	Cherry
Pterocarpus hayesii	Mountain Kaway
Quararibea sp.	Coco mama
Rheedia edulis	Waika plum
Rinorea sp.	Wild coffee
Sabal mauritiiformis	Batam Palm
Sabal sp.	Bayleaf
Selaginella umbrosa	
Schizolobium parahybum	Quam wood
Simaruba glauca	Negrito
Sloanea sp.	Wild atta
Spondias mombim	Hog plum
Stemmademia donnell-smithii	Cojotone
Swietenia sp.	
Symphonia globulifera	Waika chewstick
Synechanthus sp.	Monkey tail
Terminalia amazonia	Nargusta
Tillandsia sp.	Wild pine
Trophis sp.	Red Ramon
Virola brachycarpa	Bastard Banak
Virola koschnyi	White Banak
Vochysia sp.	Yemeri
Xylopia sp.	
Zanthoxylon sp.	

(Traduccion del artículo anterior)

ALGUNAS ASOCIACIONES FORESTALES DE HONDURAS BRITANICA, II

PREAMBULO

El reconocimiento de las características fundamentales de los variados tipos de vegetación forma parte de la base esencial sobre la que descansa el trabajo de los técnicos forestales y demás investigadores que tienen que ver con la utilización del terreno, pero la ecología forestal tropical está todavía en pañales, los métodos de atacar el problema son numerosos, los datos acumulados son a menudo incompletos y no existe ningún libro simple que guíe al investigador en su trabajo en el campo o en el bosque. ¿Cómo se empieza? ¿Cómo puede uno estar seguro de que su propio trabajo habrá de ser comprendido? ¿Cómo evaluar los trabajos de los demás hombres de ciencia y apreciar las posibilidades de su aplicación en los diversos países?

En el 1938 el extinto Dr. J. Burtt Davey, del Instituto Forestal Imperial en Oxford indicó una solución, que puede resumirse como un registro "sistemático" de datos con detalles completos e imparciales, de acuerdo con un plan uniforme. El urgió el uso de un cuestionario que requería respuestas tanto negativas como positivas, y su proposición fué examinada, ampliada y simplificada por otros ecólogos ingleses competentes, los señores Richards, Tansley y Watt en la Disertación núm. 19 del Instituto Forestal Imperial que llevaba por título "El Registro de la Estructura, Biotipos y Flora de las Comunidades Forestales Tropicales como Base para su Clasificación."

Este método fué favorablemente acogido en Honduras Británica, donde ya habíamos tropezado con los sinsabores a que conducen los datos incompletos, las generalizaciones vagas y el pasar por alto los hechos inconvenientes, tanto así que durante la visita que hiciera el señor Bevan a la colonia aprovechamos esa oportunidad de discutir con él la trascendencia de la publicación de las descripciones que ya habíamos esbozado de las asociaciones, siguiendo el referido plan del Instituto Forestal Imperial. Nosotros decidimos que bien podría tener valor para el área del Caribe, el publicar dichas descripciones eludiendo toda discusión de la sucesión y absteniéndonos de usar tales términos de tipos generales como "bosque deciduo" o "bosque pluvioso alto" hasta que estuviéramos seguros de la verdadera concordancia de las asociaciones descritas.

En las descripciones de asociaciones que hemos sometido para ser publicadas en el "Caribbean Forester" pudiera darse el caso de que tipos forestales similares fueren descritos como asociaciones diferentes pero creemos que cuando la red de asociaciones de toda la América Tropical Caribe sea examinada y analizada, solamente entonces tendremos una idea clara de los tipos básicos de vegetación, junto con sus correspondientes asociaciones.

Las descripciones que siguen a esta breve introducción fueron hechas por el señor J. H. Nelson Smith en un área examinada por el señor C. F. Charter en un reconocimiento de investigación relativo a suelos. El área está ubicada de 5 a 10 millas al norte de la parte superior del valle Stann Creek en la región karst al norte de la Colonia. Es una planicie entre 200 a 400 pies de altura que contiene numerosas colinas calizas empinadas que alcanzan hasta 400 pies de altura. Algunos arroyos que corren en dirección al norte y nacen en el macizo central adyacente al sur atraviesan el área. En el borde de los arroyos, y en bandas de anchura variable encontramos suelos de aluvión provenientes del lavado de esquistos, areniscas, cuarcitas y grano-dioritas del macizo. En las cercanías de las hoyas Charter se señalaron cuarteles con compás y cadenas, por lo regular de tres cadenas de largo por media de ancho.

Este área fué dividida en secciones de media cadena cuadrada. Los diversos estratos de vegetación fueron enumerados sección por sección excepto en los casos en que las capas subarbustiva y arbustiva eran tan densas que fueron enumeradas sólo en una o dos secciones. Las especies subordinadas y de copa fueron contadas en todos los cuarteles. Después de enumeradas se hizo un dibujo según escala de la estratificación de la vegetación que incluía todas las especies de más de 15 pies de altura. Cuarteles más grandes hubieran dado mejor resultado pero no había tiempo suficiente.

El señor Nelson Smith sugirió que el uso de cuarteles de 10 cadenas por 1/2 cadena, con las líneas de cruce para las especies más importantes colocadas formando ángulos rectos con el eje longitudinal, sería un tamaño más adecuado para el examen minucioso pero el tamaño del cuartel depende casi siempre del tipo de vegetación a estudiarse y el tiempo que el investigador tiene a su disposición.

El área está ubicada al norte del macizo principal de colinas y se cree que su clima es intermedio entre el de Belize, Cayo y Stann Creek. Probablemente no es tan caliente como Agstat, Stann Creek o Cayo ni tan húmedo como en el valle de Stann Creek.

Temperatura

Los límites de temperatura aparecen en la Tabla 1. (Véase texto en inglés)

Precipitación

La precipitación mensual aparece en la Tabla 2. (Véase texto en inglés)

En Belize el número promedio de días sin lluvia al año es de 184; en Cayo 240; y en Stann Creek, Agstat, 172. La estación seca que incluye sólo los meses en que la precipitación media mensual no pasa de 4 pulgadas dura desde febrero hasta abril en las tres Estaciones de Belize, Cayo y Stann Creek. Los límites climáticos aparecen en la Tabla 3. (Véase texto en inglés)

Viento

Es probable que los vientos prevalecientes sobre este área son modificados por el macizo de altas colinas al sur y las numerosas colinas calizas al este y oeste.

La dirección general del viento es hacia el este, con una velocidad promedio de cerca de 12 millas por hora. La velocidad máxima raras veces excede 36 millas por hora y según los registros de 16 años solamente el 15 por ciento de las velocidades máximas durante ese período excedieron esta cifra.

La Colonia, particularmente por su parte norte se ve ocasionalmente azotada por huracanes tropicales que llevan consigo vientos veloces y fuertes lluvias. Los registros, excepción hecha de los de la capital, son incompletos y de los 8 huracanes de los últimos 150 años, 7 han tocado a Belize.

Durante los meses de invierno tienen lugar las nortadas, con velocidades moderadamente altas y temperaturas algo bajas. Estos vientos son continuos, a veces durante días, mientras que las velocidades máximas del este y sudeste son casi siempre sólo borrascas.

Los vientos en Belize durante el período de 1924-36 según fueron registrados en un anemómetro estandard a 45.7 pies sobre la tierra aparecen en la Tabla 4. (Véase texto en inglés)

Los vientos en Cayo, 60 millas tierra adentro, parecen estar influenciados por la topografía local. La ciudad está situada en el extremo más bajo al norte del desfiladero del tributario Makal del Río Belize que por aquí corre del sudeste al norte, y las colinas al sur parece que escudan la ciudad contra los vientos que vienen en esa dirección, mientras que las colinas que vienen del sudoeste al noroeste por el norte parecen ejercer influencia también. Las velocidades del viento en Cayo, calculadas por medio de la escala Beaufort aparecen en la Tabla 5. (Véase texto en inglés)

Suelo y Subsuelo

La roca madre de 7 de los cuarteles parece ser piedra caliza blanca de los cauces del Río Dulce. La roca madre de los otros cinco cuarteles es de origen metamórfico, esquistos, cuarcitas, etc. El suelo varía de arcilla pesada a un suelo limoso lómico, con piedras en algunos sitios. No hay humus presente. La hojarasca es escasa y desaparece con bastante rapidez. El suelo varía de 4 pulgadas a 5 pies de profundidad según la topografía y el drenaje del subsuelo varía de bueno a defectuoso. Por lo general las raíces penetran hasta 3 pies. La erosión es nula, el deslave es leve y el drenaje es casi siempre libre.

Historia del Area

La información sobre este aspecto es muy escasa y no hay indicios de cultivos previos.

Factores Bióticos

En los últimos 50 a 100 años se ha explotado la caoba sin regularidad y hoy día existe un sistema bastante extendido de "pases de camión" a través del área. Esto ha dado como resultado la abertura del dosel o techo forestal en ciertos puntos, aunque nunca son extensos y, aún cuando esta acción tiene que tener necesariamente una influencia definida sobre la estructura de la vegetación, es considerada como insignificante en los cuarteles descritos.

El pastoreo no se ha difundido por esta región. Los animales empleados en la explotación de la caoba se han apacentado a los lados de la quebrada usando como alimento ciertas palmas y una variedad limitada de los árboles de maderas duras de los cuales Brosimum es la principal especie utilizada. Esto dió como resultado pequeños claros en áreas localizadas, muy pequeñas.

El efecto del pisoteo y apacentamiento de los animales salvajes parece ser muy limitado. Cerdos en manadas de 50 o más vagan por el distrito y sin duda causan alguna destrucción de la regeneración. El suelo puede estar completamente expuesto y levantado sobre áreas de una cadena cuadrada o más pero su efecto en toda la vegetación puede considerarse ínfimo.

Los termiteros son comunes en todo el distrito, son casi siempre de forma ovalada y raras veces exceden 3 pies de altura. Para construir los nidos los termes se sirven de tocones muertos o troncos. Los termes subterráneos no escasean pero se desconocen sus hábitos. Aparentemente no perjudican la vegetación viva, ya que los termes están confinados a la madera muerta y ayudan a desbaratar los árboles y ramas caídas, etc.

Hormigas de tierra abundan y hacen "jardines" fungosos en la vegetación viva. Hay poca información acerca del alcance del daño en los bosques naturales pero se sabe que esta hormiga puede causar defoliaciones graves en las plantaciones de caoba y en árboles citrosos.

No había señales de quemas.

ASOCIACION ORBIGNYA-DIALUM-VIROLA DE MONTE ALTO[1]

Los doce cuarteles en esta asociación estaban ubicados en lo que se conoce como Area Dry Creek cerca del lindero este del distrito de Cayo y en el Area Manatee en la esquina sudoeste del Distrito de Belize.

1/ Esta descripción está basada en los datos recopilados para 12 cuarteles de prueba según fueron analizados en la Estación Forestal de Experimentación Tropical mientras que el artículo previo estaba basado en un cuartel.

Tamaño y Naturaleza de los Cuarteles Señalados

Once cuarteles tenían 1/2 por 3 cadenas, el duodécimo tenía 1/2 por 4 cadenas y todos estaban divididos en cuadrados de 1/2 cadena. Las palmas y árboles de maderas duras de más de seis pies de altura fueron enumerados separadamente por estratos. Las especies de menos de 6 pies de altura se enumeraron en partes de cada cuartel con la excepción de *Selaginella* que se contó sólo en pequeñas áreas en donde abundaba mucho.

Los cuarteles están situados de 160 a 220 pies sobre el nivel del mar. La mayoría de los cuarteles están abrigados y sólo tres están ligeramente expuestos. El aspecto varía pero la mayoría de los cuarteles dan al este o al noroeste. Todos los sitios eran casi planos.

Estructura y Composición

Estructura

Las copas son generalmente cerradas. Los calveros que aparecen ocasionalmente se deben a la presencia de emergentes sobre el nivel de copa general o a la influencia del viento. Del 5 al 30 por ciento de la vegetación bajo el nivel de copa recibe luz directa.

El espaciamiento de los emergentes varía mucho y existe la tendencia hacia la agrupación, con árboles con sólo 20 pies de separación y con los grupos de 200 a 600 pies de separación. El espaciamiento de los árboles de copa es generalmente regular con distancias promedio de 20 pies (fluctuando entre 10 y 60 pies). Las variaciones se deben a agrupamientos densos ocasionales de los emergentes o a la presencia de densas masas de *Orbignya cohune*. Los árboles de la capa de subordinados tienen generalmente un espaciamiento de 5 a 15 pies pero pueden estar irregularmente agrupados allí donde abunda la *Orbignya cohune* o pueden también encontrarse hasta a 35 pies de separación. Los arbustos tienen un espaciamiento de 3 a 10 pies y en áreas excepcionales tanto como 18 pies.

El diámetro de los árboles maduros aparentemente no pasa de 30 pulgadas. Los árboles más grandes en los cuarteles tienen los siguientes diámetros: (Véase la página 51)

La delimitación de la estratificación varía considerablemente. El estrato emergente está por lo general claramente definido entre 60 y 100 pies de altura, excepción hecha de un cuartel que tiene el estrato de copa tan bajo que hace que el emergente empiece en los 45 pies. El estrato de copa se distingue bien de los emergentes pero por lo general se confunde con el estrato subordinado. El estrato de copa aparece generalmente a los 50 pies aunque varía considerablemente en los diversos cuarteles (de 30 a 75 pies). La capa de subordinados que está cerca de los 20 pies (fluctuando entre 10 y 35 pies) es variable, tanto en composición como en densidad. La presencia de *Orbignya cohune* afecta grandemente la representación de los árboles de maderas duras en este estrato. En algunos cuarteles este estrato es abierto y compuesto de árboles de copa compacta. El estrato arbustivo, de 6 a 8 pies de altura, está caracterizado por una masa abundante de

Rinorea sp. y es más denso que el estrato arbóreo subordinado excepto bajo las masas de palmas. El estrato subarbustivo superior, de 3 a 6 pies de alto está caracterizado por la presencia de Heliconia aurantiaca y el estrato subarbustivo inferior de 1 a 3 pies de alto es más denso y contiene Selaginella umbrosa en abundancia.

Fisionomía y Biotipos

Las lianas son de comunes a abundantes y ascienden hasta las puntas de los emergentes causando alguna congestión en la copa. Las enredaderas son comunes y ascienden hasta 50 pies en la parte superior del estrato de copa. No están confinadas a ninguna zona en particular. La Tillandsia sp. bastante común en los árboles coposos y en los emergentes es más abundante de los 30 a los 50 pies. Los biotipos presentes son:

1. Bejuco indeterminado de hoja menuda en forma de azada que crece en los árboles de copa, subordinados y en los arbustos.

2. Bejuco de hoja grande y en forma de azada en los emergentes y los árboles de copa.

3. Bejuco de hoja mediana y en forma de azada que ocasionalmente se encuentra en los árboles emergentes y de copa hasta 60 pies.

4. Bejuco indeterminado de hoja grande y cordiforme, en los emergentes y árboles de copa.

5. Bejuco de canasta en el estrato de copas.

6. Bejuco panzudo en Orbignya cohune.

7. Enredaderas del tipo vainilla en el estrato de copas y subordinados.

8. Tillandsia sp. en los emergentes.

9. Orquídeas ocasionalmente en los emergentes, coposos y subordinados.

10. Helechos de los subordinados hasta los emergentes, los helechos arborescentes ausentes.

11. Musgos en la mayoría de los árboles.

12. Matapalos raros, en el estrato de copas.

Los árboles con raíces columnares que aparecen en un promedio de 15 por acre aparecen en la página 52.

Relativamente pocos árboles tiene raíces zancos es decir un promedio de 8 por acre en las especies que aparecen en la página 53.

October 1944
January 1945

No hay ni neumatóforos, espinas, plantas caulifloras, ni hojas ni tallos suculentos.

Numerosas palmas y la rota Desmoncus están presentes. Entre las palmas se encuentran: Orbignya cohune, Chamaedorea sp., Synechanthus sp. y Geonoma sp.

Posiblemente la mitad de los emergentes son deciduos, aunque ésto variaba considerablemente de acuerdo con los cuarteles. Las copas eran casi por completo perennifolias. La caída de la hoja se efectúa en enero y febrero y las hojas nuevas salen en marzo.

Los tipos y tamaños de las hojas aparecen en la Tabla 6. (Véase el texto en inglés)

Los estratos subarbustivos y rasante son variables en sus biotipos. En dos cuarteles había abundancia de brinzales de especies de madera dura y de numerosas palmas. No había ni matas altas ni heleches altos. Había abundancia de Selaginella umbrosa a veces tantas como 850,000 por acre. No se observaron plantas anuales y aparentemente los estratos rasante y subarbustivo prevalecen siempre.

Reproducción

El Dialium guianense produce semilla en abundancia en frutas globosas, indehiscentes, de una semilla, las que son apetecidas por los animales. No se observó ninguna reproducción por brotes.

La distribución de portagranos, latizales y brinzales de las especies principales en los 12 cuarteles combinados aparecen en la Tabla 7. (Véase el texto en inglés).

Composición Florística

El estrato emergente tiene un promedio de 15 árboles por acre, que fluctúan de 6 a 49 en los cuarteles, pero varían considerablemente. Las especies más prominentes aparecen en la página 55.

El estrato de árboles de copa tiene un promedio de 130 árboles de madera dura por acre, que fluctúan entre 92 y 263 y 25 palmas por acre, que fluctúan entre 6 y 136 por acre y entre las que se encuentran las que aparecen en las páginas 55 y 56.

El estrato de especies subordinadas tiene un promedio de 242 especies de madera dura por acre, que fluctúan entre 76 y 800 y un promedio de 172 palmas que fluctúan entre 13 y 719 por acre y que incluyen las que aparecen en la página 56.

El estrato arbustivo está compuesto de un promedio de 530 especies de maderas duras por acre, que fluctúan entre 275 y 1000 y un promedio de 423 palmas que fluctúan entre 0 y 1,956 por acre entre las que encontramos las que aparecen en la página 56.

El estrato subarbustivo superior tiene un promedio de 571 brinzales de especies de maderas duras por acre y que fluctúan entre 440 a 1,280, junto con palmitas con un promedio de 198 por acre, que varían entre 171 y 1,660 junto con Heliconia aurantiaca, la cual abunda mucho, con un promedio de 695 fluctuando entre 306 y 5656, incluyendo las que aparecen en las páginas 56 y 57.

El estrato subarbustivo inferior contiene un promedio de 1,450 brinzales de especies de madera dura por acre, que fluctúan entre 620 y 2,633 y un promedio de 73,890 helechos y musgos por acre, que fluctúan entre 104 y 448,000 y entre los cuales encontramos los que aparecen en la página 57.

El aspecto general del bosque puede apreciarse en los dibujos 1 al 3.

La lista de los nombres científicos y vulgares de las especies aparece al final del original en inglés.

Résumé

La recherche des caractéristiques fondamentaux des différents types de végétation est une des tâches essentielles qui incombent au forestier des tropiques. Le meilleur essai fait pour régulariser et ordonner la classification des types de végétation fut celui du feu Dr. J. Burtt Davey dans sa méthode systématique pour enregistrer les données d'une manière complète et impartiale, remplis de détails et selon un plan minutieusement tracé. Sa proposition, quelque modifiée et publiée comme Etude numéro 19 de l'Institut Forestier Impérial par Richards, Tansley et Watt est devenue la base de toutes les études écologiques récentes dans l'Honduras britanique.

L'idée maîtresse de l'auteur de ce travail-ci c'est de mettre à disposition des investigateurs des pays voisins des descriptions qui constituent le résultat de ses expériences sans oublier le fait que la position relative de celles forêts-ci dans la classification écologique et systématique génerale n'est pas nettement établie.

La surface forestière étudiée est située entre 5 et 10 milles vers le nord de la Vallée Stann Creek. Elle occupe un sol assez plat, fluctuant entre 200 et 400 pieds d'altitude et renfermant plusieurs collines calcaires à pente rapide. La température range depuis 60°F jusqu'à 90°F et la chute pluviométrique annuelle range depuis 66 jusqu'à 95 pouces. La saison sèche dure depuis le mois de février jusqu'en avril. La direction des vents est vers l'est, avec une vitesse moyenne de près de 12 milles l'heure. Le sol varie d'une argile lourd à une glaise boueuse legère et quelquefois pierreuse dans certains endroits. Le drainage naturel est généralment satisfaisant et les racines penètrent jusqu'à 3 pieds.

L'association Orbignya-Dialium-Virola dans la forêt de haute futaie exposée dans cet article fut étudiée parmi 12 parcelles d'espérimentation

chacune 0,1 ou 0,2 acres. Les arbres de plus de 6 pieds d'altitude ont été énumérés séparément par strates ou couches selon leur hauteur et ceux de moins de 6 pieds ont été comptés seulement dans les parcelles plus petites.

Les arbres formant la couche du dais (voûte foliacée) sont très serrés avec 15% de la végétation sous le dais recevant directement les rayons du soleil. Au-dessus se trouvent occasionnellement des emergents généralment en groupes avec un écartement de 200 à 600 pieds entre les groupes. Les arbres du dais sont régulièrement espacés avec une distance de 20 pieds entre eux. Les arbres de l'étage des subordinés ont un écartement de 5 à 15 pieds et les arbrisseaux de 3 à 10 pieds. Les arbres plus grands, avec leurs grosseurs maxima sont énumerés à la page 51.

Les strates ne sont pas faciles de distinguer exception fait de la voûte foliacée ou dais et l'étage des émergents. Les émergents ont depuis 60 jusqu'à 100 pieds de hauteur; la voûte foliacée (ou dais) tient autour de 50 pieds de hauteur; l'étage subordiné autour de 20 pieds; l'étage des arbrisseaux de 6 à 18 pieds, et l'étage inférieur ou couverture herbacée au-dessous 6 pieds. Les lianes et les plantes grimpantes sont abondantes. Tillandsia sp. se trouve parmi les émergents et les arbres du dais. Les arbres avec empâtements en éperon sont énumerés à la page 52. Les arbres avec contreforts de soutien ou échasses sont énumerés à la page 53. Les palmiers sont très abondants et parmi eux on trouve Orbignya cohune, Chamaedorea sp., Synechanthus sp. et Geoncma sp.

Possiblement la moitié des émergents sont décidus. Le dais est presque tout sempervirent. La chute des feuilles a lieu en janvier et février et les feuilles nouvelles apparaissent en mars. Les types et dimensions des feuilles sont représentés a la Table 6.

Dans la cinquième et sixième couches c'est-à-dire le sous-étage et l'étage inferieure on ne trouve que rarement des herbes ou fougères hauts, mais une abondance de brins de semences des palmiers et des arbres de bois dur. Selaginella umbrosa est très abondant mais on n'y trouve des plantes annuelles.

La distribution des arbres semenciers, plants de basses-tiges et les brins de semences des essences principaux sont montrés dans la Table 7. La composition des divers étages est représentée dans les listes dans les pages 55 et 56, et les noms communes des essences dans les pages 57 et 61.

FORESTRY IN THE COFFEE REGION OF PUERTO RICO

Frank H. Wadsworth, Forester
Tropical Forest Experiment Station
Juan B. Gaztambide, Extension Forester
Agricultural Extension Service
Puerto Rico

During the period February 12-18, 1944 a conference of Agents of the Agricultural Extension Service was held at the demonstration farm Hacienda Carmelita, near Jayuya, Puerto Rico in order to teach the Agents new developments in coffee production and bookkeeping. A portion of the time devoted to coffee was allotted for discussion of farm forestry in the coffee region. The conclusions of the discussion are here reported.

Coffee Shade and Timber Production

There are many similarities between the production and maintenance of coffee shade and of timber forests. Also there are differences, which, while small, are of significance in the management and production from each type of forest.

Similarities

Coffee production involves true forestry to a great extent. In the production of the shade necessary for the coffee trees intensive forest regeneration and silviculture is practised. Wildings of coffee shade trees are pulled and transplanted to the coffee plantation much as foresters would underplant a forest, locating them beneath openings in the canopy where they will receive sufficient light to permit their growth, and eventually providing the shade desired in that particular opening. The shade is so managed that it resembles a selection forest, in that there are always at least two age classes within the forest, sometimes three, and the older trees are continually being replaced. When young trees in a new plantation form a canopy they are pruned regularly, often each year, to maintain the proper density of shade. Although for a different purpose and following a different policy in coffee shade forests, the practice of pruning is another parallel with timber forestry. Later, thinnings are made if the trees prove to be so close together that when full grown it is difficult to prevent overdense shade without undue pruning. This practice can be likened to forest thinnings, where the better trees are favored by the removal of undesirable individuals which are competing with them.

Differences

Despite the great similarity between the management of coffee shade and of timber forests, wood production in coffee plantations can never approach that obtained from a timber forest. This is because the ideal coffee shade tree is short and has a spreading umbrella-like crown, providing uniform density of shade over a large area. On the other hand, trees best suited for timber production are those which have a straight bole and a small dense crown. In an all-aged selection forest, which is the type most nearly simulating well-managed coffee shade, density of shade is generally variable, being dense beneath trees nearing maturity of young groups of poles and light where recent cuttings have removed large trees. Also, in timber forests, in order to obtain maximum timber production, the trees are spaced as closely as is practicable, considering the limitations of available light, water, and soil nutrients upon quality growth. In a coffee plantation the trees are spaced as far apart as the requirement of a continuous canopy will permit, in order that there may be a maximum area between trees for the coffee plants.

Timber Production in the Coffee Region

Within the limitations imposed by the need for shade of a certain quality and density within productive coffee plantations it is obviously desirable that in our deforested island the yield of forest products from the coffee region be at a maximum. Two complementary recommendations toward this end, both of which also directly increase the coffee yield per acre of coffee lands are: (1) the elimination of low to non-productive lands from the area receiving care, and their designation as forest land; and (2) improved and more intensive management of both coffee plantations and forests in the coffee region.

Elimination of Non-Productive Coffee Areas

It is generally known that yield of coffee varies considerably with site differences. As might be expected, the best production is on relatively fertile soils. Where soil is deep and has not been severely eroded by past cultivation, best yields of coffee are obtained on lower concave slopes. On steep upper slopes and ridges production is much lower. Much of this poor land supports plantations which receive the same or a greater intensity of care as the better areas. There are at least 4 reasons for this:

1. Farmers do not always know which acres pay for their care, and which do not. The picking of coffee often is not organized in such a way that they are able to determine the actual and relative productivity of various portions of the farm.

2. Many of the older plantations which are now marginal or submarginal may have, in times of better markets, yielded a good profit. Although there now are occasional years of good coffee markets, the trend during the past twenty years has been toward less demand. There appears to be a general hesitancy to abandon poor areas, partly because of the hope that prices may again rise. Abandonment, when it does take place, usually means conversion of the entire plantation to some other use.

3. Coffee farmers, who have known and worked in coffee all their lives, consider their poorer lands more productive in coffee than in any other crops and are often willing to spend more on them than their other lands to bring their production up to that of the rest of the plantation. The plantations were established at considerable cost, of which continued maintenance is but a fraction.

4. No promising substitute crop is seen although vanilla and citron are possible subsidiaries. Some of these ridges and steep slopes produce some pasture, when improved, with grasses such as molasses grass, Melinus minutiflora, but because of their poor soil and because of the fact that this poor land frequently is found in tracts too small and scattered to serve well for this purpose, many of them cannot be grazed effectively. Cultivation of minor crops would be certainly temporary, and of doubtful economy even during the first years. The thought of producing forests on their poor lands scarcely occurs to coffee farmers. The forests in the region, badly culled second growth, are thought of as idle brush lands. Forest planting is considered at best a practice of questionable wisdom because of the uncertainty of the yield and its distance in the future. In addition, the coffee farmer, with acres of shade trees in need of cutting or pruning each year, is not faced with a serious problem in the procurement of his wood needs.

In the abandonment of coffee lands the tendency is to clear the best areas, those which will be most productive of other crops. While this practice is clearly justified where the other crops can be produced permanently, yielding more than coffee, where this is not the case, it leads to lower farm production and impoverishment of the soil. Conversion of the least productive coffee areas to forest, while decreasing total coffee acreage for the farm, will lower costs correspondingly if the areas converted are truly marginal. Use of fertilizer, terraces, and better shade management and spacing can greatly increase coffee yields per acre on the better lands.

As the production of coffee on the better lands can, at least at the present, be considered more remunerative than forestry (or at least more certain, as no data other than estimates are available to show the returns from forest management) there is no economic justification for the conversion of productive coffee plantations to forest, as it will entail a net loss in farm production. This point should be kept clearly in mind. However, it is estimated that at least 10 per cent of the lands under coffee plantations should be abandoned because of low or negative returns.

Better Management of Coffee Plantations

The generally discouraging outlook for coffee producers during recent years is reflected in the virtual abandonment or in the reduction in the intensity of care given the plantations. In the majority of the plantations the shade is not well managed, being of improper density due to openings, often due to attacks of the leaf miner, Leucoptera coffeella, inadequate pruning, or the use of trees inferior as to form or species. Shade management in recent years has sometimes been as much as result of high charcoal prices as a desire for better coffee production.

The shade requirements of the coffee plant are fairly well known. Only by prompt replanting of openings and by regular pruning can shade of the proper density be maintained. This, at the same time, will increase wood production.

The greatest single possibility of increasing wood production from coffee plantations is in the use of better shade trees. Leguminous tree species have always been used, as it is believed that their roots impart nitrogen to the soil. The two species in common use; guaba, Inga vera Willd. and guamá, I. laurina (Sw.) Willd.; have faults which are not found in some other species. While they are fairly rapid growing and the shade produced by the former is excellent, that of the latter becomes difficult to manage after becoming old, as the crown tends to become globular. Both are attacked by ants, Myrmelachista ambigua ramulorum, which damage the twigs and, when the ant colony is large enough, similarly attack the coffee. Guaba, even when young, is usually attacked by a bacterial wilt which results in die-back of the twigs.

Years ago a number of other species were tried for coffee shade Among them were Samanea saman (Willd.) Merill, Erythrina poeppigiana (Walp.) Cook, E. berteroana Urban, E. glauca Willd., Andira inermis H.B.K., Guarea guara (Jacq.) Wilson, Adenanthera pavonina L., and Gliricidia sepium (Jacq.) Steud. These all proved less satisfactory than the Ingas. A number of Ingas were then introduced from Venezuela in 1929. Species of this genus have generally been considered the best of the Leguminosae because of their form, and rapid ability to recover after pruning and growth. Of these Ingas, two appear to be outstanding. One, Inga fastuosa Willd. is locally called guaba peluda. Trees 9 years old at Hacienda Carmelita have grown very rapidly, some having attained 6 inches in diameter. This species does not grow tall and it is thus easy to prune. It is well adapted to our drier and well drained soils. To date there is no indication of attack by ants or the wilt. Beneath these trees is a layer of leaves about 1 foot thick which undoubtedly will improve the site. The other species, possibly I. punctata Willd. (the scientific name of which is being checked at present) here is commonly called "guamá venezolano." It is very similar in its growth habits to Inga fastuosa, growing rapidly and producing a low shade. Natural reproduction of the first of these species is not plentiful, while that of the second is very abundant. The wood of these two introduced Ingas is apparently at least as useful as that of guamá and guaba. It makes an excellent grade of charcoal.

These two Ingas are growing in small areas on the Agricultural Demonstration Farms of the Extension Service and at the Federal Experiment Station at Mayaguez. Although the plantings are young, they seemed to have shown these species to be better than those in general use. The Extension and Forest Services are cooperating in the distribution of seedlings to farmers.

Better Management of Forests

Probably 20 to 25 per cent of the lands in coffee farms, or some 40,000 acres, are best suited for forest. These lands are covered with grass, brush, or degraded forest. The measures recommended for the improvement of this area depend chiefly upon the density and height of the cover.

As most of these lands are steep, rocky, and erodable, complete clearing of brush for planting is not generally to be recommended. On areas where a forest canopy is forming, however, poor the species, its protection value should be taken into account. Crooked trees and others of inferior species may be gradually removed, always confining the cutting to locations where adequate shade will remain to preserve forest conditions. In most of the region this practice will produce ideal conditions for natural reproduction of better trees and the composition of the forest will improve as the inferior specimens are gradually removed. Underplanting with better tree species will greatly accelerate this process, particularly in old coffee plantations where few trees other than guaba are found.

If woody vegetation is absent, or does not form a forest canopy, treatment will depend upon the tree species present. In some areas the "brush" is made up of dense sprouts from recently cut stumps - often of good tree species. Here the sprouts will eventually form a canopy and should be permitted to do so. Thinning of the sprouts is often desirable and will pay its way in stakes and fuel for the farmer. If only poor tree species are present, or if trees are absent, openings of about 4 feet in diameter should be cleared in the vegetation with their centers 8 feet apart. In each a tree of some aggressive species, such as roble or maría, should be planted. Weeding at least once a year will be necessary even with these species, because of vines. If more frequent weeding is feasible Eucalyptus robusta Smith, is a good species to use, as it is more rapid-growing.

These measures recommended should not be in any way considered as intensive as might be desired but they provide the coffee farmer with a relatively cheap method of improving the productivity of his poorest lands and harvesting a maximum of products therefrom during the first forest rotation.

(Traducción del artículo anterior)

LA DASONOMIA EN LA REGION CAFETALERA DE PUERTO RICO

Durante el período comprendido entre el 12 y 18 de febrero de 1944 se celebró una conferencia de los agentes del Servicio de Extensión Agrícola, en la Granja de Demostración Agrícola de Hacienda Carmelita cerca de Jayuya, Puerto Rico, con el propósito de instruir a los agentes en los nuevos desenvolvimientos en la industria del café y la contabilidad en relación con la misma. Se dedicó parte del tiempo conferido al tema del café, a discutir la dasonomía o ciencia forestal aplicada a la finca en la región cafetalera. Las conclusiones a que se llegó en dichas discusiones aparecen a continuación.

La Sombra de Café y la Producción de Madera

Existen muchas semejanzas entre la producción y conservación de la sombra de café y la conservación de los bosques para la producción de madera pero también hay diferencias que aunque exiguas tienen su significación en el aprovechamiento y producción de cada tipo de bosque.

Semejanzas

La producción de café comprende en gran parte la dasonomía extrictamente. Para producir la sombra necesaria en las plantaciones de café se pone en práctica la regeneración forestal intensiva y la silvicultura. Los brinzales de los árboles de sombra se arrancan y trasplantan en la plantación de café en la misma forma en que los dasónomos replantan el bosque en los claros en el techo forestal para que reciban la luz suficiente que les ayude en su desarrollo y para que suministren con el tiempo la sombra que se desea en ese claro. El aprovechamiento de la sombra se efectúa de tal manera que se asemeja a la del bosque de selección en que hay siempre por lo menos dos clases de árboles según la edad, a veces tres y los árboles viejos son reemplazados continuamente. Cuando los árboles jóvenes de una plantación forestal creciente forman la corona se podan regularmente, casi anualmente, para mantener la densidad de sombra apropiada. A pesar de cumplir diferente propósito y seguir una política distinta, en los bosques para sombra de café también se observa la práctica de la poda. Más tarde se procede a entresacar en caso de que los árboles estén muy juntos, para evitar que al crecer éstos, se forme una sombra muy densa que hiciera inevitable la poda. Esta práctica puede compararse a las entresacas forestales, donde los mejores árboles se benefician al ser eliminados los ejemplares competidores menos deseados.

Diferencias

A pesar de la gran semejanza que existe entre la ordenación de los árboles de sombra de café y los de los bosques maderables, la producción de madera en las plantaciones de café no puede compararse con la de los bosques maderables. Esto se debe a que el árbol ideal para sombra de café debe ser corto y de corona desplegada, que provea una densidad uniforme sobre un área grande. Por el contrario, los árboles mejor apropiados para la producción de madera son los de tronco derecho y de corona poco densa. En un bosque de selección de edades múltiples, que es el más que se asemeja al de sombra de café bien ordenado, la densidad de la sombra varía generalmente, siendo densa debajo de los árboles casi maduros y bajo los grupos de fustales, y ligera en aquellos sitios en donde a raíz de la corta se han eliminado árboles grandes. También, para obtener un máximum de producción de madera en los bosques explotables, los árboles se espacian tan cerca como lo permitan las limitaciones de luz, agua y materias nutritivas del suelo sobre la calidad del crecimiento. En las plantaciones de café, los árboles de sombra se espacian lo más aparte posible pero que conlleve la producción de una corona contínua y suministre un área máxima entre los árboles de sombra que permita el buen desarrollo de los árboles de café.

Producción de Madera en la Región Cafetalera

Dentro de las limitaciones impuestas por la necesidad de cierta calidad y densidad de sombra en las plantaciones de café, es obviamente deseable que en nuestra isla tan despoblada de árboles el rendimiento de productos forestales en la región cafetalera alcance su máximo grado. Dos recomendaciones complementarias que cumplen este cometido y a la vez aumentan también directamente el rendimiento del café cosechado por acre son: (1) Dejar de cosechar café en aquellos terrenos que producen poco o ningún café y constituirlos en tierras forestales y (2) lograr el mejor e intensivo aprovechamiento de las plantaciones de café y de los bosques de la región cafetalera.

Eliminación de las Areas Improductivas de Café

Es de conocimiento general el hecho de que la producción de café varía considerablemente de acuerdo con el medio estacional. Como es de suponer la producción óptima se logra en los suelos relativamente fértiles. En aquellos sitios en que el suelo es profundo y que no ha sufrido los agudos efectos erosivos del cultivo intenso, el café rinde mejor beneficio en las laderas cóncavas más bajas. En las laderas más altas y pendientes la producción de café es mucho menor. En muchas de estas tierras más pobres las plantaciones reciben igual o más cuidados que las áreas de mayor rendimiento. Existen por lo menos cuatro razones que permiten que ocurra así:

1. Los agricultores no siempre conocen cuales acres han de proporcionar buen rendimiento y cuales no. La recolección del café a menudo no está organizada de tal manera que ofrezca un índice de la productividad relativa de los diversos sectores de la finca.

2. Muchas de las plantaciones viejas que actualmente son marginales o sub-marginales puede que hayan dado buenos resultados en tiempos de mejores mercados. A pesar de que se presentan a veces años de buen mercado la tendencia durante los últimos 20 años ha sido hacia una demanda menor. Existe cierta incertidumbre en abandonar el cultivo en áreas pobres, con la esperanza de que los precios habrán de subir. Cuando el abandono del cultivo tiene lugar, conlleva casi siempre la conversión de la plantación completa en cualquier otro cultivo.

3. Los cafeteros que durante toda su vida han trabajado en el café consideran que sus tierras más pobres son más productivas en café que en ningún otro cultivo y prefieren gastar más en ellas que en las tierras mejores para nivelar su producción con la del

resto del terreno. El levantar una plantación cuesta mucho dinero y sin embargo su mantenimiento sólo equivale a una mera fracción de ese costo inicial.

4. Ningún otro cultivo sustituto parece ser prometedor a pesar de que la vainilla y el limón son posibles cultivos subsidiarios. Algunos riscos y pendientes producen pasto cuando se mejoran sembrando yerbas tales como yerba yaraguá (Melinus minutiflora) pero por su suelo pobre y debido al hecho de que se encuentran en trechos pequeños y dispersados muchos de ellos no sirven para tales propósitos de apacentamiento. El cultivo de frutos menores sería sólo temporero y de dudoso ingreso aún en los primeros años. Ni siquiera se les ha ocurrido a los cafetaleros sembrar árboles en sus terrenos más pobres. Los bosques de la región que sólo constan de renuevos de árboles excesivamente talados se consideran como matorrales inútiles. Se cree que la siembra forestal es una práctica de méritos dudosos debido al rendimiento incierto y a su aprovechamiento tardío. Además, el cafetalero posee acres de árboles de sombra que corta o poda anualmente y los cuales le suministran todas sus necesidades de madera.

Al abandonar el cultivo del café la tendencia es de limpiar las áreas mejores y de más provecho para otros cultivos. Este proceder está ampliamente justificado en aquellos sitios donde otros cultivos son capaces de rendir mejores cosechas permanentes que rinden más que el café pero donde no es éste el caso, lo que resulta es menor producción agrícola y empobrecimiento del suelo. Aunque la conversión de las tierras menos productivas de café a bosque reduce el rendimiento total de café en la finca, si las tierras son realmente marginales serán menos los gastos en que se incurra. En las mejores de estas tierras el rendimiento del cafeto aumentaría grandemente si se usaran abonos, terrazas y mejor sistema de sombríos.

Como la producción de café en las tierras mejores puede considerarse, por lo menos en el presente, como más remunerativa (o por lo menos más segura, ya que no existen datos concretos sino estimados, en lo que se refiere a aprovechamiento forestal) no existe justificación económica alguna para la conversión de plantaciones productivas de café en bosques ya que ello redundaría en pérdidas netas en la producción agrícola. Es preciso tener esto siempre en mente. Sin embargo, se calcula que por lo menos en el 10 por ciento de las tierras cafetaleras debe abandonarse el cultivo de café debido a ingresos bajos o negativos.

Mejor Aprovechamiento de las Plantaciones de Café

El panorama generalmente desalentador con que se han tropezado los cafetaleros durante los últimos años se refleja en la falta o en la reducción de los cuidados que antes se les daba a los cafetales. En la mayoría de éstos, la sombra no está bien ordenada y a veces no tiene la densidad apropiada debido a los claros que a menudo son originados por el taladrador de la hoja, Leucoptera cofeella, la poda inadecuada o al uso de árboles de sombra inferiores por su forma o por ser de especies no convenientes. El aprovechamiento de los árboles de sombra en los últimos años se ha debido algunas veces tanto al buen precio del carbón como al deseo de mejorar la producción de café. La densidad de sombra necesaria en un cafetal sólo puede mantenerse resembrando los claros que surjan y podando regularmente los árboles. Estas prácticas aumentan también la producción de madera.

La única buena posibilidad de obtener más madera de los cafetales está en el uso de mejores árboles de sombra. Las especies arbóreas leguminosas siempre se han usado porque se cree que sus raíces dan nitrógeno al suelo. Las dos especies que más se usan: guaba, Inga vera Willd. y guamá, Inga laurina (Sw.) Willd., tienen algunas desventajas que no poseen algunas de las otras especies. A pesar de que ambas crecen con rapidez y de que la sombra de la primera es excelente, la sombra de la segunda es difícil de manejar al ir envejeciendo porque la copa tiende a ponerse redonda. Las hormigas, Myrmelachista ambigua ramulorum, atacan a estas dos especies, dañándole los retoños y cuando la colonia de hormigas crece lo suficiente, ataca también al cafeto. La guaba aún cuando joven se ve atacada por una bacteria que marchita los brotes.

Años atrás se probaron otras especies para sombra de café. Entre ellas se contaban Samanea saman (Willd.) Merill, Erythrina poeppigiana (Walp.) Cook, E. berteroana Urban, E. glauca Willd., Andira inermis H.B.K., Guarea guara (Jacq.) Wilson, Adenanthera pavonina L. y Gliricidia sepium (Jacq.) Steud. Todas resultaron menos satisfactorias que las Ingas. Luego se introdujeron varias Ingas de Venezuela. El género Inga, siempre se consideró como el mejor de las Leguminosas que se podía usar como sombra, debido a la forma de estos árboles. Entre estas Ingas introducidas en Puerto Rico sobresalieron dos. Una de ellas, la Inga fastuosa Willd. que localmente se conoce con el nombre de guaba peluda, no crece mucho y es por lo tanto fácil de podar. Se adapta bien a nuestros suelos más secos. Hasta la fecha no hay indicios de que sea atacada por las hormigas o la marchitez de los brotes. Debajo de estos árboles se encuentra siempre una capa de hojarasca de cerca de un pie de alto que, sin lugar a dudas, mejora el suelo. A la otra especie, que se cree sea Inga punctata Willd. (se está corroborando si este nombre científico atribuído a la especie es exacto) se le llama aquí comúnmente guamá venezolano. En la forma de crecimiento se parece mucho a la Inga fastuosa ya que crece con rapidez y produce sombra baja. La reproducción natural de la primera de éstas especies no es abundante mientras que la de Inga punctata es abundante. La madera de estas dos Ingas exóticas es por lo menos tan abundante como la de guaba o guamá y produce buen carbón.

Se están cultivando estas dos especies de Ingas en las Granjas de Demostración Agrícola del Servicio de Extensión y en la Estación Experimental Federal de Mayaguez. A pesar de que las plantaciones son muy jóvenes aún, han demostrado que estas especies son mejores que las que se usan generalmente. El Servicio de Extensión Agrícola y el Servicio Forestal cooperan en la distribución de los arbolitos a los agricultores.

Mejor Aprovechamiento de los Bosques

Probablemente del 20 al 25 por ciento del terreno en las fincas de café o sean algunas 40,000 acres, se adaptan mejor al crecimiento de bosques. Estas tierras están cubiertas de yerba, matorral o bosque degradado. Las medidas que han de recomendarse para el mejoramiento de este área dependen principalmente de la densidad y de la altura de la cubierta herbácea.

Como la mayor parte de estas tierras son laderas bastante inclinadas y sujetas a la erosión, generalmente no se recomienda el talado del matorral antes de la siembra. En las áreas donde se está formando una cubierta forestal, aunque la especie sea inferior, debe tomarse en cuenta siempre, que esta cubierta protectora que forma, tiene su valor mientras no hayan otros árboles grandes cercanos. Los árboles torcidos o de especies inferiores pueden ser eliminados gradualmente, confinándose siempre a aquellos sitios donde, después de efectuada la corta, quede sombra suficiente para preservar las condiciones forestales requeridas. En casi toda la región cafetalera esta práctica producirá condiciones ideales para la reproducción natural de los mejores árboles y la composición del bosque mejorará al irse cortando gradualmente las especies inferiores. Este proceso se acelerará si se siembran especies arbóreas superiores al pie de los árboles de especie inferior, particularmente en los cafetales viejos donde, fuera de la guaba, son pocos los árboles que existen.

Si no hay vegetación arbórea ninguna o no se ha formado un techo forestal todavía, el tratamiento requerido depende de la especie presente. En algunas áreas la maleza está constituída por los brotes de tocones recientemente cortados, y que son casi siempre de especies buenas. A fin de cuentas estos vástagos formarán un techo forestal, lo cual debe permitírsele. Es provechoso entresacar un poco los brotes pues los espeques y leña que luego han de obtenerse pagan estos gastos. Si las áreas sólo tienen especies malas o si no hay árboles, deben abrirse claros de 4 pies de diámetro en la vegetación herbácea con una separación de ocho pies del centro de cada claro. En cada uno debe sembrarse un árbol de especie agresiva tales como roble o maría. Debido a los bejucos, deben desyerbarse por lo menos una vez al año. Si es factible desyerbar con más frecuencia, puede usarse el Eucalyptus robusta Smith, que crece con más rapidez.

Estas recomendaciones no son tan intensivas como se desea pero al menos proveen al cafetalero con un medio barato de mejorar la productividad de sus tierras más pobres y obtener el máximo de productos durante el primer turno de cosecha forestal.

Résumé

Pendant le mois de février 1944 s'est tenue des reunions des Agents du Service d'Extension Agricole pour discuter, parmi d'autres sujets, le rôle et but des forêts dans la région caféière de Puerto Rico. Ces lignes-ci constituent un aperçu des conclusions auxquelles ont en est parvenu.

L'aménagement de l'ombrage forestier dans les caféiers enferme plusieurs mesures très connues du forestier. La méthode pour obtenir des arbres produisant ombre dans les caféiers s'occupe des transplantations des sauvageons de certaines essences appropriées pour cet object; des éclaircies et élagages ont lieu pour fournir un ombrage satisfaisant pour les plantes de café; et aussi une forêt de sélection est développée en plantant des jeunes arbres sous les vieux dans les endroits desserrés.

La différence principale entre les arbres à être employés dans les caféiers et celui des forêts au point de vue de la production de bois se concerne avec leur forme. Le type d'arbre idéal pour l'ombrage des caféiers possède une couronne arrondie autant que les arbres des forêts doivent avoir des bols droits et élevés. Aussi la distance entre les arbres des caféières est beaucoup plus grande que celle des arbres dans les forêts. Dans les caféières on a besoin d'une surface assez grande parmi les arbres pour le développement normal des plantes de café. Mais dans les forêts on doit utiliser au mesure du possible la surface disponible ayant compte du rendement desiré et évitant la compétence entre les divers arbres.

La production de café et de bois par acre dans la région caféière peut être augmentée en faisant la conversion de quelques plantations improductives ou peu économiques de café en forêt et aussi suivant un aménagement plus intensif des terrains en forêt et en café. A present plusieurs pentes et collines inclinées sont encore couvertes de cafiers quand même on sait que leur productivité est maintenant submarginal comme résultat des conditions actuelles du marché. Ces surfaces restent sans presque aucune culture parceque les fermiers ne connaissent pas de culture substitutive et, parcequ'il est très coûteux d'y établir une nouvelle plantation, ils ont l'habitude de planter n'importe quoi. Probablement ces superficies peu ou insuffisamment utilisées sont propres seulement à être boisées.

A ce propos, même dans les caféières, pour augmenter la production de bois la meilleure possibilité c'est l'emploi de certaines essences choisies pour produire l'ombrage. En se basant sur les connaissances techniques on peut dire que les deux essences exotiques du genre Inga récemment introduites à Puerto Rico, Inga fastuosa Willd. et Inga punctata Willd. (? dont la nomenclature sera bientôt constatée) constituent les meilleures arbres à employer dans les plantations de café. Elles sont de croissance rapide et produisent un bois de chauffage de très bonne qualité.

En conséquence, pour sauvegarder les terrains qui ne peuvent pas produire café économiquement il est absolument nécessaire de les réboiser. Dans ceux terrains ou il y a quelques essences forestières de qualité superieure dejà présentes on n'a guère besoin de planter mais au cas ou aucune essence de haute qualité n'y soit pas trouvé on doit les planter aux dépens des autres essences mais laissant toujours sufissant ombrage pour leur développement. Dans le premier cas signalé, elles peuvent être améliorées simplement par l'enlèvement graduel des essences peu désirables. S'il n'y a aucune arbre on doit planter une essence à croissance rapide, telle qu'Eucalyptus robusta Smith.

ARBOLES DE SOMBRIO DE LOS CAFETALES EN COLOMBIA

Lorenzo Uribe Uribe
Colombia

En los países originarios del cafeto la planta se ha cultivado por lo general sin sombrío. Esta medida de protección se utilizó por primera vez en América Central con lo cual se prolongó la vida de los cafetos, se aumentó la producción y se mejoró el gusto del grano. Cuando el cafeto crece en lugares libres y soleados se presenta además el enanismo caracterizado por la poca vida de la planta, su escasa frondosidad y la inutilización de gran cantidad de granos ya que en días muy soleados se marchitan muchas flores antes de llegar a ser fecundadas. Debido a los diversos beneficios que rinde un sombrío adecuado debe prestársele suma atención y cuidado a la selección de los árboles apropiados.

El sombrío de un cafetal puede ser provisional para las nuevas plantaciones, y permanente o sea definitivo. En Colombia se emplea como sombrío provisional el plátano o banano, Musa, sembrando los pies a unos 6 metros de distancia en todas direcciones. Además de beneficiar al café se aprovechan las frutas del banano. Como sombrío permanente se emplean casi exclusivamente plantas Leguminosas que fertilizan la tierra con productos nitrogenados; y entre ellas se escogen las que penetran profundamente en el suelo para que no roben así el alimento superficial que aprovecharán los cafetos, y tienen una copa suficientemente amplia para sombrear grandes espacios de cultivo.

Un árbol muy adecuado sería el pisquín o muche, Albizzia carbonaria Britton, de amplia copa aparasolada pero tiene las desventajas de ser atacado por diversos parásitos que perjudican al cafeto, de tener raíces muy superficiales, y despojarse a veces de gran parte de su follaje constituyendo un peligro para los cafetales cuando se desgaja su enorme masa. En cambio los guamos, guabos o churimos poseen las cualidades apetecidas y son nuestros árboles clásicos de sombrío, pues crecen rápidamente y muchas de sus especies dan una sombra amplia y moderada. Las especies que han dado mejores resultados en Colombia son las pertenecientes a la serie Sulcatae, que se caracterizan por sus legumbres cilíndricas y estriadas longitudinalmente, a veces retorcidas. Entre ellas la más comúnmente usada es la Inga edulis Mart. llamada guamo rabo de mono, bejuco o santafereño porque tiene forma aparasolada en la copa por lo cual sombrea un gran espacio, no suele ser atacada por parásitos que perjudiquen al cafeto y posee una apreciable longevidad. El autor ha podido observar cafetales sombreados con esta especie cuyos ejemplares tienen ya más de 30 años y aún están en plena vitalidad. En Cundinamarca una variedad de la anterior, de flores más pequeñas y legumbres más cortas es más común. La Inga ingoides (Rich.) Willd. es la ordinaria en los cafetales de la Esperanza; sus propiedades son prácticamente iguales a las de la anterior. En Antioquia, en donde existen renombradas plantaciones de café, emplean con frecuencia la Inga fredoniana

Britton & Killip y en el Tolima la Inga Duquei Harms. La Inga spuria Willd. llamada guamo arroyero es muy común, de excelentes cualidades para sombrío, pero es poco utilizada hasta ahora.

Entre las especies de legumbre plana o cuadrada se han utilizado la Inga densiflora Benth. llamada guamo macheto y la Inga chartana Britton & Killip o cuatrofilos, pero la forma de su copa poco extendida no las hace muy recomendables. Sin duda que existen otras especies que podrían ser muy útiles como la Inga interfluminensis L. Uribe de grandes proporciones y la Inga sierrae Britton & Killip, pero aún no han sido experimentadas. Omito varias especies empleadas en algunos sitios pero que son perjudiciales por los parásitos y plagas que los atacan y que perjudican al café.

Por lo tanto, podemos concluir que, al menos en Colombia, las especies del género Inga más apropiadas y más empleadas en el cultivo del café son las que tienen la legumbre cilíndrica y estriada, por su duración, su relativa inmunidad contra parásitos perjudiciales y la forma de su copa.

(Translation of previous article)

COFFEE SHADE TREES IN COLOMBIA

In its native habitat coffee has been commonly raised without shade. Shade was first used in Central America and was found to prolong the life of plantations, to increase yield and to improve the quality of the fruit. Open-grown coffee is generally dwarfed, has thin foliage, and the flowers often wither on excessively sunny days. Because of the importance of shade great care must be taken in selecting the trees or plants to produce it.

Coffee shade may be either temporary, as in new plantations, or permanent. In Colombia, banana plants, Musa, are used as temporary shade, with a spacing of 6 meters between plants. Besides being of benefit to the coffee plants, a fair banana crop is obtained by this practice. For permanent shade, leguminous trees which increase the nitrogen content of the soil are used almost exclusively, and among them deep-rooted trees are chosen so that they may not deprive the coffee plant of the nutrients it needs, and those with a wide crown, capable of giving shade over a relatively large area.

Albizzia carbonaria Britton has the form of a good coffee shade tree, but it is attacked by parasites harmful to coffee plants, its roots are superficial, sometimes it loses a large part of its foliage and when pruned the big branches may endanger the coffee plants. On the contrary, the trees known as "guanos", and "guabos" or "churimos", (all species of Inga) possess all desirable qualities, such as rapid growth and have a spreading moderately dense crown, and therefore constitute our principal coffee shade trees. In Colombia the most promising species belong to the Sulcatae group, characterized by cylindrical pods, striated longitudinally and sometimes twisted. The most common among them is Inga edulis Mart. known as "guamo

~~October 1944~~
J nuary 1945

rabo de mono", "bejuco" or "santafereño", with umbrella-like crown providing a large area of shade. It is not attacked by parasites harmful to coffee and is long-lived. The writer has observed trees more than 30 years old and yet very healthy. In Cundinamarca there is a variety of this species which has smaller flowers and shorter pods. In La Esperanza the most common species in coffee plantations is Inga ingoides (Rich.) Willd., its properties being the same as the previous species. In Antioquia where well-known plantations exist, Inga fredoniana Britton & Killip is frequently employed and in Tolima Inga Duquei Harms. Inga spuria Willds., known as "guano arroyero" is very common, posseses good qualities as a coffee shade tree but up to now has been seldom used.

Inga densiflora Benth known as "guamo macheto" and Inga chartana Britton & Killip, known as "cuatrofilos" are among the species with flat or square pods which have been used, but they are not recommended because of their more compact crowns, such species like the large Inga interfluminensis L. Uribe and Inga sierrae Britton & Killip, may well be useful but they have not been tried as yet. Some species not here named are now being used, but are attacked by parasites and pests harmful to coffee plants.

It has been found that at least in Colombia the most adequate and most used species of genus Inga are those having cylindrical and striated pods. They live longer, are immune to harmful parasites, and possess wide spreading crowns.

Résumé

Comme l'ombrage approprié sert pour prolonger la vie des caféières, pour augmenter le rendement et pour améliorer la qualité du fruit, le choix des essences les mieux adaptées pour produire cet ombrage est d'une importance extrême. Un arbre excellent pour remplir ce tâche doit avoir une couronne étendue, longue vie, racines profondes et immunité contre l'attaque des parasites nuisibles.

En Colombie les essences du genre Inga sont très satisfaisantes et parmi elles nous trouvons Inga edulis Mart. (guamo rabo de mono), I. ingoides (Rich.) Willd., I. fredoniana Britton & Killip et I. Duquei Harms. Quelques essences qui probablement peuvent réussir n'ont pas été essayées jusqu'à present sur une grande échelle.

Comme les essences qui possèdent gousses planes et carrés, par exemple I. densiflora Benth (guamo macheto) et I. chartana Britton & Killip (cuatrofilos) n'ont pas eu du succès et ceux avec gousses cylindriques et striées ont eu des bons résultats on peut conclure que ce dernière caractéristique est indicative des essences convenables.

THE CARIBBEAN FORESTER

El "Caribbean Forester", que se comenzó a publicar en julio de 1938 por el Servicio Forestal del Departamento de Agricultura de los Estados Unidos, es una revista trimestral gratuita dedicada a encauzar el mejor aprovechamiento de los recursos forestales de la región del Caribe. Su propósito es estrechar las relaciones que existen entre los científicos interesados en la Dasonomía y ciencias afines exponiéndoles los problemas confrontados, las políticas forestales vigentes, y el trabajo realizado hacia la culminación de ese objetivo técnico.

Se solicitan contribuciones de no más de 20 páginas escritas en maquinilla. Deben ser sometidas en el lenguaje vernáculo del autor, con el título o posición que éste ocupa. Es imprescindible también incluir un resumen corto del estudio efectuado. Los artículos deben dirigirse al "Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, P. R."

The Caribbean Forester, published since July 1938 by the Forest Service, U. S. Department of Agriculture, is a free quarterly journal devoted to the encouragement of improved management of the forest resources of the Caribbean region by keeping students of forestry and allied sciences in touch with the specific problems faced, the policies in effect, and the work being done toward this end throughout the region.

Contributions of not more than 20 typewritten pages in length are solicited. They should be submitted in the author's native tongue, and should include the author's title or position and a short summary. Papers should be sent to the Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, Puerto Rico.

Le "Caribbean Forester", qui a été publié depuis Juillet 1938 par le Service Forestier du Département de l'Agriculture des Etats-Unis, est un journal trimestrel de distribution gratuite dedié à l'encouragement du ménagement rationnel des forêts de la région caraïbe. Son but est entretenir des relations scientifiques de ceux qui s'intéressent aux Sciences Forestières, ses problèmes et systèmes mis à jour, avec les travaux faits pour réaliser cet objectif d'amélioration technique.

On sollicite des collaborations de pas plus de 20 pages écrites à machine. Elles doivent être écrites dans la langue maternelle de l'auteur en comprennant son titre ou position professionnel et un résumé de l'étude. Les articles doivent être adressés au "Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, Puerto Rico".


UNITED STATES
ATLANTIC
OCEAN
GULF OF
MEXICO
MEXICO
BAHAMA
ISLANDS
CUBA
JAMAICA
HAITI
DOMINICAN
REPUBLIC
PUERTO
RICO
GUADELOUPE
DOMINICA
MARTINIQUE
STA. LUCIA
TRINIDAD
BRITISH
HONDURAS
CARIBBEAN SEA
HONDURAS
GUATEMALA
SALVADOR
NICARAGUA
COSTA
RICA
PANAMA
PACIFIC
OCEAN
VENEZUELA
BR.
GUIANA
COLOMBIA

U.S.F.S.,WO-1944

The Caribbean Forester

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TROPICAL FOREST EXPERIMENT STATION
RIO PIEDRAS, PUERTO RICO

VOL. 6, NO. 3

APRIL 1945

CONTENTS

A N N O U N C E M E N T

COOPERATION IN FOREST RESEARCH IN THE CARIBBEAN

A tangible beginning in active cooperation in tropical forestry research and toward establishment of a Forest Research Center for the Caribbean Area has been accomplished by the consummation of a Memorandum of Understanding between the Comptroller for Development and Welfare of the British West Indies and the Tropical Forest Experiment Station, Forest Service, United States Department of Agriculture.

Both the British West Indies and United States Governments, through their respective forestry organizations have been interested for some time in advancing the development of scientific information on tropical forestry. This movement was given added emphasis through the action of the Agricultural Research Council of the Anglo-American Caribbean Commission at its meeting held at Charlotte Amalie, St. Thomas, Virgin Islands, in August 1943 when it adopted a broad program for coordinating the research work of the area in nutrition, agriculture, fisheries, and forestry. Thus this cooperative undertaking is a natural outgrowth of those earlier discussions and fits into the program of the Council.

The Memorandum of Understanding, which is effective immediately, provides that in accordance with such policies and plans as the parties thereto may from time to time agree upon, the Director of the Tropical Forest Experiment Station will, to the extent that funds are available therefore, conduct investigations with a view to determining and demonstrating the best methods of growing, managing, and utilizing tropical American and Caribbean woods, and the Comptroller for Development and Welfare in the British West Indies will arrange to have such money contributions made to the Tropical Forest Experiment Station as may be called for under said policies and plans.

At the time the agreement was signed the several British West Indies colonies had made initial money contributions to the joint undertaking and the Memorandum provides that these contributions shall be available for expenditure by the Director in enlarging and increasing the circulation of the Caribbean Forester through which information resulting from the forestry investigations is disseminated. The agreement further provides that such additional contributions for the same purpose shall be made from time to time on behalf of the British West Indies colonies as may be required under the mutually conceived policies and plans referred to in the agreement.

As the first step in carrying out the agreement, the Tropical Station will gradually enlarge the Caribbean Forester beginning with the third issue of Volume VI. It is also taking action to build up the mailing list to include all professional men in forestry and allied fields in the British West Indies and elsewhere in Latin America who are interested in receiving the journal.

The pages of the Caribbean Forester are open to anyone in the field of tropical forestry who has constructive technical information to contribute for publication, and the Station invites cooperation to that end. The same type of cooperative effort is also available to all other countries in the Caribbean area which may be interested.

Tropical Forest Experiment Station April 15, 1945

COOPERACION EN LAS INVESTIGACIONES DASONOMICAS EN EL CARIBE

Un comienzo tangible en el logro de cooperación activa en el campo de las investigaciones de dasonomía tropical y hacia la creación de un Centro de Investigaciones Dasonómicas del Caribe lo constituye un Memorándum de Entendido entre el Contralor de Desarrollo y Bienestar de las Indias Occidentales Británicas y la Estación de Experimentación Forestal Tropical, del Servicio Forestal, del Departmaneto de Agricultura de los Estados Unidos.

Tanto el gobierno de las Indias Occidentales Británicas como el de los Estados Unidos, a través de sus respectivas organizaciones dasonómicas han estado interesados hace tiempo en la recopilación de información científica dentro del radio de la ciencia dasonómica tropical. A este movimiento le ha dado mayor énfasis el Consejo de Investigaciones Agrícolas de la Comisión Anglo-Americana del Caribe en la sesión que tuvo lugar en la ciudad de Carlota Amalia, en Santo Tomás, Islas Vírgenes, en agosto de 1943, al adoptar un amplio programa para coordinar el trabajo científico de investigación en el área en lo que respecta a nutrición, agricultura, pesquería y dasonomía. Por lo tanto, esta empresa cooperativa es una consecuencia natural de aquellas discusiones anteriores y concuerda con el programa del Consejo.

El Memorándum de Entendido, que rige de inmediato, provee que de acuerdo con las políticas y planes que ambas partes aprueben de tiempo en tiempo, el Director de la Estación de Experimentación Forestal Tropical, según lo permitan los fondos disponibles para ello, habrá de llevar a cabo las investigaciones tendientes a determinar y demostrar los mejores métodos de establecer, ordenar y utilizar los bosques de la América Tropical y del Caribe y el Contralor del Desarrollo y Bienestar de las Indias Occidentales Británicas hará los arreglos necesarios para obtener las contribuciones monetarias que otorgarán dichas islas a la Estación de Experimentación Forestal Tropical según fueren estipuladas bajo tales políticas y planes.

Cuando se firmó el acuerdo las diversas colonias de las Indias Occidentales Británicas habían efectuado ya la contribución monetaria inicial para la realización del propósito conjunto y el Memorándum autoriza al Director para hacer uso de esas contribuciones en aumentar el número de páginas del Caribbean Forester y ampliar su circulación por medio de lo cual se disemina la información que nace de las investigaciones dasonómicas. El acuerdo dispone además que las colonias de las Indias Occidentales Británicas sometan de tiempo en tiempo las contribuciones adicionales necesarias para tales propósitos, según las políticas y planes mutuamente impulsados y comprendidos en el acuerdo.

Como primer paso en la consecusión del convenio, la Estación de Experimentación Forestal Tropical irá agrandando el Caribbean Forester gradualmente comenzando con la tercera edición del Tomo VI. También se está tomando toda acción necesaria para lograr incluir en el fichero de envíos a todos los especialistas en dasonomía y ciencias afines de las Indias Occidentales Británicas y de la América Latina que están interesados en recibir esta revista.

Las páginas del Caribbean Forester están a la disposición de todos aquellos que posean información técnica constructiva en el campo de la dasonomía tropical para ser publicados como contribución cultural y la Estación los invita a cooperar hacia esa finalidad. El mismo tipo de esfuerzo cooperativo antes descrito está también a la disposición de todas las naciones del Caribe que estén interesadas.

———oOc———

COOPERATION DANS LES RECHERCHES FORESTIERES CARAIBES

Un commencement tangible pour obtenir coopération active dans les recherches forestières des tropiques et vers la création d'un Centre de Recherches Forestières Caraïbes est accompli par le Memorándum de Concert entre le Contrôleur du Développement et Prospérité des Indes Occidentales Britanniques et la Station d'Expérimentation Forestière des Tropiques, Service Forestier des Etats-Unis.

Le gouvernement des Indes Occidentales Britanniques et celui des Etats-Unis par voie de ses organisations forestières respectives ont été depuis longtemps intéressés à recueillir toute documentation au sujet des questions forestières tropicales. Ce mouvement a pris plus d'encouragement grâce au Conseil d'Agriculture de la Commission Anglo-Américaine-Caraïbe dans sa réunion tenue à Charlotte Amalie, St. Thomas, Iles Vierges, en août 1943, en adoptant un vaste programme pour coordonner les travaux scientifiques d'investigation dans l'Archipel Caraïbe en ce qui concerne la nutrition, l'agriculture, la pêcherie et les sciences forestières. Alors, cette tâche coopérative est une conséquence naturelle des discussions antérieures et est d'accord avec le programme du Conseil.

Le Memorándum de Concert, dejà entré en fonction, stipule que d'accord avec les politiques et plans projetés et qui seront approuvés par les deux organisations de temps en temps, le Directeur de la Station d'Expérimentation Forestière des Tropiques pourra destiner les fonds disponibles à cet effet, à entreprendre les recherches necessaires pour déterminer et démontrer les meilleures méthodes pour le peuplement, aménagement et exploitation des forêts de l'Amérique tropicale et de l'Archipel Caraïbe; et le Contrôleur du Développement et Prosperité des Indes Occidentales Britanniques devra organiser l'acquisition des subventions en argent qui étaient accordées selon ces plans et projets.

Quand l'accord fut signé, les divers colonies des Indes Occidentales Britanniques avaient dejà fait leurs contributions en argent allouées pour cette entreprise commune et le Memorándum a mis les contributions à la charge du Directeur qui à cet effet leur devra employer pour agrandir le Caribbean Forester et pour augmenter sa tirage, pouvant ainsi disséminer les résultats des travaux forestières scientifiques. Le concert stipule aussi que les colonies des Indes Occidentales Britanniques doivent faire de temps en temps des contributions additionnelles nécessaires pour remplir le but dejà signalé, selon les politiques et plans muellement crées.

Comme première mesure pris pour accomplir la tâche renfermée dans le concert, la Station Tropicale agrandira le Caribbean Forester graduellement en commençant avec le troisième numéro du Volume VI. Aussi, on prendra toute action possible pour mettre dans notre liste de distribution les noms de tous les chercheurs dans le vaste champ d'activité des sciences forestières et d'autres sciences y alliées qui désirent reçevoir le journal chez les Indes Occidentales Britanniques et ailleurs en Amérique.

Les pages du Caribbean Forester sont toujours à la disposition de ceux savants dans les branches des sciences forestières qui possèdent information technique substantielle et qui veullent contribuer à atteindre les buts proposés. On invite tous les pays de l'Amérique Caraïbe qui y sont intéressés à collaborer dans l'assistance collective, de la même façon ici décrite.

THE SILVICULTURE OF CEDRELA MEXICANA

John C. Cater, B. A. (Oxon)
Senior Assistant Conservator of Forests
Trinidad and Tobago

Cedar is a fast growing, light demanding species, tolerant of a wide variety of soil types and variations in rainfall; furthermore it is a species in which a single fair-sized specimen annually produces an enormous number of small, light, winged seeds, which are distributed for considerable distances by the wind and which give a high percentage of germination. One might expect it, accordingly, to behave as a forest weed in much the same way as, for example, Cecropia peltata, and spring up in great numbers in forest clearings, burnt land and cultivation. On the contrary, while cedar seedlings are often very numerous at the beginning of the wet season, very few of them can be found at the end of it; even those which do survive the first 18 months to 2 years usually die out in the following year. This experience appears to be common to the whole Caribbean area.

Three papers on Cedrela have appeared in the Caribbean Forester, 1/, 2/, 3/. Each relates in greater or less detail the invariable failure which has resulted from efforts to establish pure plantations of this species. This result is not flattering to foresters of the Caribbean area who collectively have spent many years trying to grow cedar and many foresters may have decided that it is impossible to grow cedar under plantation conditions and have abandoned the attempt, turning their attention to other species that offer more favorable prospects of success. There would be little justification for a fourth paper on the same subject unless it could provide even the smallest ray of hope. Since, however, the problems of regenerating sal, Shorea robusta, in India and Mvule, Chlorophora excelsa, in East Africa also have only comparatively recently been solved after long periods of research, and when hope had almost been abandoned, there can be little doubt that one day similar patient research with Cedrela will bring success. The object of this paper is to revive interest in this species and to offer a suggestion as to the cause of past failures which might lead to future success.

The Site Requirements of Cedar

During the second half of 1943 whilst in charge of a Division in the south of Trinidad, the writer found time to carry out some admittedly

---

1/ Beard, J. S. Summary of silvicultural experience with cedar, Cedrela mexicana Roem. in Trinidad. Caribbean Forester 3:91-102. 1942.
2/ Holdridge, L. R. Comments on the silviculture of Cedrela. Caribbean Forester 4:77-80. 1943.
3/ Fors, Alberto J. Notas sobre la silvicultura del cedro, Cedrela mexicana Roem. Caribbean Forester 5:115-117. 1944.

rather rough observations of cedar. His journeys frequently took him through cultivated country where cedar flourishes in thousands, and it was perhaps inevitable that he should speculate as to the reason why peasants, who are traditionally described as ignorant, could grow large numbers of healthy cedar trees when technically trained foresters throughout the Caribbean area were unable to produce even one healthy cedar plantation of any considerable extent. What, if any, was the peasant's secret? Inquiry revealed that they had no secret, that in their case also cedar trees sometimes grew but often did not. However, the fact remained that they owned large numbers of healthy cedar of all sizes from saplings to mature trees, sometimes planted, but more often the result of natural regeneration, and it seemed fair to reason that if one could discover why the healthy cedar were healthy, and under what conditions they were growing, one might eventually discover whether the formation of pure cedar plantations was practicable, and if so, how it should be achieved.

The first step was to examine the sites of several hundred healthy cedar trees of all sizes in the cultivated land. In the area under examination the rainfall averages about 80 to 85 inches per annum and there is a marked dry season, which usually extends from the middle of January to the middle of May. The two principal soil types are a black calcareous clay of high fertility and an acid red-weathering clay of low fertility. The topography varies from rolling to broken country, chiefly the former. It was found that irrespective of soil type, the great majority of the cedar occurs on one or other of the following sites:

(a) The raised banks along roads, adjoining the road drains.

(b) The banks formed in cocoa plantations and sugar cane fields by the usual processes of cultivation of these crops.

(c) The ridges and knolls in areas of second growth following shifting cultivation.

(d) In close proximity to houses, or on the ruins of disintegrated tapia (mud) houses.

In each of the four site types listed above there is one constant factor, good surface drainage. In (a) it is provided by the road drains and its effect is increased by the fact that in undulating country the roads tend to follow the ridges. In (b) the cocoa and sugar cane banks are from 15 to 20 feet wide and separated by deep drains designed for the rapid removal of run-off water. In (c) there is usually no artificial drainage but the topography is such as to provide good natural surface drainage. In (d) it is the usual practice to build houses on ridges and hilltops, and in some cases to drain the land immediately around the house for reasons of health and comfort. In some cases wattle and daub houses which have fallen into disrepair have been abandoned to gradual decay and disintegration into a heap of recognisable origin. Healthy cedar trees are often found on such ruins.

The small minority of cedar which do not occur on one or other of these four site types were found in situations in which the drainage does not appear to be particularly good. An explanation of this phenomenon will be offered later in this paper.

From this examination it seemed reasonable to conclude that the most vital requirement of cedar is adequate drainage of the individual tree site. The importance of good general drainage for cedar has not been overlooked in the past, but it seemed possible that insufficient emphasis has been laid on the drainage and soil aeration conditions of each individual site. It seemed also reasonable to conclude that the varying fertility of different soil types does not affect the health of cedar, though it may affect rate of growth.

The next step was to examine individual cedar sites in an area of semi-evergreen seasonal forest in the same general locality. The southern end of the Central Range Reserve lies within a few miles of the cultivated lands where cedar is so abundant, and has the same two general soil types with a similar topography and rainfall. Cedar is, however, a comparatively rare species in the Reserve, and saplings in particular are exceedingly rare, although seedlings are often locally numerous during the early part of the wet season. The natural cedar were found on ridge-tops and knolls and the upper part of steep slopes. There appears also a tendency for the cedar to be more numerous on the calcareous clay than on the red-weathering clay: this may in part be due to the superior internal drainage of the upper layers of the calcareous clay. A main road passes through this part of the Reserve and a considerable proportion of the cedar is found on the banks of this road, which follows a long ridge with relatively steep sides. Cedar is completely absent from flat areas in this forest, and is very rare on the lower parts of slopes.

These observations appear to confirm the conclusion that conditions of good drainage of individual cedar sites are essential for the proper growth of cedar, and that the relative scarcity of available well-drained sites in natural forest is responsible for the scarcity of forest cedar: It can further be argued that in cultivated land the better drainage afforded by the processes of cultivation provides a larger number of suitable individual cedar sites for any given area of land, which together with the natural tendency of persons to retain and tend valuable cedar seedlings during cultural operations has resulted in a higher cedar population in cultivated land than in natural forest land in the same locality.

How can the past failure of all cedar plantations be explained on the basis of the paramount importance of adequate site drainage, or, in other words, of a satisfactory soil-moisture relationship? Previous experience in Trinidad with attempts to grow cedar plantations in clear-felled areas of natural forest on various soil types and within varying climatic regions may be summarized as follows: Germination is usually good, and the young cedar make rapid, healthy growth for the first 18 to 24 months, after which they become unhealthy and usually die out during the third or fourth year. During the latter period they shed their leaves periodically throughout the wet season and die-back of the crown occurs; there is often a change in form of growth from the normal to one resembling a weeping willow; production of feeding rootlets is reduced or ceases entirely, and there is decay of the root system. The saplings, in effect, show every sign of suffering from physiological drought.

The above course of events appears to be explainable as follows: The good germination and subsequent satisfactory early growth are due to the availability of adequate moisture as a result of a suitable condition of the topsoil which, having only just been cleared of forest, is well aerated, has plenty of litter, a well-developed crumb structure and a high content of organic matter. The topsoil is thus in the early stages in an ideal condition for the development of the very superficial roots of the young cedar seedlings. As the cedar grows older, however, the larger roots develop and penetrate, or attempt to penetrate, more deeply into less well aerated soil, and at the same time the deterioration of the physical condition of the topsoil caused by erosion, insolation, and the removal of the litter-producing forest renders the topsoil increasingly less and less porous and hence less and less suitable for the development of feeding roots. The cessation of litter replacement when forest is felled leads to the degeneration of the upper organic layer, to a decrease in the carbon-nitrogen ratio and to excessive nitrification. The crumb layer below is affected and it too loses its organic matter with the result that the soil aggregations which constitute the crumb break down into their smaller mineral constituents, thereby reducing porosity. The resulting non-porous soil is unsuitable for normal root development. It is possible that toxic substances, produced by the processes of anaerobic decomposition of organic matter, may also contribute to the general reduction in fertility. It has been found that the felling of forest results in a raising of the water-table in the wet season, and such might further restrict the area of soil available for the cedar roots. The reduction of soil permeability is doubtless accelerated by the repeated trampling of laborers employed to tend the cedar. The net result is a soil which easily becomes waterlogged and in which the roots of the cedar are periodically unable to obtain sufficient oxygen, and in which water, though present, is not available to the plant. This causes the death of the finer roots, the tree experiences a resulting physiological drought and may actually go out of leaf until a temporary reduction in the rainfall allows the upper soil layer to dry out sufficiently to permit the redevelopment of the feeding roots. As the cycle is repeated at intervals depending on the distribution of the rainfall, the tree suffers from chronic ill-health and eventually dies.

Professor Hardy, Soil Chemist of the Imperial College of Tropical Agriculture in Trinidad, in the course of discussion of this theory stressed his observations of the enormous importance of root-room in forest crops, including economic crops such as cocoa, root-room being defined as the physiological depth of soil suitable for healthy root growth. Such depth varies greatly in different soil types. Thus in a deep, loose, uniform, sandy soil the feeding rootlets ramify within a relatively deep surface layer, provided this contains sufficient humus in the right biological condition. Such a sandy soil must, of course, be well-drained, since the presence of a high water-table would greatly reduce the physiological depth of what would otherwise be a quite satisfactory soil. In clay soils, physiological depth may be very variable. In the untouched mesophytic forest the feeding root zone is mostly the very uppermost mineral soil layer which is markedly crumby, and merges closely into the rotting litter. Tree rootlets may be normally associated here with mycorrhiza; their contact with the rotting litter seems at least to be accentuated by the presence of dense white mycelial webs which appear to attach the rootlets to the rotting leaves and twigs. The total thickness of the litter, rootlet-mat and crumb soil in clay types may only be small, even less than one inche, but its biological importance seems to be incalculable. Thus, if this all-important layer overlying a clay soil is injured, burnt, desiccated, eroded away, over-trampled or even seriously changed by thinning out the canopy or altering the tree flora, then the biological condition of the soil deteriorates. Clay soils differ greatly among themselves in the ease of crumb formation and in humic penetration through proneness to cracking, as well as in natural drainage as decided partly by topography and partly by internal structural impedence. The views expressed here are elaborated on the basis of field investigations in a publication to which reference is invited.4/

The position, then, can be summarised as follows; Cedar regenerates freely and grows healthily in cultivated areas on clay soils wherever the physiological depth and biological condition of the soil are suitable, and the existence of these suitable conditions is at least partly and probably principally due to the combined natural and artificial drainage of such areas. What matters is that there should be a sufficient depth of soil in a suitable condition for the ramification of the feeding roots and that the soil condition is such as to render its moisture available to the cedar. The comparative scarcity of cedar in the natural forest may be attributed in part to the extreme shallowness of the root-room of certain clay soils which may be due in part to erosion, and to the inadequacy of natural drainage over large areas of forest, with the result that possible cedar sites are confined to small areas on ridge tops and knolls or even rotting logs and stumps. Such sites are, of course, often occupied by other more aggressive and tolerant species with the result that they are not available to cedar, or again no seed may fall on the small suitable sites. It is only when a gap is caused on such a site without damage to soil conditions and cedar seed falls therein that cedar has a chance of establishing itself.

The failure to establish healthy cedar plantations in areas of felled forest is likewise attributable to the general inadequacy of natural drainage of most clay soils and to the destruction through the felling of the forest, erosion, burning, desiccation and puddling by human trampling of the essential physiological depth of soil necessary for healthy root growth.

4/ McCreary, C. W. R., McDonald, J. A., Mulloon, V. I. and Hardy, F. The root system of Cacao. Tropical Agriculture XX (11):207-220. 1943.

The Silvicultural System

Several important factors have to be taken into account in deciding the silvicultural system and the technique under which cedar plantations may be established. In Trinidad the danger of fire is so great in the areas of low and medium rainfall where cedar is most at home that such localities are at present out of the question for cedar plantations. They are, in fact, reserved for the planting of fire-resistant teak wherever the soil and topography are suitable. Thus, if cedar plantations are to be made at all in Trinidad, they must be made in areas of comparatively high rainfall, say 85 to 120 inches per annum, where there is a reasonable degree of safety from fires. In areas of such high rainfall as 120 inches per annum cedar is definitely on the extreme edge of its natural range, and its establishment is likely to present greater difficulties in such regions than in those of only 80 to 90 inches per annum.

At first sight there appear to be certain advantages in a system of clear felling and artificial regeneration. The complete removal of the original forest by intensive exploitation for timber and fuel, and the elimination of the unmerchantable trees and the lop and top by burning, enable the planting or sowing of the cedar at regular spacing with the minimum of inconvenience and expense. Root competition by other trees is eliminated, the cedar have full sunlight and are not exposed to drips. Intensive artificial drainage of the whole plantation can also be carried out with the least difficulty. The danger of fire from an accumulation of debris is effectively removed for a number of years. Against these advantages must be set the disadvantages, which in the opinion of the writer are overwhelming. The most serious disadvantage, and likely to be a fatal one, lies in the complete destruction by fire, insolation and erosion of the all-important upper layer of soil and litter, the thin layer which may not exceed 1 inch in depth in which all the feeding roots of young cedar ramify. This layer, once lost, cannot easily be replaced since its source of supply, the natural forest, has been destroyed. Even if the site is not burnt, insolation and erosion will rapidly cause the same loss of the upper soil layer. Other disadvantages of clear-felling are the inevitable invasion by a rank growth of grasses, the encouragement of vines and the raising of the water-table during the wet season which usually accompanies the felling of forest. Finally attack by Hypsipyla is more likely to prove of serious consequences in the open than under shade.

The alternative is the shelterwood system, and since cedar has been found to grow satisfactorily under the partial shade of a light shelterwood of evenly spaced dominants, this system has been adopted in current trials in Trinidad. The shelterwood affords the best protection of the soil against erosion and insolation, and inhibits the growth of grasses. By its constant shedding of leaves and twigs it helps to maintain a satisfactory organic content in the soil and hence a satisfactory physical condition, and by the processes of transpiration it removes from the soil appreciable quantities of water. Its effect, therefore, is to maintain the soil in the optimum condition for tree growth. Damage due to Hypsipyla is kept at a minimum under a shelterwood and recovery from attack is better than in the open. Finally, should the cedar plantation prove a failure, no damage will have been done to the site if a shelterwood has been retained.

The Planting Technique

It has been argued that cedar will only become established on well-drained individual sites where the topsoil is in a satisfactory physical and biological condition and that such sites in natural forest are rare and mainly confined to ridge tops and knolls. The problem before us is to discover how to create a large number of such sites per unit of area. This problem might be solved by forming the whole plantation area into a series of narrow banks and deep drains such as are found in many cocoa plantations. This would enable the whole of the area to be planted in cedar at a close spacing, but even were the method successful the cost would be high and probably out of proportion to the revenue which could be expected later from the sale of the cedar timber. There is, furthermore, no apparent reason for close planting since the early thinnings are unsaleable, provided that other means can be found to produce satisfactory stem form.

An alternative method is to plant only enough cedar to give a good stocking of the species at maturity, say approximately 40 trees per acre, and to lavish on this smaller number all the care necessary for their successful establishment, relying on natural regeneration of other species to make up the remainder - and in the early years the majority - of the crop. It is on this principle that tests have been begun in Trinidad and which, if successful, will enable large areas to be treated at reasonable cost. This method involves only the artificial manufacture and drainage of the 40 sites per acre, as compared with the intensive drainage of a whole acre when cedar is planted throughout at, say, 6 feet spacing. The technique may be described as follows: The proposed site of the plantation having been selected in natural forest in broken or at least undulating country, the first step is the formation of the shelterwood. This is achieved by removing all the trees in the lower storeys and by thinning out the dominants where necessary to give a light shelter of tall, evenly-spaced trees. The trees cut can, of course, be converted into timber and fuel or charcoal. Reference is invited to a previous description of the shelterwood technique.5/ The exact optimum density of shelterwood is not yet known, but it is suggested that a shelterwood which admits to the forest floor about 50% of the available sunlight is suitable. The next step is to prepare the individual cedar planting sites. As far as possible these should be fairly evenly spaced, swampy areas and badly drained lowlying land being avoided, and it is suggested that they should number about 40 per acre. The provision of a moist yet perfectly aerated soil for the young cedar is of primary importance, and for this reason the seedlings are planted or the seeds sown on mounds. The mounds are prepared in the following manner. A square of 5 feet or 6 feet sides (or a circle of similar diameter) is marked out with pegs. Around the square for a width of about 2 feet the topsoil is bared by raking off the litter, which is thrown within the square. Rotten wood and branches

---

5/ Brooks, R. L. The regeneration of mixed rain forest in Trinidad. Caribbean Forester 2:164-173. 1941.

amongst the litter are roughly placed around the sides of the square to help to stabilise it. The topsoil from the bare strip is then dug out to a depth of 3 inches and spread within the square over the litter, and shaped into a slightly convex surface. The mound so produced varies from about 12 inches to 18 inches in height at the centre according to the amount of litter available on the ground. A pinch of cedar seeds is then sown in the centre of the mound, which is afterwards mulched with leaf litter. The resulting seedlings are gradually thinned out until only one remains.

Current trials in Trinidad have now reached that stage. Germination has been good and so far the seedlings are healthy. One possibility that had given some concern was that of destruction of the mounds by heavy rain. In the month that followed the formation of the mounds and the sowing of the seeds over 30 inches of rain fell, yet damage was negligible. The mounds appear to be well protected by the mulch, and even a number of control mounds which had not been mulched suffered little from erosion. Throughout this period of heavy rain the soil of the mounds remained in a friable, porous condition and not at all waterlogged. The strips around the mounds from which the topsoil had been removed were subject to a small amount of scouring but the soil so removed was deposited again a few feet away amongst the ground litter lower down the slope.

It is not suggested that the method of mound construction described above is the only, or even the best method. Research alone can show what is the best area and height of mound. Furthermore, it may be preferable to form the mounds by placing all the litter on top of a mound of topsoil instead of burying part of it under the excavated topsoil from the surrounding strip. This would simulate the natural processes under forest, where the organic content of the soil is maintained principally by additions of leaves, etc. to the surface and to a less extent by the decay of buried material such as dead roots. There is a possible danger that by burying a mass of litter its proper breadkdown may be prevented. There is a further possibility of utilising natural mounds in the form of rotting stumps and logs as the basis of planting sites which requires investigation.

It is expected that future tending operations will include the following:

(a) The maintenance of a soil-preserving mulch of litter, cut bush, etc., on the mounds.

(b) The establishment of a crop of young trees of various species by natural regeneration which together with the cedar will give an initial spacing of about 6 feet by 6 feet.

(c) The establishment of a dense understory of tree seedlings, shrubs and herbs to protect the soil against erosion.

(d) The prevention of suppression of the cedar by vines and other tree species.

(e) The gradual removal of the shelterwood by poisoning as and when necessary.

(f) The thinning of the mixed crop to give increasing room for the development of the cedar. Ultimately, of course, all or nearly all the dominant trees in the new crop except cedar will be removed in thinnings.

The Economic Aspect

Such intensive preparation of the land for planting as the formation of large mounds must inevitably be comparatively expensive, and can only be justified if the expected returns are also large. The formation of a shelterwood by the employment of timber licensees and charcoal burners is a cheap operation, and, in fact, usually yields an appreciable net revenue. The tending of a cedar plantation should prove no more expensive than the tending of a teak or galba (Santa María) plantation. The additional expense is represented only by the preparation of the mounds and the maintenance of a mulch. The experiments carried out in Trinidad showed that labour inexperienced in such work and not noticeably enthusiastic about it could prepare a complete mound in one hour. With experience a better performance can be hoped for, but even at this slow rate and with a daily labour wage of $1.14, the mounds only cost 14 cents each. Thus the preparation of the 40 mounds per acre would cost $5.60. The cost of maintaining the mulch is more difficult to estimate but as mulching would be done at the time of tending with materials close at hand it is unlikely to be excessive.

It is by no means uncommon in Trinidad for a cedar tree to reach a breast height girth of 8 feet in about 30 years. A crop of 40 such trees to the acre, which in Trinidad are worth $16.00 each in royalty would therefore be worth about $640.00 per acre standing. So valuable a crop can repay very heavy expenditure in the early years of establishment. In addition to the final return from the cedar there would be earlier returns from the sale of the thinnings of the mixed intermediate trees as poles, firewood, and for charcoal burning.

Cedar on Badly-drained Sites

There are apparent exceptions to every rule and it is quite possible to find large cedar trees growing in conditions where the drainage is apparently poor. This has already been commented on and it is necessary to offer an explanation of this apparent anomaly.

Examination of a number of such sites leads the writer to the conclusion that originally, at the time of germination of the seed and in the early years of growth, the drainage of the site was better than it became subsequently, and that deterioration of an originally well-drained site has taken place. There are two outstanding examples of this process at Mt. Harris in the Central Range Reserve, where two cedar trees about 35 feet high and 2 feet in girth are growing rapidly and healthily - they are only 5 or 6 years old - on a flat plateau where the soil is gritty clay which is waterlogged for long periods in the wet season. Both these trees which are only a few feet apart, obviously started life on top of a rotting tree trunk which lay on the ground. The tree trunk has now entirely disappeared but its former existence can be seen from the shape of the cedar trees; their stems really begin about 9 inches above present ground level and there is a large space between the roots above ground. Thus, in their early life these two cedar trees, being perched some 9 to 12 inches above ground level and growing in rotten wood and debris, enjoyed a moist yet well-drained rooting zone. Similarly, many cedar which are now growing in sites with poor drainage may have begun life on piles of litter, decaying logs and rotten tree stumps, which initially afforded good drainage. There is here an indication that, once well established, cedar can tolerate conditions in which drainage is not exceptionally good, and if this is so it would appear that the maintenance of planting mounds and mulching will be unnecessary after the fourth or fifth year.

Conclusion

The object of this paper is to stimulate interest in the silvicultural problems presented by Cedrela mexicana. This species is of such importance and value and is so widespread throughout the Caribbean that further attempts to find a method by which plantations can be successfully established should take a high priority in the work of the Forest Services of the region. It is possible that the solution of the problem is beyond the reach of foresters with the usual Jack-of-all-trades training, and that several years of combined effort by a plant physiologist and a soil chemist may be required. Any money spent in a successful search for the secret will be well repaid by the new possibilities for forestry thereby opened up. The theory advanced here is that the first essential of success with cedar is a satisfactory soil-moisture relationship, and that this can best be provided by mound-planting and mulching. While this theory may eventually prove incorrect, it appears at present to fit the known facts, and it is hoped that Forest Services in the Caribbean region will at least give the method a trial and report their results in due course in the Caribbean Forester.

Summary

1. Although cedar is a fast growing species which produces large numbers of light winged seeds, it fails to regenerate naturally in the degree which might be expected. Numerous attempts to form pure plantations of cedar in various Caribbean countries have ended in failure.

2. Cedar is found in large numbers in cultivated land in south central Trinidad. It is more numerous in cultivated land than in natural forest in the same locality. The great majority of the cedar in cultivated land are found on the drainage banks along roads, on artificially-drained banks in cocoa and sugar cane fields, on ridges and knolls in land subject to shifting cultivation, and around houses. The outstanding characteristic of such sites is good drainage.

3. In natural forest the cedar are almost entirely confined to the upper parts of steep slopes, ridgetops and knolls. Here again good drainage obtains. It is concluded that conditions of good drainage of individual cedar sites are essential for the proper growth of cedar, and that the relative scarcity of available well-drained sites in natural forest is responsible for the scarcity of forest cedar, whereas the presence of more numerous well-drained sites in cultivated land produced through cultural operations allows a greater cedar population in cultivated lands.

4. The common experience with cedar plantations in which the trees grow healthily for the first 18 to 24 months and then die back is explained as follows: At the time of formation of the plantation the topsoil, having just been cleared of forest, is in good condition for the development of the cedar roots, which are mostly very superficial. After a while, however, deterioration in the topsoil takes place, caused by erosion, insolation and the removal of the litter-producing forest. Trampling by labourers further damages the shallow, all-important topsoil. The crumb structure breaks down and the topsoil becomes less and less porous and hence less and less suitable for the ramification of feeding roots. Decreasing porosity is accompanied by the development of a low carbon-nitrogen ratio and excessive nitrification. The net result is a soil which easily becomes waterlogged and in which the roots of the cedar are periodically unable to obtain sufficient oxygen, and in which water, though present, is not fully available to the plant. This causes the death of the finer roots, the tree experiences a physiological drought and may actually go out of leaf until a temporary reduction in the rainfall allows the upper soil layer to dry out sufficiently to permit the redevelopment of feeding roots. As the cycle is repeated at intervals depending on the distribution of the rainfall, the tree suffers from chronic ill-health and eventually dies.

5. It is suggested that cedar should be planted under a light shelterwood in view of the protection which the shelterwood affords to the soil, and that only about 40 trees per acre be planted or sown on specially prepared artificial mounds to ensure adequate drainage of every individual site. Such mounds have been prepared in Trinidad by marking out a square of 5 feet or 6 feet sides (or a circle of similar area) and removing the forest litter in a strip 2 feet wide around the square. The litter is spread within the square and the topsoil from the bared strip is dug out to a depth of 3 inches and spread in the square over the litter, and shaped into a slightly convex surface. Such mounds are from 12 inches to 18 inches high, depending on the amount of litter available. Seeds are sown or a seedling planted in the middle. The mounds are mulched to prevent erosion and to maintain the soil in good condition. Each mound costs about 14 cents in Trinidad and takes one hour to prepare. The mounds should be

made at roughly equal distances throughout the plantation, avoiding badly-drained areas. There are, of course, other and perhaps better methods of making mounds, and it may be possible largely to utilize natural mounds formed by rotting stumps and logs.

(Traducción del artículo anterior)

LA SELVICULTURA DE CEDRELA MEXICANA

El cedro es una especie de crecimiento rápido, de luz, tolerante de una amplia variedad de tipos de suelos y fluctuaciones en la precipitación; además, un solo ejemplar de algún tamaño produce anualmente un número enorme de semillas pequeñas, livianas y aladas que el viento esparce sobre distancias considerables y cuya capacidad germinativa es bastante alta. Por lo tanto, es de suponer que esta especie se encuentre por todos sitios en el bosque, como sucede con Cecropia peltata, y que crece en grandes números en los claros del bosque o en las tierras quemadas o bajo cultivo. Lo que sucede es lo contrario; los brinzales de cedro son a menudo muy numerosos al comenzar la estación lluviosa pero al terminarse ésta son pocos los que quedan y aún aquellos que sobreviven en los primeros 18 meses hasta los 2 años casi siempre mueren al año siguiente. Esta experiencia se repite en todo el área del Caribe.

En el "Caribbean Forester" han aparecido tres artículos sobre Cedrela 1/, 2/, 3/. Cada uno de ellos expone con más o menos detalles el invariable fracaso de los esfuerzos tendientes a establecer plantaciones puras de esta especie. Este resultado no es muy lisonjero para los dasónomos del área del Caribe quienes por muchos años han tratado de cultivar el cedro y muchos de ellos han decidido que es imposible cultivarlo bajo las condiciones prevalecientes en las plantaciones y han abandonado el intento, ocupándose de otras especies con mayores probabilidades de éxito. Habría poca justificación para un cuarto artículo sobre el mismo tópico, a menos que proporcionase aunque fuera una pequeña luz de esperanza. Pero sin embargo, como los problemas sobre la regeneración de Sal (Shorea robusta) en India y de Mvule (Chlorophora excelsa) en Africa Oriental han sido resueltos en tiempos comparativamente recientes, después de largos períodos de investigación y cuando ya se había perdido casi toda esperanza, no cabe la menor duda que algún día, se obtendrá éxito con Cedrela, al cabo de pacientes investigaciones. El objetivo de esta disertación es revivir el interés en esta especie y sugerir la causa de los fracasos anteriores, lo cual puede conducir a éxitos futuros.

Los Requisitos de Habitación del Cedro

Durante la segunda mitad del año 1943 mientras estaba a cargo de una División al sur de Trinidad, el autor pudo observar el cedro aunque no muy detenidamente. En sus viajes tenía que cruzar con frecuencia a través de terrenos cultivados donde florecían miles de cedros y era inevitable que especulase sobre el porqué los campesinos, quienes se juzgan tradicionalmente como ignorantes, podían cultivar gran cantidad de árboles de cedro robustos mientras que los dasónomos del área del Caribe, de amplia preparación técnica, no podían obtener ni siquiera una plantación sana de grandes proporciones. ¿Cuál era, si lo había, el secreto de los campesinos? Al indagar al respecto se encontró que no había tal secreto ya que también en su caso los cedros crecían sólo a veces. No obstante, lo cierto era que ellos poseían gran número de cedros robustos de todos tamaños, desde pies hasta árboles maduros, obtenidos a veces por medio de siembra pero por lo general como resultado de la regeneración natural. Parece lógico suponer que si se descubriera el porqué de esa robustez y bajo qué condiciones es que crecen los cedros, eventualmente se podría determinar si la formación de plantaciones puras de cedro es factible y como debería procederse si así fuera.

El primer paso a efectuarse era examinar el medio estacional de los diversos cientos de cedros robustos de todos tamaños que crecían en los terrenos cultivados. El área que se examinó tenía una precipitación promedio de 80 a 85 pulgadas anuales con una época seca bastante pronunciada que casi siempre se prolonga desde mediados de enero hasta mediados de mayo. Los dos tipos principales de suelos son: una arcilla calcárea negra muy fértil y una arcilla rojiza poco fértil. La topografía varía entre ondulante y quebrada, predominando la primera. Se determinó que no importa el tipo de suelo, la mayoría de los cedros aparecían en uno y otro de los siguientes medios:

(a) Los taludes a lo largo de las carreteras, cerca de las zanjas de desagüe.

(b) Los bancos formados en las plantaciones de cacao y de caña mediante los procesos usuales efectuados al cultivar estos productos.

(c) Los cerros o lomas en áreas cubiertas de la vegetación secundaria que origina el sistema de conuco.

(d) Cerca de las casas o en las ruinas de viviendas de tapia (barro).

En cada uno de los cuatro tipos estacionales enumerados arriba existe un factor común constante, es decir, buen drenaje superficial. En (a) lo proporcionan las zanjas, cuyos efectos están acentuados por el hecho de que en terrenos ondulantes las carreteras tienden a seguir el curso de los cerros. En (b), los bancos en las plantaciones de cacao y caña de azúcar son de 15 a 20 pies de ancho y están separados por zanjas hondas que sirven para remover con rapidez el agua de deslave. En (c) usualmente no hay drenaje artificial pero la topografía provee buen drenaje superficial natural. En (d) es preciso notar que las casas se construyen casi siempre en lo alto de las lomas y cerros y en algunos casos se procede al drenaje del terreno alrededor de las casas, con fines higiénicos y por comodidad. Las casas de barro que han sido abandonadas a la podredumbre y desintegración se convierten en un montón de origen fácil de reconocer. En tales ruinas crecen a menudo cedros robustos.

La escasa minoría de cedros que no se hallaron en uno u otro de estos cuatro tipos de habitación se encontraron en sitios en donde el drenaje no era particularmente bueno. Más adelante se expondrá una explicación de ese fenómeno.

Del examen practicado parece lógico concluir que el requisito más vital del cedro es el drenaje adecuado del medio estacional de cada árbol individual. La importancia del buen drenaje general en el caso del cedro no ha sido pasado por alto anteriormente pero puede que no se le haya dado suficiente énfasis a las condiciones en relación al drenaje y aeración edáfica de cada habitación individual. También parece lógico concluir que los diversos grados de fertilidad de los distintos tipos de suelos no afecta la robustez del cedro aunque puede afectar su índice de crecimiento.

El próximo paso consistió en examinar las habitaciones individuales del cedro en un área de bosque estacional semi-perennifolio, en la misma localidad general. El extremo sur de la Reserva Central Range está situado a pocas millas de los terrenos cultivados donde abunda el cedro y tiene los mismos dos tipos generales de suelos que éstos y topografía y precipitación similar. Sin embargo, el cedro es una especie cuya presencia es comparativamente rara en la Reserva y los pies, en particular, son excesivamente raros aunque los brinzales son a menudo numerosos localmente durante los comienzos de la época de lluvias. Se encontraron cedros naturales en la cima de los cerros y lomas y en la parte alta de pendientes inclinadas. Los cedros también parece que tienen la tendencia de ser más abundantes en la arcilla calcárea que en la rojiza lo cual probablemente se debe en parte al mejor drenaje interno de las capas superficiales de la arcilla calcárea. Una carretera principal pasa a través de esta parte de la Reserva y una considerable parte de los cedros se encuentran en los taludes de esa carretera que sigue el curso de un cerro largo con lados relativamente inclinados. No existe absolutamente ningún cedro en las áreas llanas del bosque y es muy raro en la parte baja de las laderas.

Estas observaciones parecen confirmar la conclusión de que el buen drenaje de las habitaciones individuales del cedro es esencial para su crecimiento adecuado y la escasez de cedros en el bosque natural se debe a la escasez relativa de sitios bien avenados. Puede argumentarse además, que en terrenos cultivados los procedimientos empleados en los cultivos dan como resultado un mejor avenamiento que provee así mayor número de sitios apropiados para el cedro por unidad de superficie, lo cual, junto con la tendencia natural de la gente de retener y cuidar los valiosos brinzales de cedro durante las operaciones culturales ha dado como resultado en una misma localidad, una población de cedro más crecida en las tierras cultivadas que en el bosque natural.

¿Cómo pueden explicarse los pasados fracasos de todas las plantaciones de cedro tomando como base la gran importancia del drenaje estacional adecuado, o en otras palabras de una relación satisfactoria entre suelo y humedad? En Trinidad, las experiencias previas con el fin de obtener plantaciones de cedro en diversas áreas de bosque natural que habían sido taladas, en sitios de diferente tipo edáfico y en varias localidades climáticas pueden resumirse como sigue:- La germinación es casi siempre buena y los brinzales crecen rápidos y robustos durante los primeros 18 a

24 meses, después de lo cual pierden su robustez y casi siempre mueren al tercero o cuarto año. Durante esta última etapa se les caen las hojas periódicamente durante la época de lluvias y sufren la marchitez descendiente de la copa; a menudo aparece un cambio en la forma de crecimiento normal hacia una semejante a la del sauce llorón; se reduce o bien cesa por completo la formación de pelos radicales y comienza la pudrición del sistema de raíces. En efecto, los pies muestran todos los indicios de la sequía fisiológica.

El curso de los acontecimientos arriba expuestos bien puede explicarse como sigue: La buena germinación y el satisfactorio crecimiento inicial se deben a la humedad adecuada que la planta puede asimilar como resultado de la excelente condición del somosuelo, el cual, debido a la receiente tala del bosque está bien aireado; tiene gran cantidad de mantillo, una estructura migajosa bien desarrollada y un gran contenido de materia orgánica. Por consiguiente, el somosuelo está provisto en las primeras etapas de una condición ideal para el desarrollo de las raíces tan superficiales de los brinzales de cedro. Sin embargo, según va creciendo se desarrollan las raíces más largas que penetran o tratan de penetrar en los suelos profundos menos aireados y al mismo tiempo comienza el deterioro de la condición física del somosuelo por los efectos de la erosión e insolación y como ya no existe el bosque que producía el mantillo, el somosuelo va tornándose menos y menos poroso y de hecho menos y menos apropiado para el desarrollo de los pelos radicales. Al cesar el reemplazo del mantillo por la ausencia de bosque se origina la degeneración de la capa orgánica superior y disminuye la proporción carbono-nitrógeno produciéndose una nitrificación excesiva. La capa subyacente de estructura migajosa también es afectada, pierde la materia orgánica y se desmenuza en sus componentes minerales más pequeños con lo cual se reduce la porosidad. El suelo que resulta no es poroso ni adecuado para el desarrollo normal de la raíz. Es posible que la producción de substancias tóxicas que nacen de la descomposición anaeróbica de la materia orgánica contribuya también a la reducción general de la fertilidad. Se ha encontrado que la tala del bosque da como resultado un aumento en el nivel freático durante la época lluviosa lo cual limita más aún el suelo de que pueden disponer las raíces de cedro. Sin lugar a dudas, el pisoteo de los obreros empleados para cuidar los cedros acelera la reducción de la permeabilidad del suelo. El resultado neto es un suelo que se anega con facilidad y en el que las raíces de cedro se ven periódicamente incapacitadas de obtener oxígeno suficiente y el agua, aunque presente, no puede ser asimilada por la planta. Esto ocasiona la muerte de las raicillas por lo que el árbol sufre una sequía fisiológica y puede perder todas las hojas hasta que una reducción temporera de las lluvias permite que la capa superior del suelo se seque lo suficiente para que nazcan de nuevo los pelos radicales. Como este ciclo se repite a intervalos que dependen de la distribución de las lluvias, el árbol sufre de mala salud crónica y finalmente muere.

El profesor Hardy, Químico de Suelos del Colegio Imperial de Agricultura Tropical de Trinidad, en el curso de una discusión sobre esta teoría hizo hincapié en sus observaciones sobre la importancia enorme que tiene el espacio radical para las cosechas forestales, incluyendo las cosechas de índole económico tales como el cacao; definiendo el espacio radical como profundidad fisiológica necesaria para un crecimiento normal y sano de la raíz. Esa profundidad varía grandemente según los diversos tipos edáficos. Por lo tanto, en un suelo profundo, suelto, uniforme y arenoso los pelos radicales se ramifican en una capa relativamente profunda si ésta tiene suficiente humus en la condición biológica correcta. Este suelo debe estar bien drenado ya que la presencia de un nivel freático alto reduciría la profundidad fisiológica de dicho suelo que en otras circunstancias sería satisfactorio. En los suelos arcillosos la profundidad fisiológica puede ser muy variable. En los bosques mesofíticos inalterados, la zona pilífera está situada casi siempre en la capa superior de suelo mineral que es marcadamente migajoso y que se estrelaza estrechamente con el mantillo en descomposición. Los pelos radicales de los árboles pueden asociarse aquí normalmente con las micorrizas: su contacto con el mantillo en descomposición parece estar acentuado por la presencia de redes de micelios blancos que parecen unir las raíces a las hojas y ramas en putrefacción. El espesor total del mantillo, la zona de los pelos radicales y el suelo migajoso de los tipos arcillosos puede ser pequeña, aún menor de 1 pulgada, pero su importancia biológica parece ser incalculable. Por lo tanto, si esta capa tan importante, que está sobrepuesta a los suelos arcillosos se perjudica, quema, deseca, erosiona, pisotea o se cambia gravemente debido a una poda extrema del vuelo o por alteración de la flora arbórea, entonces se deteriora la condición biológica del suelo. Los suelos arcillosos poseen grandes diferencias en cuanto a la facilidad con que se forma la estructura migajosa y en penetración húmica debida a la tendencia a agrietarse, así como en drenaje natural determinados en parte por la topografía y en parte por los impedimentos estructurales internos. Los puntos de vista aquí expresados fueron elaborados a base de los estudios en el terreno, que ya han sido publicados y a los cuales el autor hace referencia.[4]

Lo anterior puede resumirse como sigue:- El cedro regenera libremente y crece con robustez en áreas cultivadas y de suelos arcillosos siempre que la profundidad fisiológica y la condición biológica del suelo sean favorables; y la existencia de estas condiciones favorables se debe por lo menos en parte y quizás principalmente al drenaje natural y artificial combinados de tales áreas. Lo que importa es que debe haber cierto espesor de suelo que posea una condición adecuada a la ramificación de los pelos radicales y que la condición edáfica sea tal que proporcione humedad que el cedro pueda asimilar. La comparativa escasez del cedro en el bosque natural puede atribuirse en parte a la extrema superficialidad del espacio radical que ofrecen ciertos suelos arcillosos lo cual se deba en parte a la erosión y en parte al drenaje natural inadecuado que existe en grandes áreas del bosque, lo que redunda en el hecho de que los únicos sitios apropiados para el cedro están confinados a las áreas pequeñas en las cimas de cerros y lomas y hasta en trozas o troncos en putrefacción. Desde luego, tales sitios están a menudo ocupados por otras especies más agresivas y tolerantes quienes excluyen al cedro de su habitación adecuada o también puede ser debido a que las semillas no caen en esos pequeños sitios privilegiados. La única oportunidad que el cedro tendría para establecerse sería que se hiciera un hoyo en tal sitio, sin perjudicar las condiciones edáficas, y que la semilla del cedro cayese en él.

El fracaso del establecimiento de plantaciones robustas de cedro en áreas taladas debe atribuirse por lo tanto a la deficiencia general del drenaje natural en los suelos arcillosos y a la destrucción de la profundidad fisiológica del suelo esencial al sano desenvolvimiento de la raíz del cedro, por vía de la erosión, tala, quema, desecación y pisoteo.

El Sistema Silvícola

Para decidirse sobre el sistema silvicultural y la técnica para establecer las plantaciones de cedro deben considerarse varios factores importantes. En Trinidad la amenaza del fuego es tan grande en las áreas de precipitación baja o mediana preferidas por el cedro que hoy día no hay ni siquiera que pensar en tales localidades para el establecimiento de plantaciones de cedro. De hecho, estas áreas, en aquellos sitios donde lo permiten la topografía y el suelo se han reservado para la siembra de teca, especie que resiste el fuego. Por lo tanto, si han de establecerse plantaciones de cedro en Trinidad deben hacerse en áreas de precipitación relativamente alta, es decir de 85 a 120 pulgadas anuales, donde no existe el peligro inminente del fuego. En áreas de precipitación tan elevada como 120 pulgadas anuales el cedro está definitivamente en el límite extremo de su distribución natural y por lo tanto su establecimiento ofrece mayores dificultades en estas regiones que en las de sólo 80 a 90 pulgadas anuales.

A primera vista parece ventajoso un sistema de corta total y regeneración artificial. La completa remoción del bosque original por la explotación intensiva de la madera y leña, la eliminación de árboles no maderables y de los despojos de corta por medio de la quema facilitan la siembra directa por semillas o por arbolitos (semillones) siguiendo un espaciamiento regular con menos inconveniencia y gastos. De esa manera se elimina la competencia de las raíces de los otros árboles, los cedros obtienen luz solar directa y no están expuestos al goteo del agua de las hojas de los árboles mayores. También puede practicarse con menos dificultad el drenaje artificial intensivo de toda la plantación. La amenaza de fuego debido a la acumulación de debrís puede ser así efectivamente eliminada por espacio de varios años. Contra estas ventajas podemos poner las desventajas, que a juicio del autor son abrumadoras. La desventaja más grave y casi fatal descansa en la amenaza de destrucción completa debido al fuego, insolación y erosión de la capa edáfica superior y del mantillo que puede no pasar de 1 pulgada de profundidad y cuya importancia estriba en el hecho de que allí ramifican los pelos radicales de los cedros jóvenes. Una vez perdida esta capa no puede ser reemplazada ya que el bosque que la proveía ha sido destruído. Aún cuando no se haya quemado el sitio, la insolación y la erosión rápidamente ocasionan la pérdida de esta capa edáfica. Otras desventajas de la corta total o tala son: la inevitable invasión de yerbas, porque favorece el desarrollo de bejucos y porque el nivel freático aumenta durante la época de lluvias. Finalmente, el ataque de Hypsipyla es de más graves consecuencias en campo abierto que bajo la sombra.

La otra alternativa es el sistema de cortas de abrigo y como se ha encontrado que el cedro crece satisfactoriamente bajo la sombra parcial de un monte de abrigo ligero de dominantes espaciados con regularidad, este sistema ha sido adoptado en los tratamientos corrientes en Trinidad. El sistema de abrigo ofrece la mejor protección del terreno contra la erosión e insolación e inhibe el crecimiento de yerbas. Debido a la constante caída de hojas y ramas, ayuda a mantener un contenido orgánico satisfactorio en el suelo y por ende una condición física satisfactoria y por los procesos de transpiración remueve del suelo cantidades apreciables de agua. Por lo tanto, su efecto consiste en mantener una condición edáfica óptima para el crecimiento arbóreo. El daño debido al *Hypsipyla* se mantiene en un mínimo en el sistema de abrigo y la convalescencia se efectúa mejor que a campo abierto. Por último, en caso que la plantación de cedro resulte un fracaso, no se le habrá infringido ningún daño al sitio ya que queda siempre el monte de abrigo.

Técnica de Siembra

Se ha dicho que el cedro puede establecerse en medios estacionales individuales bien drenados, donde el somosuelo exhiba condiciones físicas y biológicas satisfactorias, y que tales sitios son raros en el bosque natural, y están confinados a la cima de cerros y lomas. El problema ante nosotros es encontrar el medio de crear mayor número de tales sitios por unidad de superficie. Este problema puede resolverse dividiendo la plantación en una serie de bancos por medio de hondas zanjas al estilo de las que se encuentran en muchas plantaciones de cacao. Esto permitiría la siembra de cedro con espaciamiento menor y aún dado el caso de que este método resultara bueno el costo sería alto y no guardaría proporción con el rendimiento que podría esperarse de la venta de la madera de cedro que de allí se obtuviera. Además, en caso de que existan otros métodos por los cuales se produzcan buenos troncos, no existe aparentemente ninguna razón para sembrar los árboles cerca unos de otros, ya que los productos de los clareos iniciales no sirven para la venta.

La alternativa es el método de sembrar suficiente cedro para obtener una buena cosecha de la especie en su madurez, digamos aproximadamente 40 árboles por acre y prodigarle a este grupo menor todos los cuidados necesarios para su establecimiento satisfactorio y dependiendo de la regeneración natural de otras especies para llenar los huecos y proveer en los primeros años la mayoría de la cosecha.

Se ha comenzado la investigación en Trinidad basándose en los susodichos principios, los que en caso de éxito permitirían el tratamiento de grandes áreas a bajo costo. Este método incluye sólo la obtención y drenaje artificial de 40 sitios por acre, comparado con el drenaje intensivo del área en caso de que se sembrara cedro digamos a sólo 6 pies de separación. La técnica puede describirse como sigue: - Habiendo escogido el sitio de la plantación dentro del bosque natural en terreno quebrado o por lo menos ondulante, el primer paso es la formación del monte de abrigo. Esto se logra removiendo todos los árboles de los pisos inferiores y aclarando los dominantes en aquellos lugares donde sea imprescindible para obtener un abrigo leve de árboles altos, espaciados con regularidad. Los árboles cortados pueden convertirse en madera aserrada, leña o carbón. Hacemos referencia aquí a una descripción previa del método de cortas de abrigo 5/. La densidad óptima exacta del método de abrigo no se conoce aún, pero se sugiere que un monte de abrigo que proporcione al sotosuelo alrededor del 50% de la luz disponible es bastante adecuado. El próximo paso consiste en preparar los sitios individuales para los cedros. El espaciamiento debe ser lo más regular posible, deben evitarse los sitios pantanosos o bajos y de drenaje deficiente y se sugiere que se siembren alrededor de 40 por acre. Es de primordial importancia que se provea a los pies de cedro con un suelo húmedo pero bien aireado y por esta razón los brinzales o las semillas se siembran en montículos que se preparan de la manera siguiente: Se marca un cuadrado de 5 o 6 pies por cada lado (o un círculo de diámetro similar) con estaquitas. Al terreno que queda alrededor del cuadrado se le quita el mantillo en un espacio de 2 pies de ancho hacia fuera y alrededor del cuadrado y se echa dentro del cuadrado. Madera o ramas podridas del mantillo se pueden poner en los lados del cuadrado para estabilizarlo. Entonces el somosuelo de la faja exterior de donde se ha quitado el mantillo se excava hasta una produndidad de 3 pulgadas y la tierra obtenida se echa sobre el mantillo en el cuadrado dándole al montículo una forma más o menos convexa. El montículo así obtenido tiene de 12 a 18 pulgadas de alto en el centro, de acuerdo con el mantillo que haya en el terreno. Luego se echa un puñado de semillas de cedro en el centro del montículo y se cubre bien con hojarasca. Las plantitas que nazcan se entresacan gradualmente hasta que sólo queda la más robusta.

Los experimentos que se llevan a cabo en Trinidad ya están en esa etapa. La germinación ha sido buena y hasta la fecha los brinzales están saludables. Había la posibilidad de que las lluvias fuertes destruyeran los montículos pero en el mes que siguió a la siembra cayeron más de 30 pulgadas de lluvia y el daño fué insignificante. Parece que la hojarasca protege a los montículos y aún varios montículos testigos a los que no se les echó hojarasca han sufrido poco por los efectos de la erosión. En todo este período de fuertes lluvias el suelo de los montículos se conservó en una condición friable, porosa y sin anegarse en ninguna forma. Los surcos alrededor de los montículos, de donde se había removido el somosuelo habían sido lavados un poco pero el suelo así removido se había depositado algunos pies más abajo en el mantillo de la ladera.

No intentamos sugerir que el método del montículo aquí descrito sea el único ni aún el mejor. Sólo las investigaciones ulteriores podrán indicar cual es el área mejor así como la altura más apropiada del montículo. Además, puede que sea preferible formar los montículos poniendo todo el mantillo en la superficie en vez de enterrar parte de él con el somosuelo que se excava de la faja circundante. Así se simularían más los procesos naturales que ocurren en el bosque, donde el contenido orgánico del suelo se conserva principalmente por la adición de hojas, etc. a la superficie y en menor grado por la pudrición del material enterrado tal como las raíces muertas. Existe el posible peligro de que al enterrar ese mantillo se impida su desintegración adecuada. Otra posibilidad que merece investigación es la utilización de montículos naturales formados por tocones o trozas en putrefacción como sitios para sembrar los cedros.

Se espera que las futuras operaciones necesarias para cuidar el cedro habrá de incluir las siguientes:

(a) Conservación del mantillo de hojarasca etc. en los montículos.

(b) Establecimiento de otra cosecha de arbolitos de varias especies por regeneración natural los que, juntos con los cedros equivaldría a un espaciamiento inicial de 6 pies por 6 pies.

(c) El establecimiento de un subpiso denso de brinzales, arbustos y yerbas que protejan el suelo contra los efectos de la erosión.

(d) Evitar la supresión del cedro por bejucos u otras especies arbóreas.

(e) La remoción gradual del monte de abrigo por envenamiento, cuando sea necesario.

(f) El aclareo o entresaca de la cosecha arbórea mixta para darle suficiente espacio al cedro para su desarrollo. Desde luego, en último término, todos o casi todos los árboles dominantes de la nueva cosecha con excepción del cedro serán removidos en las entresacas.

Aspecto Económico

La preparación cultural del terreno para la siembra de cedros, de índole tan intensiva como implica la formación de montículos del tamaño requerido, tiene necesariamente que ser relativamente costosa y puede sólo justificarse si los rendimientos futuros son también grandes. La formación del monte de abrigo usando a los permisionarios y carboneros resulta barata, y de hecho, rinde casi siempre un ingreso neto apreciable. El cuidado de la plantación de cedro no resulta más costoso que la de teca o gualba (Santa María). Los gastos adicionales se cifran sólo en lo que se relaciona a la preparación del montículo y conservación de la hojarasca en él. Los experimentos que se han venido realizando en Trinidad indican que obreros sin experiencia previa en esta clase de trabajos y sin entusiasmo aparente pueden hacer un montículo en una hora. Es de esperarse que con mayor experiencia se efectuará con más rapidez pero aún con esta lentitud inicial y con los jornales de $1.14, los montículos costarían a razón de 14¢ cada uno. Por lo tanto, la preparación de 40 montículos por acre costaría $5.60. Es más difícil calcular el costo de la conservación de la hojarasca en el montículo pero como esta operación se puede hacer con material tan a mano, el gasto no habrá de ser excesivo. No es nada extraño encontrar en Trinidad árboles de cedro de 30 años que tengan una circunferencia de 8 pies a la altura del pecho. Una cosecha de 40 árboles por acre de esas dimensiones, que en Trinidad están valorados en $16 cada uno, equivaldría a un valor de $640 por acre en pie. En una cosecha tan valiosa vale la pena gastar bastante en los primeros años de su establecimiento. Además del ingreso final que se obtiene del cedro también habrá ingresos más tempranos de la venta del material mixto que se obtiene en las entresacas de árboles intermedios y que incluyen postes, leña y carbón.

El Cedro en los Sitios de Drenaje Deficiente

Toda regla tiene su excepción y por lo tanto es posible encontrar cedros grandes que están creciendo bajo condiciones de drenaje aparentemente pobre. Ya hemos señalado este hecho y es necesario dar una explicación sobre esta aparente anomalía.

Un examen detallado de cierto número de esos sitios hizo que el autor llegase a la conclusión de que originalmente, durante el período de germinación de la semilla y los primeros años de crecimiento el drenaje era mejor del que resultó subsiguientemente debido al deterioro del medio estacional que una vez poseía buen drenaje. Existen dos ejemplos notables de este proceso en Mt. Harris, en la Reserva Central Range donde hay 2 cedros de 35 pies de alto y 2 pies de circunferencia que crecen robustos en una planicie cuyo suelo es una arcilla arenisca, que se anega durante largos períodos en la época lluviosa. Estos árboles tienen sólo de 5 a 6 años, y están separados por una distancia de algunos pies. Es obvio que nacieron en lo alto de un tronco viejo tirado en el suelo. El tronco ya ha desaparecido pero su previa existencia puede deducirse de la forma de los cedros; sus tallos comienzan realmente a 9 pulgadas del nivel actual del suelo y existe un ancho espacio entre las raíces que pueden verse sobre el nivel del suelo. Así pues, en los primeros años de su vida estos dos cedros estaban a 9 o 12 pulgadas del suelo y crecían en madera en estado putrefacto y en debrís lo cual equivalía a una zona húmeda pero bien drenada. De la misma manera, muchos de los cedros que hoy día ocupan sitios de drenaje pobre puede que nacieran en montones de mantillo, trozas o troncos en estado de putrefacción que les suministraban el drenaje apetecido. Esto indica que el cedro, una vez establecido puede tolerar condiciones en que el drenaje no es excepcionalmente bueno. Si es éste el caso en realidad, entonces se podría prescindir de la conservación de los montículos y de la hojarasca después de los primeros 4 o 5 años.

Conclusión

El objetivo de esta disertación es estimular el interés en los problemas silviculturales de Cedrela mexicana. Esta especie es tan importante, de tanto valor y tan conocida a través del Caribe que la búsqueda de métodos por los cuales se puedan establecer plantaciones satisfactoriamente debe tener mucha prioridad en lo que se refiere a los trabajos que emprendan los Servicios Forestales en esa región. Es posible que la solución de este problema esté más allá del alcance de los conocimientos del dasónomo y que se necesite la labor combinada del fisiólogo y del químico de suelos durante varios años para llegar a la meta final. Todo el dinero que se gaste en investigar este secreto lo pagarán con creces las nuevas orientaciones dasonómicas que su solución conlleva. Este trabajo expone la teoría avanzada

zada de que para lograr éxito con cedro, el primer requisito esencial es una relación satisfactoria de suelo-humedad y que la mejor manera de proveerlo es por medio de la siembra en montículo y protección del brinzal con hojarasca. Aunque puede ser que esta teoría no sea correcta, por lo pronto parece cuadrar con los conocimientos actuales y se espera que los Servicios Forestales de la región del Caribe le den una oportunidad de prueba al método e informen los resultados obtenidos en el Caribbean Forester.

Resumen

1. A pesar de que el cedro es una especie de rápido crecimiento, que produce gran número de semillas aladas y livianas, su regeneración natural no es como debía esperarse. Los numerosos intentos para formar plantaciones puras de cedro en los diversos países del Caribe han culminado en fracasos rotundos.

2. En las tierras laborables al centro de la parte Sur de Trinidad se encuentran muchos ejemplares de cedro. Su abundancia es mayor en los terrenos cultivados que en el bosque natural de la misma localidad. La gran mayoría de los cedros de las tierras laborables se encuentran en los taludes a lo largo de las carreteras, en los bancos de drenaje artificial en las plantaciones de cacao y caña de azúcar, en los cerros o lomas de las tierras en que se practica el sistema de conucos y cerca de las viviendas campesinas. La característica primordial común a todos esos sitios es buen drenaje.

3. En los bosques naturales el cedro está confinado casi por completo a las partes más altas de las laderas inclinadas y a las cimas de cerros y lomas. Aquí se repite el caso de buen drenaje. Por lo tanto debemos llegar a la conclusión de que el buen drenaje individual de los medios estacionales del cedro es esencial para su crecimiento y que a la relativa escasez de sitios bien drenados y disponibles en el bosque natural es que se debe la escasez de cedros allí, mientras que en los terrenos laborables, son más numerosos debido al drenaje producido por determinadas operaciones culturales.

4. Para explicar la experiencia común al establecer plantaciones de cedro de que los brinzales crecen vigorosos durante los primeros 18 a 24 meses y luego se marchitan podemos decir lo siguiente:- Cuando se forma la plantación, el somosuelo, que se vé desprovisto del bosque que los cubría, posee aún las condiciones adecuadas para el desarrollo de las raíces de cedro que son en su mayoría muy superficiales. Pero luego se inicia el deterioro del somosuelo ocasionado por la erosión, insolación y ausencia del bosque cuya hojarasca y humedad producía el mantillo forestal. El pisoteo de los trabajadores también perjudica el somero e importante somosuelo. La estructura migajosa se rompe y el somosuelo va perdiendo su porosidad y se hace menos adecuada la ramificación

de los pelos radicales. La pérdida gradual de la porosidad va acompañada del desarrollo de una proporción baja de carbono/nitrógeno y de nitrificación excesiva. El resultado neto es un suelo anegadizo en el que las raíces del cedro se ven periódicamente incapacitadas de obtener suficiente oxígeno; y el agua, aunque presente, no puede ser asimilada por la planta. Por consiguiente, las raicillas más finas mueren y el árbol sufre por sequía fisiológica y aun pierde la hoja hasta que una reducción temporera de las lluvias permite que se seque el suelo superficial lo suficiente para que renazcan los pelos radicales. Al repetirse este ciclo a intervalos que dependen de la distribución de las lluvias, el árbol sufre de un estado crónico de mala salud que culmina en su muerte.

5. Se recomienda que se siembre el cedro bajo la protección de un monte de abrigo ralo en vista de que éste también protege el suelo y que se siembren sólo 40 árboles por acre en montículos artificiales preparados especialmente para proporcionar un drenaje adecuado a cada ejemplar de cedro. Estos montículos se preparan en Trinidad marcando un cuadrado de 5 ó 6 pies en cada lado (o un círculo de área similar) y removiendo el mantillo en una faja de 2 pies de ancho alrededor del cuadrado. El mantillo que se saque de esas fajas se esparce por el cuadrado y el somosuelo de la faja se remueve en una profundidad de 3 pulgadas y se esparce en el cuadrado sobre el mantillo, formando una superficie algo convexa. Estos montículos tienen de 12 a 18 pulgadas de alto según la cantidad de mantillo presente. En el centro de ese promontorio se siembran algunas semillas o se planta un brinzal. Los montículos se cubren de hojarasca para impedir la erosión y para mantener el suelo en buenas condiciones. En Trinidad, cada montículo cuesta aproximadamente 14¢, se prepara en una hora y todos se hacen lo más equidistante posible a través de la plantación, evadiendo las áreas mal drenadas. Desde luego, existen otros métodos y quizás mejores para hacer los promontorios y tal vez se puedan usar extensamente los montículos naturales que forman los troncos o trozas en putrefacción.

Las referencias que se citan en el trabajo aparecen al pie de la primera página del original en inglés.

Résumé

1. Le cédrel ou acajou amer, Cedrela mexicana, est une essence à accroissement rapide et qui produit une grande quantité de semences légères et ailées mais on ne peut pas obtenir sa régénération naturelle au degré souhaitable. Tous les nombreux essais faits pour établir des peuplements purs de cette essence dans les divers pays de l'Archipel Caraïbe n'ont trouvé que

l'insuccès.

2. On trouve un bon nombre de cédrèles parmi les cultures dans les secteurs centraux au Sud de l'île de Trinidad. Ils sont beaucoup plus nombreux dans les terrains cultivés que dans les forêts naturelles dans la même localité. Dans les terrains cultivés ils se trouvent principalement et presque seulement près des bancs de drainage le long des chemins, dans les bancs artificiellement drainés des cacaoyères et des plantations de cannes à sucre, dans les sommets et collines à pente rapide, parmi les terrains dediés à l'agriculture nomadique ou changeant et autour des maisons champêtres. La caractéristique saillante et commune à tous ces endroits est un bon drainage.

3. Dans la forêt naturelle les cédrèles y sont confinées complètement aux cimes des coteaux et des collines à pente rapide. On y trouve aussi un drainage excellent. Alors, il saut aux yeux que les conditions de bon drainage du site ou habitat individuel du cédrel est essentiel pour une croissance satisfaisante et l'absence relative de sites avec drainage approprié dans les forêts naturelles y est la cause de la rareté des cédrèles forestières, tandis que la présence de beaucoup de sites bien drainés dans les terrains cultivés, à cause des opérations culturelles, y est responsable des peuplements de cédrèle.

4. Les expériences communes aux forestiers qui ont travaillé avec le repeuplement du cédrel montrent que les arbres croissent robustes pendant les premiers 18 jusqu'à 24 mois et depuis ce temps là ils commencent à mourir. Cela peut-être clarifié comme suit; À l'époque de la formation du boisement, la couche supérieure du sol qui vennait d'être dépourvue de la forêt que jadis l'on couvrait est dans une bonne condition pour le développement des racines très superficielles du cédrel. Cependant, un peu plus tard commence la détérioration du sol à cause de l'érosion, l'insolation et l'éloignement du bois qui était le source de la litière. Le parcours des ouvriers qui soignent les peuplements fait tort aussi au sol, si important et superficiel. La structure mietteuse se délabre et la couche supérieure du sol devienne de moins en moins poreuse et ainsi de moins en moins appropriée pour la ramification des poils absorbants. La diminution en porosité est accompagnée d'une proportion de carbone/nitrogène assez basse et d'une nitrification excessive. Le résultat net est la production d'un sol facilement stagné et dans lequel les racines du cédrel périodiquement ne peuvent pas obtenir l'oxygène necessaire et oú l'eau, bien que présente, n'est pas complétement assimilable. Cela cause la mort des poils absorbants et l'arbre souffre d'une sécheresse physiologique, perdant les feuilles jusqu'à

ce qu'une reduction passagère de la precipitation sèche la couche supérieure du sol et en permettant le redéveloppement des poils absorbants. Comme ce cycle se répète à intervalles qui dépendent de la distribution des pluies, l'arbre souffre d'une maladie chronique qui culmine avec sa mort.

5. On recommande la plantation du cédrel sous une forêt d'abri car elle protégè le sol. Aussi, on doit planter seulement 40 arbres dans chaque acre et sur des tas ou terrasses de terre artificiellement preparées pour assurer un drainage convenable. A Trinidad on avait preparé les tas en designant un carré de 5 ou 6 pieds dans chaque coté (ou un cercle avec la même aire); puis on enlévè la litière dans une bande de 2 pieds de largeur autour du carré. Après avoir répandu la litière sur le carré on creuse le sol de la bande dépourvue de litière jusqu'à une profondeur de 3 pouces en le répandant dans le carré, sur la litière. Le tas ainsi fait aura une superficie un peu convexe et une hauteur de 12 à 18 pouces, selon la quantité de litière disponible. Puis on place les semences ou plante les semis en haut du tas. On ameuble le tas avec des feuilles mortes pour empêcher l'érosion et pour conserver les bonnes conditions du sol. Chaque terrasse est fait pendant une heure et coûte 14¢ à Trinidad. On doit les faire à la même distance plus ou moins, en evitant les sites mal drainés. Il y en a peut-être d'autres et meilleures méthodes pour faire les tas et aussi peut-on utiliser les tas naturels formés par les troncs et billes pourrissants.

Conclusion

L'objet de ce travail-ci est de faire ressortir l'intérêt pour les problèmes sylvicoles de *Cedrela mexicana*. Cette essence est tellement importante et appréciée et est si distribuée à travers l'Archipel Caraïbe que les efforts à faire pour résoudre les problèmes de sa régénération occupent une haute priorité parmi les travaux des Services Forestiers de la région Caraïbe. Il est possible que pour surmonter ces difficultés on ait besoin des jointes recherches d'un spécialiste en physiologie des plantes et d'un chimiste du sol pendant plusieurs années car peut-être l'éducation generale d'un forestier n'en est pas suffisante. L'argent employé dans ces recherches vaut la peine à cause des nouvelles possibilités offertes par l'heureuse régénération du cédrel. La théorie à laquelle on avait abouti peut se résumer comme suit; Pour atteindre le succès avec le cédrel la chose plus importante c'est un rapport sol-humidité satisfaisant fourni par un bon drainage et par la conservation d'un sol poreux pendant les premières années du développement de l'arbre. Bien que cette théorie éventuellement puisse être incorrecte, jusqu'à présent elle est en accord avec les faits dejà connus. L'auteur constate que les Services Forestiers dans la région Caraibe doivent au moins éssayer la méthode ici décrite et publier leur résultats dans le Caribbean Forester.

EL QUINO VUELVE AL HOGAR

Fué necesario una guerra mundial y que el Japón envadiera el Pacífico Sur para que el quino volviese a reinar sobre las altas cumbres andinas. El interés de América en la planta está demostrado por la enorme publicidad dada a la cinchona. Entre los diversos artículos de los que extraímos estas notas están: "Pearl Harbor Sent Quinine Home" por W. C. Davis; "La Quina y sus Descubridores", por el Hno. León y "Hunting Cinchona in the Peruvian Andes", por W. H. Hodge.

La leyenda que rodea su descubrimiento, su rapto y aclimatación en el Oriente y su regreso al Nuevo Mundo es único. El nombre científico se originó del hecho de que la Condesa de Cinchón, esposa del Virrey del Perú, fué la primera persona en curarse de la malaria con esta planta. Más tarde La Condamine y Jussieu la estudiaron en Loja, Ecuador, su primer centro de extracción. José Celestino Mutis, el célebre botánico, estudió los quinos de la Nueva Granada (Colombia) y los dió a conocer en numerosas publicaciones. Debido en parte a la divulgación hecha por Mutis, las potencias europeas se interesaron y encontramos entre otros al inglés Charles Ledger en 1859 recolectando semillas en los Andes del Perú y Bolivia las que secretamente hizo llegar a Inglaterra. Clements R. Marham recibió el encargo de llevar plantas y semillas desde los Andes a la India británica lo que finalmente logró con éxito. Hasskarl introdujo plantas en Java en 1859.

Los años sucesivos fueron de prolijos cuidados y experimentación. Los científicos holandeses e ingleses pudieron aclimatarla en las Indias Orientales, las que se convirtieron en productoras casi exclusivas.

El ataque a Pearl Harbor motivó el retorno de la cinchona a América. El material de propagación de las Indias Orientales y de las Filipinas era conducido a Australia y de allí por avión hasta los Estados Unidos donde la semilla era cuidada con esmero para luego distribuir las plantas por Centro y Sur América.

Los especialistas están explorando los bosques desde Colombia hasta Bolivia y la explotación del quino silvestre o cascarilla se ha realizado con ritmo acelerado. Las pocas plantaciones anteriormente establecidas en Centro y Sur América, muchas de las cuales habían sido abandonadas, han sido puestas bajo cultivo intenso.

La "Vuelta al hogar" es una bella realidad aunque el futuro todavía no puede profetizarse. Los años subsiguientes serán de paciente labor científica. El Departamento de Agricultura de los Estados Unidos ha asumido la dirección técnica y los otros países americanos están colaborando enérgicamente para que el quino se quede en su legítimo hogar.

TREES FOR ROADSIDE PLANTING IN PUERTO RICO

George N. Wolcott, Entomologist
Agricultural Experiment Station
Río Piedras, Puerto Rico

"No country can afford to be ugly or to neglect the comfort, both physical and mental, of its own or a visiting people. The roads of the island (of Puerto Rico), particularly those through the lowland country, are usually hot and unattractive for lack of proper shade. There are some notable exceptions to this, but their occurrence serves rather to heighten the discomfort after they are passed. Such a one is the avenue of flamboyán bordering the military road between Caguas and Cayey. The kind of tree is of nearly as much importance as the fact that there are trees at all. Thus the almácigo and the jobo, to mention two of the most common, have little to recommend them for roadside planting, except their ease of propagation and rapidity of growth. In the open country, trees that are tall and carry their branches high on a straight, clean trunk offer little obstruction to the view or the circulation of air, yet they protect the roadway during the midday hours from the beating sun, and relieve the monotony of cultivated fields and pastures." This quotation from L. S. Murphy's "Forests of Porto Rico", Bull. # 354, U.S. Dept. Agr., Washington, D. C., 1916, raises a point that has never been settled; the really satisfactory tree, or trees, for tropical roadside planting.

The experience in Puerto Rico has been peculiarly unfortunate because every tree specifically selected for planting appears to have some outstandingly objectionable feature, in most cases of an entomolcgical character. One of the earliest directed attempts at roadside planting was of the maga, _Montezuma speciosissima_, along the main road from Isabela to Aguadilla. The maga naturally grows well in this region, where it is in fact endemic. Altho its leaves are attacked by several insects which do not occur outside of Puerto Rico, notably the caterpillars of the moth _Gonitis (Anomis) praerupta_ Möschler, the damage caused by these is negligible. The maga is of the family Malvaceae, and unfortunately its fruits and seeds serve as alternate hosts for an introduced pest, the pink bollworm of cotton, _Pectinophora gossypiella_ Saunders, which sometimes becomes quite abundant in them immediately after the cotton crop has been harvested. Sea Island cotton is an important crop in the Isabela region, and as this region is generally free of wild cotton, the presence of maga trees here along the roadside prevented the clean-up of alternate hosts of pink bollworm from being more than partially successful. Naturally, the planting of maga was criticized severely as having been detrimental to agriculture, altho in every other respect the tree seemed especially desirable.

Fruit flies of the genus _Anastrepha_ had long been known to attack the fruits of the jobo, _Spondias mombin (= lutea)_, in Puerto Rico, and, to a rather limited extent, those of the mango, _Mangifera indica_. The peons just naturally cut down the mango trees which had fruit infested with maggots, and as a consequence, most of the local mango trees had sound fruit. From the very beginning of grapefruit production in Puerto Rico, the demand of northern markets was for the earliest fruit, and practically all fruit was picked as soon as it could possibly be considered ripe enough to ship. The first effect of competition with the more recently developed grapefruit industry in the lower Rio Grande valley of south Texas was that this insistent demand for early fruit from Puerto Rico failed to develop, and growers dissatisfied with prices commenced leaving their fruit on the trees as long as possible, in the vain hope that prices would improve at the end of the season. Such dead ripe fruit proved to be susceptible to fruit fly infestation, and the careful studies of Mr. Francisco Seín indicated that two distinct species of Anastrepha occurred in Puerto Rico: the one attacking jobo and mango, which he named mombinpraeoptans, and another closely resembling it but with very different habits, A. suspensa Loew, which normally attacked the fruits of Psidium guajava, the husks of the almendra, Terminalia catappa, and some less common native fruits, and finally tree-ripened grapefruit. The remembrance of the Mediterranean fruit fly invasion and clean-up in Florida was still too recent in the United States for the potential or fancied threat of fruit fly maggots in Puerto Rican grapefruit to be ignored. Immediately all the guava bushes in the pastures near grapefruit groves, and all the almendra trees along the roads near grapefruit groves were eliminated. No one had previously imagined that the almendra was anything but a mildly desirable tree, erect and rapid growing, easily pruned to branch far above traffic and giving a dense shade underneath. But as soon as its role in harboring the fruit fly attacking grapefruit became clearly established, all these trees had to be cut. The crisis has passed by now. No Puerto Rican grapefruit is being exported, and the almendra trees remaining are no longer molested.

Plant introduction enthusiasts are always certain that plants and trees brought in from somewhere else are ever so much more desirable than those native to the country. Very shortly after the discovery of Puerto Rico by Columbus, many kinds of plants and trees were introduced and some became so firmly established that it is often difficult to prove now that they were not always here. But within much more recent times, the foresters have attempted to introduce trees, especially those of most rapid growth, some of which have found in Puerto Rico a most difficult environment. Where now are the California pepper trees, Schinus molle, of which so many were planted thirty years ago on the South Coast? The Australian silk oak, Grevillea robusta, proved to be very susceptible to attack by the pustule scale, Asterolecanium pustulans Cockerell, so much so indeed that at the present time only a few of them have survived. A more recent introduction, Sciacassia siamea, is equally susceptible, but displays such vigor that watershoots often spring up from the base of a dead trunk killed by the mass attack of the scale. Such trees are a menace to all the other kinds of trees that can serve as host of this scale to a lesser extent, for they maintain a constant focus of infection as long as they are allowed to exist.

The large and profuse purple blossoms of flor de la reina, Lagerstroemia speciosa, are almost the only reason for planting this tree, and they certainly do make a wonderful display when the trees are in blossom. Unfortunately, it is almost invariably heavily infested with scale insects, notably Coccus viridis Greene, which are attended by ants eager to collect the honey dew which the coccids secrete. The surplus honey dew, falling on leaves and twigs, is a preferred medium for the growth of a black sooty mold a fungus non-injurious in itself, but a serious detriment to the beauty of the tree. This coating of black soot sticks to the leaves until they fall, and a fresh layer soon appears on new leaves almost as soon as they are formed. The flor de la reina and the flamboyán flower at the same time in the summer, and, if adjacent, produce a violent and most painful clash of vivid colors.

The African cloth bark tree, Ficus nekbuda, extensively planted in Muñoz Rivera Park, brought its own special pest, a wax scale, Ceroplastes denudatus Cockerell, found on no other host in Puerto Rico. Its presence and the honey dew excretions which it secretes keep the leaves of these trees constantly covered with a layer of black sooty mold, greatly detracting from their appearance as ornamentals.

The tender leaves of the common cosmopolitan laurel de la India, Ficus nitida, are host to a specific thrips, Gynaikothrips ficorum Marchal, which becomes so abundant during long spells of dry weather that every new loaf becomes curled and crumpled, and so shriveled that they soon fall off. The adult thrips are little, long, black insects, which do not bite and are not actively injurious to people, but it is hardly pleasant to have them crawling over one, and they are a decided nuisance. The older leaves of Ficus nitida are also infested by several kinds of scale insects, but their attack is rarely sufficiently severe to cause noticeable defoliation, except in the case of the very striking white wedding-cake scale, Icerya montserratensis Riley & Howard, which at times in the past has been very abundant on the twigs and branches of these trees in the plazas at Caguas and Manatí.

The very abundant little figs of the jaguey, Ficus laevigata, furnish a welcome food for birds, and its fig cross-pollination insects; Blastophaga insularis Ashmead, Secundeisenia mexicana Ashmead, Idarnes carmae Walker and Colyostichus longicaudatus Mayr, are normally so busy with their specific activities as to bother nobody. In Puerto Rico, however, some large jagueyes are heavily infested with the hormiguilla, Myrmelachista ramulorum Wheeler, so that twigs and branches are constantly falling off, and older trees also seem to be favorites of the wasp, Polistes major PB and Polistes crinitus Felton, in which to build their paper nests, and as such are a menace to people resting beneath them. This is a minor point of course, but you may not feel that way after having been stung by a wasp.

The flamboyán, Delonix (Poinciana) regia, which makes such a brave showing of bright flowers in the summer-time, when the number of tourists to admire it is negligible, and is largely or totally devoid of foliage during so much of the year when its shade might be welcome, is a favored host of the common nigger-head nest termite, or "comején", Nasutitermes costalis Holmgren. If one starts to count the tunnels on the flamboyans along any highway, he soon becomes convinced that only an exceptional tree is uninfested, and most of them have the nests or "comejeneras" as well. Indeed, nests and tunnels are so typical of flamboyán, that artificial nests and tunnels of concrete, painted black, were added to his product for authenticity by one manufacturer of imitation rustic garden furniture and arbors, made out of concrete. Periodically, the camineros are urged to destroy all the comején nests on the trees along their section of road, but since nobody bothers with those on trees not on the road, it is a losing campaign in which the termites always win eventually. Flamboyán trees are sometimes almost completely defoliated for miles along a road by outbreaks of a grey looper, or "agrimensor", Melipotis acontioides Guenée, which often occurs in such numbers that hundreds of hungry caterpillars crawl over everything in the neighborhood in search for food after all the flamboyán leaves have been devoured. The landlord of a house shaded by these trees reported that his tenants moved out when the caterpillars started coming in, and he was unable to secure new tenants, all being repelled by the starving creatures.

Island-wide outbreaks of the leaf-webbing, or "pega-pega" caterpillars Pyrausta cerata F., on péndula, Citharexylon fruticosum, destroying all the leaves on all the trees at the same time, as observed from Isabela and Cabo Rojo to Patillas and Yabucoa in 1937, and again in 1940, eliminate pendula from consideration regardless of its other characteristics.

If the young sapling of roble, Tabebuia pallida, can reach a reasonable height before being attacked by the caterpillars of the twig borers, Pseudohemiceras krugii Möschler or Pachymorphus subductellus Möschler, it is generally tough enough to outgrow attacks on the leaves by the caterpillars of Hyblaea puera Cramer and Mesocondyla concordalis Hübner, and mass infestations of the leafhopper Protalebra tabebuiae Dozier, so that eventually it becomes a straight, erect tree. Later attack by these twig-borers, and by witches-broom disease, on lateral twigs and branches only makes the foliage more dense, and they may then be considered beneficial to that extent. On the larger roble trees, the brief burst of flowers, lasting but a day, is singularly beautiful against a spring sky, and if these trees were used for mass roadside planting would be as impressive as that of the famous Japanese cherry blossoms in Washington, or any apple or pear orchard in the States.

The preceeding discussion is admittedly not of the economic factors that determine the value of trees for forest planting, but the points mentioned, from the standpoint of the people affected, are vital in determining the desirability of trees growing near their homes or along roads. It may well be asked, are there no trees which are not attacked by insects? The common cupey or strangler fig, called "Scotch lawyer" in Trinidad, Clusea rosea, has such a milky, sticky juice that no insect attacks it, but this is really not much of a tree. The endemic mago, Hernandia sonora, which normally grows at sea level in the Luquillo region, has no insect pests, either native or introduced. Some individual trees at least, grow very rapidly, straight and erect, with beautiful heart-shaped leaves, and begin producing their quaint but useless fruit (called "jack in-the-box" in Barbados) when only a few years old. The wood is light and fragile, and dead branches break off at a touch, but the larger trees become majestic as they mature, and are ideal for the roadside when they have reached considerable size.

The large leaves of the mago, constantly being shed, are a decided nuisance, as indeed are those of most other trees. In this respect, the mamey, Mammea americana, is almost an evergreen, and has other advantages such as comparative freedom from insect pests, as well as a straight habit of growth and a dense mass of foliage giving perfect shade. The mamey must be planted as seed where it is to grow, however, and when young its growth is discouragingly slow, while very old trees tend to die out at the top and develop hollow trunks.

Like the mamey, the maria, Callophyllum calaba, has evergreen leaves, somewhat smaller and often curiously wrinkled by infestations of a blister mite on their under surface, but it has almost no insect pests or other undesirable characteristics. The algarrobo, Hymenaea courbaril, is also practically devoid of insect pests, and makes a singularly noble and impressive tree as it approaches maturity. Its heartwood is even more resistant to the attacks of the polilla, Cryptotermes brevis Walker, than is mahogany, and is so hard that it was originally used for the making of rollers of the first cane mills. The quenepa, Melicocca bijuga, is also almost entirely devoid of insect pests, and is the more especially desirable because of the dense shade that it affords in dry regions, sometimes the only spot of green when everything else is withered and brown. One other tree common to both the wet and the dry sections of the Island is the moca, Andira inermis, but is subject to attack by a great variety of insect pests. The shady road east from Ponce towards Santa Isabel is largely lined by a mingling of moca and quenepa, a most grateful refuge after passing miles of lesser trees, cane fields and salt marshes. All of the trees mentioned grow well at or near sea-level; for the roads in the mountains an even greater number of native trees might be suggested with every desirable requirement for roadside planting.

Despite the number of possibly desirable trees actually available, no general agreement has been reached as to those to be adopted for roadside planting. Because the experience in Puerto Rico has been in fact so disappointing, it may be well to consider practices in other tropical American countries. For formal planting, as on plazas, the laurel de la India, Ficus nitida, is an almost universal favorite, despite the fact that in South America it is attacked by great hairy black caterpillars that have frightened the small charges of many a nursemaid. In many Brasilian cities, mangoes are planted in solid unbroken rows, and pruned high so that their branches do not interfere with traffic. The most obvious objection to mangoes in the cities and towns of Puerto Rico, and along roadways, is that boys attempting to knock down the fruit are absolutely deaf to the warning horns of passing cars. This is merely because mangoes are so scarce that the fruit becomes a rarity. If enough of them were present, there would be fruit enough for everybody, and nobody would be so keen about getting it as to be a traffic problem. The city of Belem in Brasil is as large as any in Puerto Rico, and mangoes have been planted so universally along its streets that mango fruits have no its streets that mango fruits have no marketable value. Of course the rotten fruit is a nuisance on the sidewalks, and the leaves are so large and keep dropping so constantly that they must be swept up every day (Fig. 1), but otherwise the mango appears to have few disadvantages. The leaf-cutting or parasol ant, Atta sexdens L., sometimes carries away all the leaves of one mango tree overnight, but this is a continental ant which does not exist in Puerto Rico. Mango trees in Brazil are host to a very persistent and common mistletoe, which is really a serious pest, but as the trees in the business section of town are also used as a support for orchids brought from the jungles, apparently the mangoes have sufficient vigor to withstand all these drains on their vitality, for not a single dead one is to be seen, nor a gap where one has been removed.

The city of Paramaribo, Dutch Guiana, has planted the small-leaved mahogany, Swietenia mahagoni, along most of its streets, and this seems to be an almost perfect answer to the problem (Fig. 3). The only real objection to mahogany is its slow growth, but the Dutch moved in hundreds of years ago and apparently expect to be there forever, thus slowness of growth is only a temporary disadvantage. Some of the older trees had low, large branches, but the younger trees have been pruned earlier so that their crowns are high above traffic (Fig. 2). They make a high canopy of filtered shadow under which even the most dignified Dutchman can comfortably ride a bicycle to his office. And, best of all, the mature trees are a source of future income which seems as assured as anything can be in a changing world.

(Traducción del artículo anterior)

ARBOLES PARA LAS CARRETERAS DE PUERTO RICO

"Ningún país debe arriesgarse a que se entronice en su suelo la fealdad ni tampoco debe descuidar el bienestar físico y mental de sus habitantes o de los viajeros que lo visiten. Viajar por las carreteras, especialmente las de las costas de la isla (de Puerto Rico), es desagradable y caluroso por la falta de sombra. Las notables excepciones a esta situación hacen resaltar más la incomodidad luego que de las sombreadas se pasa a las otras. Una de estas excepciones es la avenida de flamboyanes alineados a la orilla de la carretera militar entre Caguas y Cayey. La clase de árbol es casi tan importante como su presencia. Así, el almácigo y el jobo, para mencionar dos de los más comunes, con excepción de su fácil multiplicación y rápido crecimiento tienen poco que los recomiende como árboles para sombrear carreteras. A campo abierto, los árboles de elevada estatura, que ramifican alto, de tronco erecto y limpio, no obstruyen la contemplación del paisaje ni la circulación de aire y además protegen la carretera al medio día de los candentes rayos del sol y rompen el monótono panorama de campos cultivados y pastos." La cita anterior, que está tomada de "Forests of Puerto Rico", de L. S. Murphy, Bull. #354, U. S. Dept. Agr. Washington, D.C., 1916, suscita la discusión de ese asunto que nunca ha sido resuelto: ¿Cuál es el árbol o los árboles verdaderamente satisfactorios para las carreteras en regiones tropicales?

Fig. 1.— Sweeping up debris under mangoes, Belén, Pará, Brazil.

Fig. 2.—Old mahogany trees, pruned high, Paramaribo, Dutch Guiana.

La experiencia adquirida en Puerto Rico ha sido peculiarmente desafortunada porque cada uno de los árboles específicamente seleccionados parece tener alguna característica sobresaliente no deseable, que en la mayoría de los casos es de naturaleza entomológica. Uno de los primeros intentos directos de seleccionar árboles para las carreteras fué la siembra de maga, Montezuma speciosissima, a lo largo de la carretera principal de Isabela a Aguadilla. La maga crece bien en esa región de donde es endémica y aunque varios insectos propios de Puerto Rico atacan sus hojas, especialmente las orugas de la alevilla, Gonitis (Anomis) praerupta Möschler, el daño causado es insignificante. Pertenece la maga a la familia de las malváceas, y desgraciadamente sus frutos y semillas sirven de planta hospedera intermediaria de una plaga de origen exótico: la oruga rosada del algodón, Pectinophora gossypiella Saunders, a veces en abundancia inmediatamente después que el algodón ha sido cosechado. El algodón Sea Island es un cultivo importante en la región de Isabela y como allí por lo general no hay algodón silvestre, las magas de la carretera limitan el éxito de las labores encaminadas a eliminar las plantas donde se refugia la plaga entre cosechas de algodón. Naturalmente, la siembra de magas en la carretera fué duramente censurada por el perjuicio que causaba a la agricultura, aunque desde cualquier otro punto de vista esos árboles parecían ser especialmente deseables.

Desde hace mucho tiempo, se sabía que en Puerto Rico las larvas de moscas del género Anastrepha atacaban las frutas del jobo, Spondias mombin (= lutea) y además las del mango, Mangifera indica aunque en muy poca abundancia, Los peones meramente por inclinación natural tumban los mangos cuyas frutas se agusanan, y como consecuencia, la mayor parte de los árboles locales de mango producen fruta libre de gusanos. Desde que se empezó a establecer el cultivo de la toronja en Puerto Rico, la demanda en los mercados norteamericanos fué por la fruta más temprana y por lo tanto, casi toda la de la isla se recogía de los árboles tan pronto como su desarrollo permitía embarcarla. El primer efecto de la competencia con la industria de la toronja desarrollada después que en Puerto Rico en la parte sur del valle del Río Grande de Tejas, fué que disminiyó la demanda de fruta temprana puertorriqueña y los agricultores de Puerto Rico, disgustados con los precios bajos, empezaron a dejar las toronjas sin cosechar en los árboles en la vana esperanza de que mejoraran los precios al fin de la estación. Las toronjas maduras dejadas en el árbol resultaron ser susceptibles a los gusanos de las moscas Anastrepha. Un cuidadoso estudio de dichas moscas llevado a cabo por el Sr. Francisco Seín, demostró que en Puerto Rico hay dos especies: una que ataca jobos y mangos, y a la cual dió el nombre de mombinpraeoptans, y otra muy parecida pero de diferentes costumbres, A. suspensa Loew que normalmente ataca las frutas de Psidium guajava, la corteza de la fruta de la almendra, Terminalia catappa y otras frutas indígenas menos abundantes, y finalmente toronjas maduras en el árbol. El recuerdo de la invasión de la Florida por la mosca del Mediterráneo y la campaña para erradicarla era todavía demasiado reciente en los Estados Unidos de Norteamerica para que pasara desapercibido el peligro real o aparente de los gusanos de Anastrepha en las toronjas que de Puerto Rico podían exportarse a aquel país. Inmediatamente se procedió a tumbar los guayabos en los pastos y los almendros en las carreteras cercanos a los toronjales. Nadie se había imaginado antes que el almendro fuera otra cosa que un árbol medianamente deseabl

Fig. 3.— The narrow-leaved mahogany, Swietenia mahagoni, on a business residential street in Paramaribo, Dutch Guiana.

erecto y de rápido crecimiento que por medio de la poda, fácilmente podía hacerse ramificar muy por encima del tránsito y proporcionar densa sombra. Pero tan pronto como se comprobó claramente que albergaba la mosca cuyos gusanos atacaban las toronjas, había que tumbarlos todos. Ya la crisis ha pasado, no se exporta toronja de Puerto Rico y los almendros que quedan se han dejado en paz.

Los que se entusiasman importando plantas y árboles exóticos están siempre seguros de que lo que importan es aún más deseable que lo nativo del país en cuestión. Poco después del descubrimiento de Puerto Rico los colonizadores españoles trajeron a la isla muchas clases de plantas y árboles de los cuales algunos echaron tales raíces que ahora se hace difícil probar su origen extraño. Pero en épocas mucho más recientes, los dasónomos han intentado aclimatar árboles, especialmente los de más rápido crecimiento, algunos de los cuales han encontrado en Puerto Rico un ambiente sumamente adverso. ¿Dónde están hoy los pimenteros de California, Schinus molle, de los cuales tantos se sembraron hace treinta años en la costa sur de Puerto Rico? El roble plateado de Australia, Grevillea robusta resultó ser tan susceptible a la queresa de pústula, Asterolecanium pustulans Cockerell, que muy pocos han sobrevivido. La Sciacassia siamea, importada más recientemente es igualmente susceptible a la queresa de pústula; pero su vigor se sobrepone al daño viéndose a veces retoñar los tocones de árboles aniquilados por la queresa. Esos árboles vigorosos son una amenaza para las demás plantas hospitalarias susceptibles de ataque, puesto que constituyen focos constantes de infección mientras se les permita existir.

Las flores grandes y abundantes de la reina de los flores, Lagerstroemia speciosa, son casi la única razón por la cual se siembra ese árbol y constituyen ciertamente un maravilloso espectáculo. Desgraciadamente, casi siempre los atacan las queresas, en particular Coccus viridis Greene, acompañadas de hormigas que acuden a recoger las secreciones dulces de estos cóccidos. Lo que las hormigas no recogen sobre ramas y hojas sirve para que se desarrolle un hongo que no causa daño pero menoscaba la apariencia de las plantas al mancharlas de negro. El hongo se adhiere al follaje hasta que se desprenden las hojas del árbol y se forma sobre las hojas nuevas tan pronto brotan. La flor de la reina y el flamboyán florecen al mismo tiempo en el verano y si contiguos producen un violento contraste de vívidos colores.

El Ficus nekbuda africano extensamente sembrado en el parque Muñoz Rivera, trajo consigo al importarse, su plaga propia especial, una queresa cerosa, Ceroplastes denudatus Cockerell, que no se encuentra en ninguna otra planta en Puerto Rico. Su presencia y el licor dulce que segrega mantiene las hojas constantemente cubiertas del hongo negruzco, reduciendo grandemente su valor ornamental.

Las hojas tiernas del cosmopolita laurel de la India, Ficus nitida, son atacadas por un trips específico, Gynaikothrips ficorum Marchal, que llega a abundar tanto en épocas largas de sequía que toda hoja tierna se enrosca, arruga y encoje, desprendiéndose. Los trips en su estado adulto son insectos pequeños, alargados y negros que no pican ni activamente incomodan a la gente; pero no es muy agradable que digamos sentirlos correteándonos por el cuerpo y no cabe duda que son una molestia. Las hojas más viejas del Ficus nitida son atacadas por varios tipos de queresas, pero casi nunca hasta el extremo de causar su desprendimiento en abundancia, excepto en el caso de la queresa blanca "bizcocho de bodas", Icerya montserratensis Riley & Howard, que en ocasiones pasadas, ha llegado a ser muy abundante en las ramas y ramitas de esos árboles en las plazas de Caguas y Manatí.

Las frutitas que en gran abundancia produce el jagüey, Ficus laevigata, son gratas a los pájaros y los insectos que las polinizan: Blastophaga insularis Ashmead, Secundeisenia mexicana Ashmead, Idarnes carmae Walker y Colyostichus longicaudatus Mayr, están normalmente tan ocupados con sus actividades específicas que no molestan a nadie. Sin embargo, en Puerto Rico, la hormiguilla, Myrmelachista ramulorum Wheeler, suele infestar abundantemente algunos de los jagüeyes más grandes ocasionando un constante desprendimiento de ramas y ramitas. Los jagüeyes más viejos parecen ser preferidos por las avispas Polistes major PB y Polistes crinitus Felton donde fabrican sus avisperos, lo cual los convierte en amenaza para quienes pretendan descansar bajo su sombra. Esto parece trivial por supuesto, pero puede ganar en importancia después de haber sido picado por una avispa.

El flamboyán Delonix (Poinciana) regia, que tan excelente despliegue de brillantes flores ofrece en el verano, cuando hay tan pocos turistas para apreciarlo, carece de follaje parcial o totalmente durante gran parte del año cuando tanto se necesita su sombra. El flamboyán es una planta hospitalaria favorita del comején Nasutitermes costalis Holmgren, que forma comejeneras semejantes a cabezas de negro. Si uno, al pasar por las carreteras se dedica a contar los caminitos del comején, se convencerá de que es excepcional el flamboyán que no los tiene y que casi todos tienen además de caminitos, también los "panes" o comejeneras. En verdad, son tan característicos del flamboyán que al fabricar emparrados y muebles rústicos de concreto para jardines, un fabricante en Puerto Rico, para darle mayor parecido con los de madera rústica, les ponía "panes" y caminitos de comején pintados de negro. Periódicamente se urge de los camineros la destrucción del comején en los árboles de su jurisdicción, pero como nadie se molesta en destruir el que puedan tener los árboles que no están a orillas de la carretera, es guerra perdida en la cual el comején siempre gana. Algunas veces, en trayectos de muchos kilómetros, los flamboyanes son despojados casi completamente de hojas por la oruga agrimensora gris, Melipotis acontioides Guenée que luego se desparraman hambrientas por todas partes. El dueño de una casa de alquiler sombreada por flamboyanes informa que los inquilinos se mudaron huyendo y que no pudo conseguir luego quien la alquilara porque a todos espantaban y ahuyentaban las orugas.

La péndula, Citharexylon fruticosum, sufre los ataques de un "pega-pega"; la oruga Pyrausta cerata F., que devora todas las hojas como ha sucedido de Isabela y Cabo Rojo a Patillas y Yabucoa en 1937 y de nuevo en 1940. Esto hace desechar la péndula sin que puedan tomarse en cuenta otras buenas características.

Si un roble, Tabebuia pallida logra alcanzar suficiente tamaño sin ser atacado por las orugas Pseudonemiceras krugii Möschler o Pachymorphus subductellus Möschler, se habrá endurecido lo bastante ya para que sus hojas escapen del ataque de las orugas de Hyblaea puera Cramer y Mesocondyla concordalis Hübner así como del homóptero Protalebra tabebuiae Dozier. Llegará por lo tanto a ser árbol derecho y erguido. Los ataques subsiguientes por esas orugas y por la enfermedad: "escoba de bruja", en las ramas laterales sólo hace más denso el follaje y hasta ese punto pueden considerarse beneficiosos. En los robles más grandes, la breve explosión de flores - que sólo dura un día - es de singular belleza contra el fondo del cielo primaveral. Si los robles se sembraran en largas extensiones a la orilla de las carreteras serían tan impresionantes como los cerezos japoneses de Washington o cualquier manzanar o peral norteamericano.

La exposición anterior prescinde de los factores económicos que determinan el valor de los árboles como especies para la repoblación pero sí señala la vital importancia que conlleva el seleccionar los árboles deseables en las carreteras y cercanías de las viviendas desde el punto de vista de las personas afectadas. Podría preguntarse, ¿no hay árboles invulnerables al ataque de los insectos? El cupey Clusia rosea, llamado en Trinidad "abogado escocés" al parecer porque agarra hasta estrangular, tiene una savia tan pegajosa que ningún insecto lo ataca; pero no es en realidad árbol que valga la pena. El endémico mago, Hernandia sonora, que por lo regular crece a nivel del mar en la región de Luquillo no es atacado por insectos, ni nativos ni importados. Algunos ejemplares, por lo menos, crecen rápidamente, derechos y erguidos, con hermosas hojas acorazonadas y empiezan a producir sus bellas aunque inútiles frutas (llamadas "muñeco en la caja de resorte" en Barbada) a los pocos años. La madera es liviana y frágil pues las ramas secas se rompen al menor contacto, pero los árboles grandes adquieren majestuosidad al alcanzar su madurez y son ideales para las orillas de las carreteras al alcanzar tamaño considerable.

Las grandes hojas del mago, como las de casi todos los árboles son una gran molestia ya que constantemente están cayendo. En ese particular, el mamey, Mammea americana es casi perennifolio y tiene como buenas cualidades adicionales, su relativa invulnerabilidad al ataque de plagas de insectos, crecimiento derecho y erguido y espeso follaje que produce una sombra perfecta. Hay empero que sembrar la semilla de mamey directamente donde ha de crecer el árbol, el crecimiento de los árboles jóvenes desespera por su lentitud y en los viejos, existe la tendencia a marchitarse el cogollo, ahuecando el tronco.

Como el mamey, la María, Calophyllum calaba tiene hojas perennes un tanto más pequeñas y a veces singularmente arrugadas como resultado del ataque de un ácaro a su superficie inferior, pero casi carece de plagas de insectos u otras características indeseables. El algarrobo, Hymenaea courbaril, está también prácticamente exento de plagas de insectos y llega a ser árbol de singular e impresionante porte según se acerca a la madurez. Su madera de corazón es menos atacada por la polilla, Cryptotermes brevis Walker que la caoba, y es tan dura que fué usada para los rodillos en los primeros trapiches. La quenepa, Melicocca bijuga, carece también casi por completo de plagas de insectos. Es especialmente deseable por la densa sombra que proyecta en las regiones secas, a veces la única mancha verde cuando todo lo demás está marchito y bronceado por el sol. Otro árbol que abunda tanto en las regiones secas de Puerto Rico como en las húmedas es la moca, Andira inermis, pero sufre los ataques de una gran variedad de plagas de insectos. La carretera al este de Ponce hacia Santa Isabel está sombreada por una combinación de mocas y quenepas, gratísimo refugio para el que ha recorrido millas y millas bajo pequeños árboles y a lo largo de cañaverales y pantanos. Todos los árboles mencionados crecen bien a nivel del mar o a poca altitud; para las carreteras en las montañas se podría sugerir aún un número mayor de árboles nativos poseedores de todos los requisitos deseables para ser plantados a la orilla de las carreteras.

A pesar del gran número de árboles disponibles y a la vez deseables, no se ha llegado a ningún acuerdo en cuanto a cuáles deben sembrarse. Ya que la experiencia en Puerto Rico ha sido tan desafortunada, sería provechoso considerar lo que se ha hecho en otros países de la América tropical. El laurel de la India, Ficus nitida, es preferido para sembrar en las plazas, casi universalmente, a pesar de que en América del Sur se desarrollan en su follaje grandes orugas negras y peludas que han atemorizado más de una vez a los chiquillos que bajo su sombra se recrean. En muchas ciudades del Brasil se siembran mangos en hileras compactas, y con poda adecuada se evita que las ramas bajas estorben el tránsito. El defecto más evidente de los mangos en ciudades y pueblos de Puerto Rico y en las carreteras, es que la muchachería que codicia su fruta no atiende al sonido de las bocinas de los automóviles poniendo su vida en peligro. Tal cosa sucede porque los mangos escasean tanto que sus frutas son una rareza. Si hubiera suficientes de modo que cualquiera pudiera obtener todos los que pudiera desear, dejarían de ser un problema de tránsito. La ciudad de Belém en el Brazil que es tan grande como la mayor de Puerto Rico tiene tantos mangos sembrados en sus calles que no tienen valor alguno. Naturalmente que la gran cantidad de fruta podrida en las aceras es una gran molestia y caen tantas hojas que es preciso barrerlas a diario, pero fuera de eso, el mango parece tener pocas desventajas. La hormiga arriera que acumula hojas en sus hormigueros, a veces deja un mango sin hojas de la noche a la mañana; pero es continental y no existe en Puerto Rico. El mango en el Brasil alberga un muérdago persistente y abundante que es en verdad una plaga de consideración, pero como los mangos en el centro de las ciudades sirven además para albergar las orquídeas que traídas de los bosques son depositadas sobre sus troncos y ramas para que el público pueda gozar la belleza de sus flores, parece que tienen suficiente vigor para soportar todas esas sangrías de su vitalidad ya que no se ve uno sólo que haya sucumbido ni un hueco donde falte alguno.

En la ciudad de Paramaribo, en la Guayana Holandesa se ha sembrado la caoba de hoja pequeña, Swietenia mahagoni, en casi todas las calles y parece una solución casi perfecta al problema. La única objeción real que pudiera hacerse a la caoba es su lento crecimiento, pero como los holandeses llegados hace cientos de años al parecer suponen que se quedarán para siempre, para ellos la lentitud de crecimiento es una desventaja temporera. Algunos de los caobos más viejos han echado grandes ramas y alcanzado poca altura, pero los más jóvenes fueron podados y han ramificado a gran altura por encima del tránsito formando una bóveda alta de sombra filtrada bajo la cual aún el holandés más ceremonioso puede viajar cómodamente en bicicleta hasta su oficina de trabajo. Y lo mejor de todo es que al llegar a su madurez, los árboles constituyen una fuente de ingreso al parecer tan segura como puede serlo cosa alguna en un mundo tan cambiable.

Résumé

Dans les pays tropicaux l'ombrage le long des chemins est indispensable car les rayons du soleil punissent les pédestriens. En plantant des arbres on soulage cet effect et procure l'embellissement du panorama. À Puerto Rico on avait planté des arbres au bord des routes depuis plusieurs années mais beaucoup d'essences, par des raisons ordinairement entomologiques, sont peu satisfaisantes.

Parmi les premières essences employées comme arbre ornemental on trouve le "maga", *Montezuma speciosissima*, mais il est un des hôtes alternes de *Pectinophora gossypiella*, Saunders, un fléau grave du coton, ravageur éxotique d'un produit agricole assez important. Des insectes du genre *Anastrepha*, les mouches des fruits, attaquent les fruits de *Spondias mombin*: (= *lutea*), *Mangifera indica* et *Terminalia catappa* et par conséquent ces arbres ont été considerés comme peu désirables pour planter au bord des routes dans certaines régions de l'île. Le *Schinus molle* et le *Grevillea robusta*, autrefois largement plantés ont disparus, en le dernier cas dû aux attaques d'un kermès, c'est-à-dire l'*Asterolecanium pustulans* Cockerell, qui attaque aussi le *Sciacassia siamea*.

Le *Lagerstroemia speciosa*, arbre qui possède des jolies fleurs d'une couleur violette, est attaqué par des kermès particulièrement par *Coccus viridis* Greene dont l'excrément sucré est très cherché par les fourmis et par un champignon fuligineux qui couvre les feuilles, en rendant cette essence moins ornementale. D'une manière semblable, le *Ficus nekbuda* est attaqué par *Ceroplastes denudatus* Cockerell et ses feuilles sont généralement couvertes avec un champignon fuligineux. Le *Ficus nitida* est l'hôte de *Gynaikothrips ficorum* Marchal et de maints kermès y compris l'*Icerya montserratensis* Tiley and Howard. *Ficus laevigata* est l'hôte de *Myrmelachista ramulorum* Wheeler. L'élégant *Delonix (Poinciana) regia* est presque toujours infesté avec *Nasutitermes costalis* Holmgren et perd souvent les feuilles presque complètement par l'invasion de *Melipotis acontioides* Guenée. *Citharexylum fruticosum* et *Tabebuia pallida* sont attaqués par plusieurs insectes qui diminuent leur attrait.

Mais pas tous les arbres sont attaqués par des fléaux d'insectes. L'*Hernandia sonora* est très joli et n'a pas des fléaux d'insectes indigènes ou éxotiques. Le *Mammea americana*, le *Calophyllum calaba* et l' *Hymenaea courbaril* n'ont pas des fléaux d'insectes mais sont à accroissement lent. Le *Clusia rosea* n'est pas attaqué par les insectes mais il ne sert pas comme arbre ornemental. Le *Melicocca bijuga* est désirable dans

les régions sèches car il projète un ombrage dense et protège les promeneurs contre les rayons du soleil.

Deux autres arbres employés ailleurs sont le Mangifera indica et Swietenia mahagoni. Si l'on plante le Mangifera indica à longue échelle pour fournir beaucoup des fruits il n'aura pas le désavantage d'être si désiré par les enfants, en constituant un problème de circulation des véhicules dans les routes. Le Swietenia mahagoni n'est pas à accroissement rapide mais il fournit un ombrage idéal et un bon bois d'ébénisterie.

---oOo---

"NOTES OF INTEREST FROM ANNUAL REPORT OF BRITISH HONDURAS FOREST DEPARTMENT FOR THE CALENDAR YEAR 1943"

The value of all exports was $1,763,639 of which 93.5 per cent was forest produce, the highest proportion in the records which have been kept from 1923 to date. The total export of mahogany increased about 10 per cent, in log form decreasing about 25 per cent and in lumber form increasing nearly 120 per cent over 1943 exports. Chicle exports increased about 10 per cent and rubber exports over 100 per cent. The reduction in log exports of domestic mahogany was due to the opening of accessible supplies in the neighboring Department of Petén in Guatemala, the cessation of work in areas damaged by the 1942 hurricane and the cutting out of some licence areas in the Colony.

Management and Survey

The programme of work for Freshwater Creek Reserve was abandoned as a result of the destruction caused by hurricane, and revision was postponed pending the extraction of the blown mahogany. Efforts to dispose of the estimated quantity of a quarter of a million board feet of mahogany failed until October when a license for the 1944 season was approved. It is now unlikely that this operation will begin, partly owing to the restrictions on the shipment of small wood and the depreciation of the fallen trees due to pinworms (Ambrosia beetles).

Silviculture

No silvicultural work was done in Freshwater Creek Reserve. Mahogany trees left standing by the hurricane have died only where the crown was almost entirely broken off. Other trees with lesser damage are recovering but there has been no report of pods on the trees this season. It is probable that seed will not be produced until the trees have recovered full virility. In the meantime the hurricane debris is breaking down and a dense growth of secondary species is coming up in which some regeneration of mahogany and other secondary species is flourishing. The mahogany seedlings were observed along the cleared roads and presumably are of pre hurricane origin. In some areas there has been a heavy growth of annual creepers but these will doubtless disappear under the second growth. No further work was done in the improvement areas in Silkgrass.

The six acre polak (Ochroma sp.) plantation at Middlesex was cleared in January and the seedlings were thinned to 2-3 feet spacing. Six months later a second thinning increased the spacing to six feet. The plantation is fairly evenly stocked and has a height growth of ten to fifteen feet. Sample plots will be established in 1944 and a comparison of the growth of local polak and Ecuador Balsa will be possible.

Prima Vera (Tabebuia donnel-smithii) saplings and poles, which have shown very poor height growth of about two feet a year when growing in lines cleared in low second growth, displayed remarkable coppicing powers when the bush was cleared and the saplings and poles were cut back to within one or two feet of the ground. At the time of clearing many individuals were severely scorched by fire but proved to be resistant. Shoots have been pruned to one per stool and have grown eight to twelve feet in six months.

Land planning, conservation and cooperative projects

A large scale scheme for forest development, particularly for the regeneration of mahogany and pine was still under preparation at the end of the year. The basis of the scheme will be the settlement of population in the forest areas, providing forest work initially as the chief source of income and encouraging the growth and use of food crops in allotments close to their houses. The planting of forest crops by taungya will supply other food for local use and for sale. The design is to reverse the present occupation of many of the rural inhabitants who bolster up their meagre earnings from agricultural work by forest or other work, which often takes them far from their holdings, and to concentrate groups of settled inhabitants closer to the forest which will support them, to permit the maintenance of social services, which it is imposible to provide for a scattered population, to decrease the present seasonal nature of forest work and to provide opportunity for private enterprise. The great aim is to establish compact accessible blocks of fully stocked mahogany and pine plantations capable of producing a substantial yield of ten million board feet of mahogany and twenty million feet of pine annually.

Legislature

A bill entitled An Ordinance to provide for the rehabilitation of forests damaged by hurricane, which sought to prohibit the felling of all standing mahogany trees, in an area devastated by the 1942 hurricane, for fifteen years in order to regenerate the area, and which offered relief from land tax wholly or in part on such land where the revenues of the owner had been adversely affected by the prohibition, was introduced in July, 1943, and was thrown out on the second reading in October, 1943. The chief objection appeared to be to the proposed control of the rights of private ownership.

FOREST ASSOCIATIONS OF BRITISH HONDURAS, III

J. H. Nelson Smith
Assistant Conservator of Forests
British Honduras

BROKEN RIDGE ASSOCIATION[1]

The plots studied in this association are located in the Manatee area in the southwest corner of the Belize District.

Habitat[2]

Data presented in the previous article on temperature, precipitation and wind are equally applicable for these plots.

Soil and Subsoil

The underlying rock is believed to be metamorphic, slates, quartzites, etc. The soil is a sandy loam, varying from a dark red to yellow brown. In one plot it is gritty with quartz particles, while in the other it contains ferruginous concretions of manganese. The texture becomes finer in the subsoil until in some places a pan-like layer is formed at depths ranging from 1 to 5 feet. Cover of litter is almost complete and a faint F horizon is present. Roots penetrate to 2 or 3 feet. Erosion is nil, runoff slight, and drainage is free. Nothing is known of soil-water relations.

History of the Area

Little information is available on this subject. No signs of old cultivation were observed.

Biotic Factors

For the past 50 to 100 years mahogany exploitation has been carried out spasmodically, and at the present time there exists a fairly extensive system of "truck passes" throughout the area. This has resulted in a certain opening of the canopy in localised areas which are never extensive, and although such influence must necessarily have a definite effect on the

1/ Description based upon data collected from 2 sample plots by the author as summarized at the Tropical Forest Experiment Station.

2/ J. H. Nelson Smith, Forest Associations of British Honduras, II, The Caribbean Forester, 5:45-70, October 1944.

structure of the vegetation it is considered to be negligible in the plots described.

There has been no widespread grazing. Animals employed on mahogany workings are grazed at the creek sides, and suitable palms and a limited variety of hardwoods, of which Brosimum alicastrum is the principal species, are utilized for feeding purposes. This results in a certain opening of the vegetation over very small localized areas.

The effect of grazing or trampling by wild animals appears to be limited. Warrie pigs in herds of 50 or more roam the district and undoubtedly cause some destruction of the regeneration. The soil may be completely exposed and upturned over areas of one square chain or more in extent, but the effect on the vegetation as a whole must be considered as small.

Termite nests are common throughout the district. They are usually oval in shape and seldom exceed three feet in height. Some form of support such as dead stumps or trunks of trees are utilized in building the nests. Subterranean termites are not uncommon but little is known of their habits. There is apparently little or no damage done to living vegetation as the termites appear to restrict themselves to dead timber and assist in the breaking down of fallen trees, branches, etc.

Wee wee ants, which live in the ground, are common and use living vegetation for their fungal "gardens." There is little information as to the extent of damage in uncultivated forests but it is known that these ants may cause serious defoliation in mahogany plantations and on citrus.

There was no sign of burning.

Size and Nature of Sample Studied

One of the two plots was 1/2 by 3 chains; the other, 1/2 by 4 chains. They were both divided into 1/2-chain squares for enumeration. The vegetation seemed typical of the locality and without apparent biotic modification. Care was taken to exclude vegetation which might have been influenced by trails.

The altitude of the plots is from 180 to 260 feet above sea level. Slopes are gentle, from 2 to 15 per cent. Aspect west to northwest.

Structure and Composition

Structure

The canopy is generally closed, although in some places as much as 30 per cent of the subordinate vegetation receives direct sunlight due to unevenness in the canopy caused by trees of different heights or windfalls. On the average about 10 per cent direct sunlight reaches the subordinate vegetation.

The spacing of emergents varies. In one plot they are regularly spaced at 90 to 120 feet, while in the other they were found in groups 60 to 80 feet apart, the individual trees being separated by 15 to 30 feet. The canopy species are spaced more regularly at 10 to 30 feet. Subordinates are regularly spaced at 3 to 15 feet. Shrubs and saplings are evenly distributed at 5 to 10 feet apart. Individuals of _Thrinax wendlandiana_, 20 to 30 feet in height, are spaced 15 to 20 feet.

The diameters of the larger trees are as follows:

Species	Diameter in inches
Podocarpus sp.	14
Licania hypoleuca	10
Aspidosperma megalocarpon	10
Lucuma belizensis	12

The emergent stratum is well defined, being from 40 to 80 feet in height. The canopy, 20 to 50 feet in height, is dense except where windfalls may leave openings of 10 to 30 feet square. It is not easily distinguished from the subordinate layer, although canopy species generally have more widespread crowns. The subordinate layer, from 18 to 30 feet in height, is poorly defined. The shrub layer, 6 to 20 feet high, may be distinguished from the subordinates by its greater density and the smaller crown size of its individuals. The field layers, 0 to 6 feet in height, are distinguished by an abundance of _Cephaelis_ spp. and _Thrinax wendlandiana_.

Physiognomy and Life Form

Lianes are generally common and ascend into the crowns of practically all canopy species to a height of 40 feet, causing some congestion. They are found also in the subordinate and shrub layers beneath openings caused by windfalls. Climbers are common on canopy trees and ascend into the crowns. Smaller varieties are numerous on subordinates and smaller saplings. Orchid-type epiphytes are occasional on the branches of canopy and subordinate species, and _Tillandsia_ sp. is occasional on emergents and subordinates. The types noted are as follows:

1. Indeterminate large heart-shaped leaf tie tie on emergents and canopy species.

2. Indeterminate large spade-shaped leaf tie tie on emergents and canopy species.

3. Indeterminate small spade-shaped leaf tie tie on canopy, subordinates, and smaller saplings.

4. Indeterminate vanilla-type creeper on subordinate species.

5. Tillandsia sp. on Podocarpus sp., Licania hypoleuca, Lucuma belizensis, and Virola koschnyi.

6. Orchid-type epiphytes on canopy and subordinate species with some zonation at 15 to 30 feet

7. Indeterminate ferns on Podocarpus sp. and Aspidosperma megalocarpon.

8. Indeterminate mosses on all boles.

Virola koschnyi, Sloanea sp., and Lucuma belizensis have buttresses, and about 20 trees are found per acre. Pourouma aspera and Symphonia globulifera have stilt roots but few large trees are found. Euterpe panamensis has modified aerial breathing roots. Thorny trunks and branches, cauliflory, corky bark, and succulent leaves and stems are absent. Special life forms include palms, Crysophylla argentea, and rattan, Desmoncus sp. Bamboos are absent. The only deciduous species noted is Aspidosperma megalocarpon, which is deciduous when mature.

The types and sizes of leaves are shown in Table 1.

Table 1.—Leaf Types and Sizes in Broken Ridge Plots

Species	Type	Number of Leaflets	Size[3] Leaves	Size[3] Leaflets
Calophyllum brasiliense	Simple		Mesophyll	
Lucuma belizensis	Simple		Mesophyll	
Aspidosperma megalocarpon	Simple		Mesophyll	
Licania hypoleuca	Simple		Mesophyll	
Podocarpus sp.	Simple		Leptophyll	
Sloanea sp.	Simple		Megaphyll	
Protium copal	Pinnate	5-7	Macrophyll	Mesophyll
Simaruba glauca	Pinnate	to 30	Macrophyll	Mesophyll
Inga sp.	Pinnate		Mesophyll	Microphyll
All Palms	Pinnate	Numerous		
Xylopia hypoleuca	Simple		Microphyll	
Virola koschnyi	Simple		Mesophyll	
Miconia spp.	Simple			
Cupania sp.	Simple		Mesophyll	
Mouriria sp.	Simple		Mesophyll	
Pseudolmedia sp.	Simple		Mesophyll	
Rheedia edulis	Simple		Mesophyll	
Pterocarpus hayesii	Pinnate		Macrophyll	Mesophyll

3/ Raunkiaer's leaf size classes.

The ground and field layers are characterized by Cephaelis spp. and numerous mixed hardwood and palm seedlings. Ferns and tall herbs are absent but small mosses were noted on stems and trunks. No annual plants were noted, and there is apparently no seasonal dying down of the field and ground layers.

Reproduction

Calophyllum produces a plentiful quantity of seed, and reproduction is dense in patches. No vegetative reproduction was observed. The distribution of seedbearers, saplings and seedlings in one of the two plots is as shown in Table 2.

Table 2.—Seedbearers, Saplings, and Seedlings in Broken Ridge Forest, by Species

Species	Seedbearers	Saplings	Seedlings
Licania hypoleuca	12	31	8
Calophyllum brasiliense	1	4	583
Lucuma belizensis	3		4
Aspidosperma megalocarpon	1		6
Melastomaceae spp.	79	100	342

Floristic Composition

The emergent layer contains 10 to 60 trees per acre. Prominent are:

Licania hypoleuca
Aspidosperma megalocarpon
Lucuma belizensis
Xylopia hypoleuca

The canopy contains 80 to 120 hardwoods per acre with as many as 90 palms per acre in addition in some places. The more prominent species are:

Podocarpus sp.
Pseudolmedia sp.
Pourouma aspera
Miconia sp.
Protium copal
Thrinax wendlandiana
Euterpe panamensis
Cupania sp.
Virola brachycarpa
Sloanea sp.

The subordinate layer is composed of from 200 to 2,750 plants per acre including palms. The more prominent species are the following:

Euterpe panamensis	Inga sp.
Simaruba glauoa	Synechanthus sp.
Cephaelis sp.	Thrinax wendlandiana
Black ridge coffee	Mioonia sp.
Mouriria sp.	White banak
Cassipourea podantha	Orbignya oohune

The shrub layer contains 1,100 to 1,500 stems, among which Melastomaceae, Thrinax wendlandiana, and Cephaelis sp., are the most common. Rinorea sp. is absent to rare. Other species found are:

Calophyllum brasiliensis	Blue Ridge wild coffee
Synechanthus sp.	Black Ridge ooffee
Mouriria sp.	Broken Ridge coffee
Matayba oppositifolia	Broken Ridge cacho
Xylopia frutescens	Inga sp.

The field layer contains from 3,000 to 10,000 plants per acre. Common species are Melastomaceae spp., Cephaelis spp., Chamaedorea sp., and seedlings of Calophyllum brasiliense are abundant. Other species are:

Synechanthus sp.	Vochysia sp.
Black Ridge coffee	Matayba oppositifolia
Eugenia capub	Orbignya cohune

A general profile of this association appears in Fig. 1.

CHICLE FOREST ASSOCIATION 4/

The plots studied in this assooiation are looated between Dry Creek and Sibun River, the locality being known as the Dry Creek area, situated within Cayo distriot near its eastern boundary.

Habitat

Data presented in the previous article 2/ on temperature, precipitation, and wind are equally applioable for these plots.

Soil and Subsoil

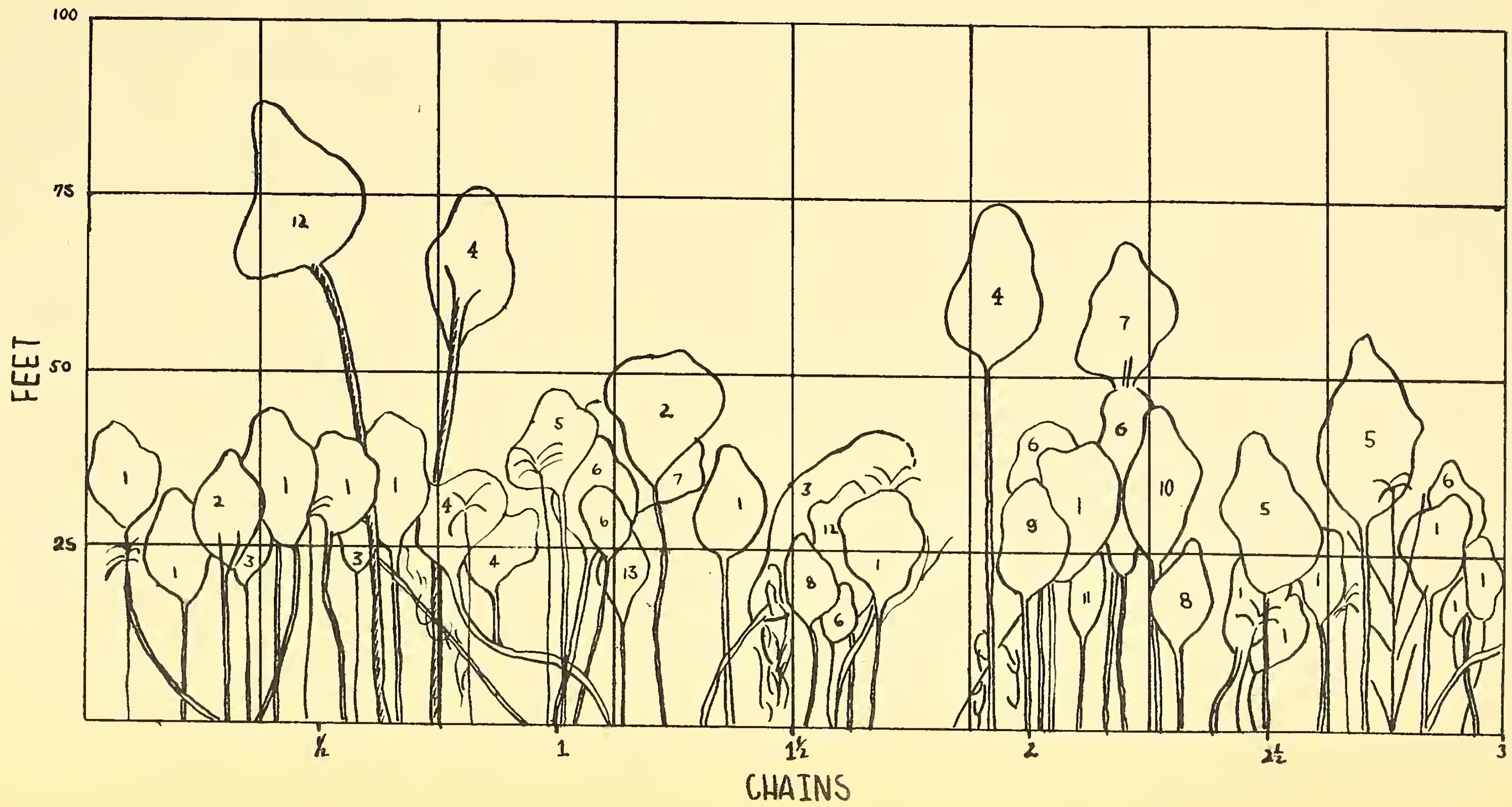
The underlying rock is white limestone of the Río Dulce beds. The soil down to 14 to 20 inches, is a chocolate brown heavy loam, sometimes with iron concretions. Near the base of this layer the soil becomes sticky and gives place to a yellowish clay, containing in some places decomposing limestone fragments. Roots penetrate to 3 feet. The leaf litter is variable in thickness, sometimes forming a complete soil covering with a definite F horizon, and in some places almost oompletely absent. The rate of

4/ Description based upon data collected by author as summarized at the Tropioal Forest Experiment Station

Fig. 1—A Typical Profile in the Broken Ridge Association, B. H. Plot 19
(*Croquis de un Perfil Típico en la Asociación en Broken Ridge, H. B. Lote 19*)

Key to Species (Clave)

1. *Miconia* sp. - Maya
2. *Virola* sp. - Banak
3. *Protium copal* - Red copal
4. *Swietenia macrophylla* - Mahogany
5. *Licania hypoleuca* - Pidgeon plum
6. Indeterminate
7. *Aspidosperma megalocarpon* - My lady
8. *Mouriria* sp. - Jug
9. *Virola koschnyi* - White banak
10. *Lucuma belizensis* - Silion
11. *Cupania* sp. - Grande Betty
12. *Cassipourea podantha* - Waterwood
13. *Symphonia globulifera* - Waika chewstick



disappearance is rapid. Detailed information on soil-water relations is not available but the water table is presumably high, 1 to 3 feet in the wet season. Erosion is nil, runoff slight, and drainage is free.

History of the Area

Little information is available on this subject. No signs of old cultivation were observed.

Biotic Factors

Same as for broken ridge association.

Size and Nature of Sample Studied

The two plots were each 1/2 by 3 chains. Both were located at the site of old soil survey pits, and there was no evidence of biotic modification. The plots were divided into 1/2-chain squares for enumeration and small plants were tallied on only a part of the area.

One plot is at 150 feet, and the other at 220 feet above sea level. The site is level and sheltered.

Structure and Composition

Structure

The canopy is generally closed, although gaps produced by windfalls are not uncommon. Ten to 20 per cent of the subordinate species receive direct light.

The distribution of emergents appears to be fairly regular, at a spacing of from 30 to 80 feet, although wider spacing up to 120 feet, is not uncommon. The emergent layer was absent in one plot. Canopy trees are regularly spaced at distances of 10 to 40 feet. Subordinates are spaced at 3 to 20 feet.

There is a general uniformity in the size of mature trees, seldom exceeding 24 inches in diameter, although *Achras sapote* may exceed 30 inches.

The diameters of some of larger trees are as follows:

Species	Diameter in inches
Metopium brownei	12
Terminalia amazonia	20
Swietenia macrophylla	24
Calophyllum brasiliense	20

Layering is not generally well defined. The emergents are clearly separated and form a high discontinuous layer at 90 to 100 feet. The canopy, at 35 to 70 feet is not clearly distinct from the subordinate layer, although it is higher and the trees have greater crown spread and lighter foliage. The subordinates, at 15 to 35 feet are distinguished from the two adjacent layers chiefly by size and number of individuals. The shrub and field layers are also difficult to distinguish except by number of individuals. The field layer contains many palms, and is generally open.

Physiognomy and Life Form

Lianes are occasional to common but do not affect crown of the canopy or subordinate trees. "Ropes" hang down close to the main trunks and do not disturb the lower vegetation. Small climbers are common in one plot but do not develop large leaves. They may ascend to 50 feet. This association is relatively free of tie ties. Tillandsia is common on large trees and favors a zone of 20 to 50 feet. The types noted are as follows:

1. Indeterminate medium spade-shaped leaf tie tie, occasional on canopy.

2. Indeterminate small vanilla-type climber, rare on canopy and subordinates.

3. Indeterminate small heart-shaped leaf tie tie on subordinate and canopy trees and occasionally on shrubs. Zone of maximum aggregation, 20 to 30 feet. Maximum height, 40 feet.

4. Indeterminate large heart-shaped leaf tie tie, occasional on canopy trees from 20 to 30 feet.

5. Orchid-type epiphyte common on branches of subordinate trees at 25 to 55 feet.

6. Desmoncus on canopy trees, 40 to 50 feet.

7. Thin arboreal mosses common on trunks.

Terminalia amazonia and Swietenia macrophylla have plank buttresses, about 8 trees per acre. No plank buttresses were seen in or near one plot. Stilt roots are absent although Caesalpinia sp. has a fluted trunk. Scale-like spines are present on the stems of Crysophylla argentea. Pneumatophores, and succulent leaves and stems are absent. Cauliflory is present in an indeterminate shrub species. Metopium brownei, Caesalpinia sp., Terminalia amazonia, Swietenia macrophylla, and Aspidosperma megalocarpon are deciduous in their adult forms. The emergent layer is 65 per cent deciduous, the canopy 40 per cent, and the subordinate layer 15 per cent or less. Leaves develop in March and fall in January and February.

The types and sizes of leaves are shown in Table 3.

Table 3.—Leaf Types and Sizes in Chicle Forest

Size	Type	Number of Leaflets	Size[5/] Leaves	Leaflets
Terminalia amazonia			Microphyll	
Swietenia macrophylla	Simple	8	Macrophyll	Mesophyll
Erythroxylon sp.	Simple		Macrophyll	
Lucuma belizensis	Simple		Macrophyll	
Aspidosperma megalocarpon	Simple		Mesophyll	
Brosimum alicastrum	Simple		Mesophyll	
Achras sapote	Simple		Mesophyll	
Mouriria sp.	Simple		Microphyll	
Rinorea sp.	Simple		Mesophyll	
Calophyllum brasiliense	Simple		Mesophyll	
Acacia sp.	Bipinnate	to 60		Leptophyll
Caesalpinia sp.	Bipinnate			Leptophyll
Metopium brownei	Simple		Mesophyll	
Coccoloba sp.	Simple		Macrophyll	
Stemmademia donnel-smithii	Simple		Mesophyll	
Guettarda sp.	Simple		Macrophyll	

Ferns, herbs, and mosses are notably absent in the ground layer. Many hardwood and palm seedlings are present, however. No annuals were noted, and it is believed that there is no seasonal dying down of the field layers.

Reproduction

The principal species in the two plots and the representation of their seedlings and saplings are shown in Table 4.

Table 4.—Seedbearers, Saplings, and Seedlings in Chicle Forest by Species

Species	Seedbearers	Saplings	Seedlings
Swietenia macrophylla	1		
Calophyllum brasiliense	1		
Aspidosperma megalocarpon	3	7	
Erythroxylon sp.	5	4	
Achras sapote		6	
Lucuma belizensis	2		4
Metopium brownei	2		

5/ Raunkiaer's leaf size classes.

Table 4.— Continued

Species	Seedbearers	Saplings	Seedlings
Rinorea sp.	44	40	30
Crysophylla argentea	7		180
Indeterminates	25	51	343

No vegetative reproduction was noted.

Floristic Composition

The emergent layer contains approximately 18 trees per acre. Prominent species are:

Terminalia amazonia
Swietenia macrophylla
Calophyllum brasiliense

The canopy contains 100 to 150 hardwoods with about 10 additional palms per acre, and includes the following species:

Metopium brownei	*Caesalpinia* sp.
Erythroxylon sp.	*Guettarda* sp.
Coccoloba sp.	*Cupania* sp.
Aspidosperma megalocarpon	*Lucuma belizensis*
Acacia sp.	*Sabal mauritieforans*

The subordinate layer is composed of from 175 to 225 hardwoods and 45 to 75 palms per acre, and includes the following species:

Vitex sp.	White banak
Rinorea sp.	*Lucuma belizensis*
Aspidosperma megalocarpon	*Erythroxylon* sp.
Orbignya cohune	*Crysophylla argentea*
Brosimum alicastrum	*Thrinax wendlandiana*

The shrub layer contains 575 to 750 hardwoods and 300 to 400 palms per acre. *Rinorea* sp. is very common. Other species are:

Stemmadenia donnel-smithii	*Orbignya cohune*
Sweetia sp.	*Piper* sp.
Thrinax wendlandiana	*Mouriria* sp.
Sabal mauritieforans	*Synechanthus* sp.
White banak	

The upper field layer contains 680 hardwood seedlings per acre in one plot and 3,740 in the other. Palms number 500 to 1,500 per acre. Prominent species are:

Thrinax wendlandiana	Orbignya cohune
Crysophylla argentea	Rinorea sp.
Sabal mauritieforans	Piper sp.

The lower field layer contained 59,000 hardwood seedlings per acre in one plot, possibly because of a good recent seed year. In the other plot there were found 1,200 per acre. Palms number 300 to 400 per acre. The most numerous species are indeterminate. Others are Thrinax wendlandiana and Crysophylla argentea.

A general profile of this association appears in Figure 2.

BAMBOO ASSOCIATION6/

The plot studied in this association lies near the Dry Creek-St. Thomas (Sibun River) truck pass, 20 chains east of St. Thomas. The locality is known as the Dry Creek area, and lies within the Cayo district near its eastern boundary.

Habitat

Data presented in the previous article2/ on temperature, precipitation and wind are equally applicable for this plot.

Soil and Subsoil

The underlying rock is presumed to be white limestone of the Río Dulce beds overlaid by old river beds. The soil is a light brown fine silty loam with mica present. Texture is constant to a depth of at least 7 feet, although river stones are scattered at this depth. Litter is often completely absent. Detailed information on soil-water relations is not available. The depth of the water table is below 7 feet during the rainy season. A narrow creek valley lies 2 chains distant from the plot, and 8 feet below it. Erosion and runoff are nil.

History of the Area

Little information is available on this subject. No signs of old cultivation were observed.

Biotic Factors

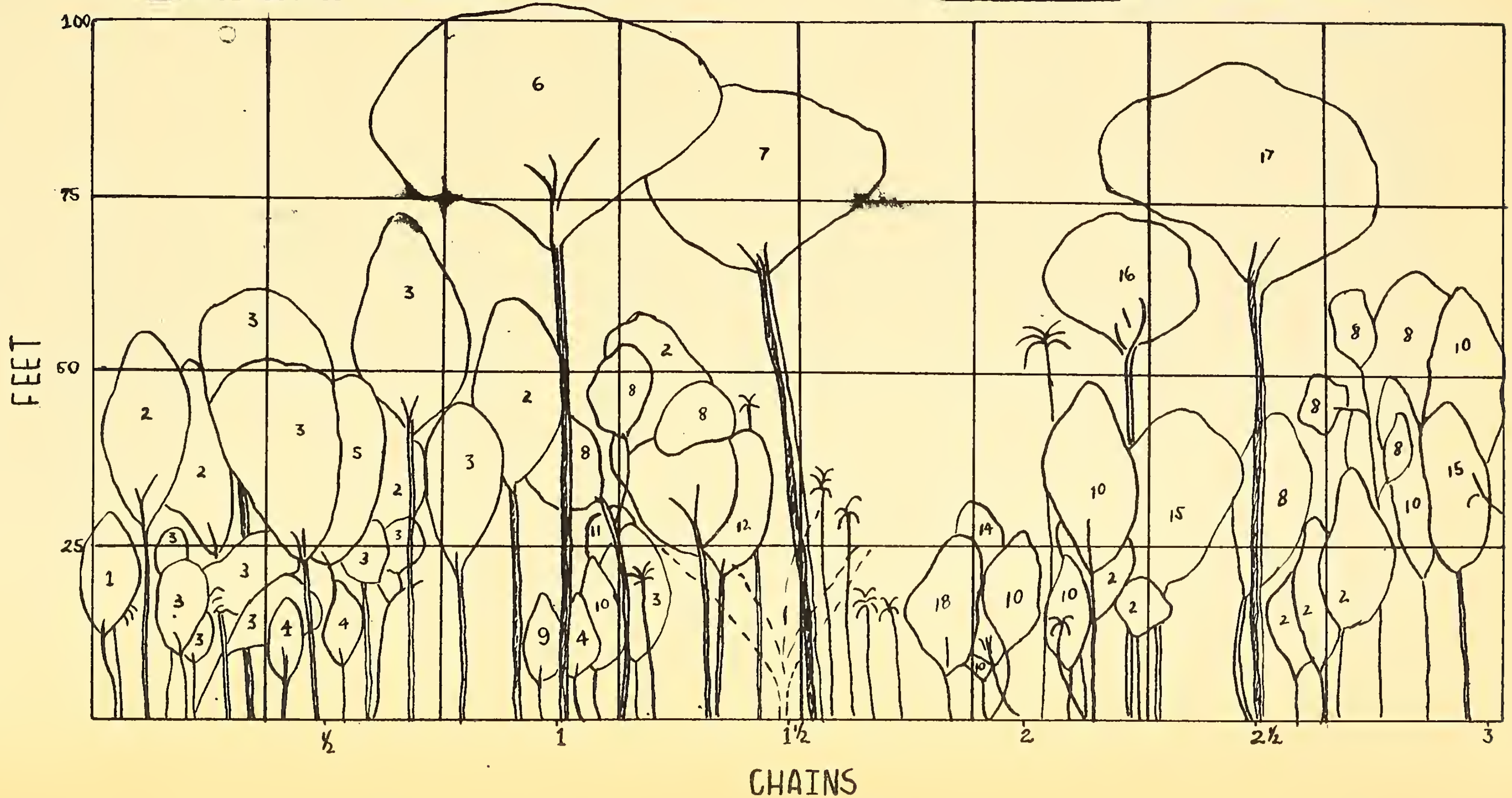
Same as for broken ridge association.

6/ Description based upon data collected by author as summarized at the Tropical Forest Experiment Station.

Fig. 2—A Typical Profile in the Chicle Forest Association, B. H. Plot 24
(Croquis de un Perfil Típico en la Asociación Forestal Chicle, H. B. Lote 24)

Key to Species (Clave)

1. Vitex sp. - Fiddlewood
2. Erythroxylon sp. - Redwood
3. Indeterminate
4. Rinorea sp. - Wild coffee
5. Guettarda sp. - Glasswood
6. Terminalia amazonia - Nargusta
7. Swietenia macrophylla - Mahogany
8. Coccoloba sp. - Wild grape
9. Achras sapote - Sapodilla macho
10. Aspidosperma megalocarpon - My lady
11. Brosimum alicastrum
12. Cupania sp. - Grande Betty
13. Sabal mauritieforans - Bayleaf palm
14. Lucuma belizensis - Silion
15. Lucuma sp.
16. Caesalpinia sp. - Warriewood
17. Calophyllum brasiliense - Santa María
18. Synechanthus sp. - White banak



Size and Nature of Sample Studied

The plot studied is 1/2 by 1/4 chain, and was located at the site of a soil survey pit. The vegetation appeared typical of the locality without apparent biotic modification. A count of all species in the plot was made, and emergent trees were noted over a large area. The altitude of the plot is 200 feet above sea level. The site is level and sheltered.

Structure and Composition

Structure

The canopy is closed, the bamboo and herbaceous creepers forming a dense mass of vegetation. The distribution of large trees is irregular and very open, at a spacing of from 100 to 200 yards. Smaller trees, such as *Cecropia* sp. and *Inga* sp. are very widely scattered and may be entirely absent over one or more acres. Trees such as *Schizolobium parahybum* and *Pithecolobium* sp. grow to 3 feet in diameter.

The vegetation is structureless, trees being too widely spaced to be justifiably incorporated into the profile.

Physiognomy and Life Form

Woody tie ties and epiphytes are absent. Herbaceous creepers are abundant. Approximately 1 tree per acre has plank buttresses (*Schizolobium parahybum*, *Virola koschnyi*, and *Pithecolobium* sp.) and 3 have stilt roots. Bamboo has thorny trunks and branches, approximately 2,214 per acre. Pneumatophores, cauliflory, corky bark, and succulent leaves and stems are absent. Palms and tree ferns are absent.

Of the woody species 98 per cent are evergreen. *Schizolobium parahybum* sheds leaf in January and February and refoliates in March. Leaf sizes were not noted.

Floristic Composition

Tree species noted over a wide area include:

Species	Height in feet
Schizolobium parahybum	120
Virola koschnyi	100
Zanthoxylum sp.	100-120
Pithecolobium sp.	100-120
Cecropia sp.	30
Inga sp.	30

The ground vegetation reaches from 3 to 12 feet in height. Where the bamboo is scarce creepers predominate with *Heliconia* sp. up to 12 feet and *Heliconia aurantiaca* to 8 feet, occuring in patches. Bamboo is abundant throughout the vegetation. Total number of individuals per acre, 4,054.

The general profile of this forest is seen in Fig. 3.

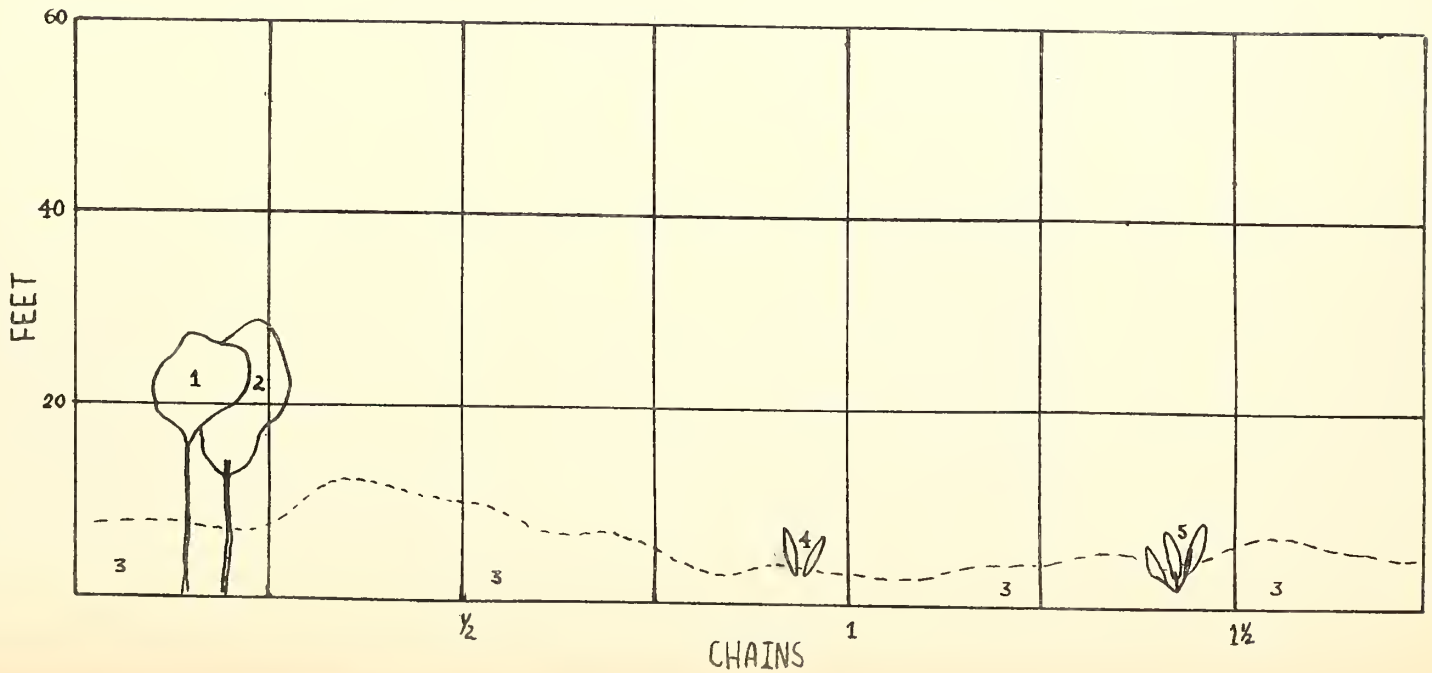
A list of species with common names appears below:

Scientific Name	Common Name
Acacia sp.	Cockspur
Achras sapote	Sapodilla macho
Aspidosperma megalocarpon	My lady
Brosimum alicastrum	
Caesalpinia sp.	Warriewood
Calophyllum brasilense	Santa María
Cassipourea podantha	Waterwood
Cecropia sp.	Trumpet
Cephaelis sp.	African root
Cephaelis tomentosa	
Chamaedorea sp.	Pacaya
Coccoloba sp.	Wild grape
Crysophylla argentea	Give and Take
Cupania sp.	Grande betty
Erythroxylon sp.	Redwood
Eugenia capub	Walk naked
Euterpe panamensis	Mountain cabbage
Guettarda sp.	Glasswood
Heliconia aurantiaca	Wild plantain
Heliconia sp.	Waha leaf
Inga sp.	Bri bri
Licania hypoleuca	Pidgeon plum
Lucuma belizensis	Silion
Matayba oppositifolia	Boy job
Metopium brownei	Black poisonwood
Miconia sp.	Maya
Mouriria sp.	Jug
Orbignya cohune	Cohune
Piper sp.	Spanish elder
Pithecolobium sp.	Tamarind
Podocarpus sp.	
Pourouma aspera	Mountain trumpet
Protium copal	Red copal
Pseudolmedia sp.	Cherry
Pterocarpus hayesii	Mountain kaway
Rheedia edulis	Waika plum
Rinorea sp.	Wild coffee
Sabal mauritieforans	Bayleaf palm
Schizolobium parahybum	Quamwood

Fig. 3— A Typical Profile in the Bamboo Association, B. H. Plot 27
(Croquis de un Perfil Típico de la Asociación de Bambú, H. B. Lote 27)

Key to Species (Clave)

1. *Cecropia* sp. - Trumpet
2. *Inga* sp. - Bri bri
3. Bamboo and bastard cow itch
4. *Heliconia aurantiaca* - Wild plantain
5. *Heliconia* sp. - Waha leaf



A list of species with common names. (Continued).

Scientific Name	Common Name
Simaruba glauca	Negrito
Sloanea sp.	Wild atta
Stemmademia donnel-smithii	Cojotone
Symphonia globulifera	Waika Chewstick
Synechanthus sp.	Monkey tail
Sweetia sp.	Billy webb
Swietenia macrophylla	Mahogany
Terminalia amazonia	Nargusta
Thrinax wendlandiana	Saltwater pimento
Virola brachycarpa	Bastard banak
Virola koschnyi	Banak
Vitex sp.	Fiddlewood
Xylopia hypoleuca	Polewood
Zanthoxylum sp.	
Inga sp.	Broad leaf bri bri
	Broken ridge coffee
	Broken ridge cacho
Mouriria sp.	Blue Ridge wild coffee
Synechanthus sp.	Black ridge coffee
	White banak

(Traducción del artículo anterior)

ALGUNAS ASOCIACIONES FORESTALES DE HONDURAS BRITANICA, III

ASOCIACION BROKEN RIDGE[1]

Los cuarteles que se estudiaron en esta asociación están ubicados en el área Manatee, situada en la esquina sudoeste del Distrito de Belize.

Habitat

En lo que concierne a temperatura, precipitación y viento, los datos presentados en el artículo previo sobre asociaciones forestales de Honduras Británica se aplican también a estos cuarteles.

Suelo y Subsuelo

La roca madre parece ser de origen metamórfico, esquistos, cuarcitas,

1/ Descripción basada en los datos de dos cuarteles de prueba recopilados por el autor y resumidos en la Estación de Experimentación Forestal Tropical.

etc. El suelo es lómico arenoso y varía de rojo obscuro a pardo amarillento. En un cuartel el suelo es arenisco con partículas de cuarzo mientras que el otro contiene concreciones ferruginosas de manganeso. La contextura se torna más fina en el subsuelo hasta que en algunos sitios se forma una capa semejante a un banco duro a una profundidad que varía entre 1 y 5 pies. La cubierta de litera es casi completa y existe un tenue horizonte F. Las raíces penetran de 2 a 3 pies. La erosión es nula, el deslave leve y el drenaje libre. No se conoce nada de las relaciones de suelo-agua.

Historia del Area

La información sobre este aspecto es muy escasa y no hay indicios de cultivos previos.

Factores Bióticos

En los últimos 50 á 100 años se ha explotado la caoba sin regularidad y hoy día existe un sistema bastante extendido de "pases de camión" a través del área. Esto ha dado como resultado ciertas aberturas del dosel o techo forestal en ciertos puntos, aunque nunca son extensas, y aún cuando esta acción tiene que tener necesariamente una influencia definida sobre la estructura de la vegetación, es considerada como insignificante en los cuarteles descritos.

El pastoreo no se ha difundido por esta región. Los animales empleados en la explotación de la caoba se han apacentado a los lados de la quebrada usando como alimento ciertas palmas y una variedad limitada de los árboles de maderas duras de los cuales Brosimum alicastrum es la principal especie utilizada. Esto dió como resultado ciertos claros en áreas localizadas, muy pequeñas.

El efecto del pisoteo y apacentamiento de los animales salvajes parece ser muy limitado. Cerdos en manadas de 50 o más vagan por el distrito y sin duda causan alguna destrucción de la regeneración. El suelo puede estar completamente expuesto y levantado sobre áreas de una cadena cuadrada o más pero su efecto en toda la vegetación puede considerarse ínfimo.

Los termiteros son comunes en todo el distrito, son casi siempre de forma ovalada y raras veces exceden 3 pies de altura. Para construir los nidos los termes se sirven de tocones o troncos muertos. Los termes subterráneos no escasean pero se desconocen sus hábitos. Aparentemente no perjudican la vegetación viva, ya que estos termes atacan sólo la madera muerta y hasta ayudan en cierto modo pues desbaratan los árboles muertos y ramas caídas, etc.

Las hormigas de tierra abundan y hacen "jardines" fungosos en la vegetación viva. Hay poca información sobre el alcance del daño que ocasionan en los bosques naturales pero se sabe que esta hormiga puede causar graves defoliaciones en las plantaciones de caoba y en los árboles citrosos.

No había indicio alguno de quemas.

Tamaño y Naturaleza de los Cuarteles Estudiados

Uno de los cuarteles tenía 1/2 por 3 cadenas; el otro 1/2 por 4. Ambos se dividieron en cuadrados de 1/2 cadena para el estudio que se efectuó. La vegetación parecía típica de la localidad y aparentemente sin ninguna modificación biótica. Se tomó especial cuidado en excluir datos de la vegetación que podía haber sido alterada por el pisoteo humano.

La altitud de estos cuarteles es de 180 a 260 pies sobre el nivel del mar. La inclinación es leve, de 2 a 15 por ciento. El aspecto es de oeste a noroeste.

Estructura y Composición

Estructura

Las copas son generalmente cerradas aunque en algunos sitios hasta el 30 por ciento de la vegetación subordinada recibe luz solar directa debido a desigualdades en el nivel del dosel causadas por las diversas alturas de los árboles y por caídas de éstos debido al azote del viento. Un promedio del 10 por ciento de la luz solar llega hasta la vegetación subordinada.

El espaciamiento de los emergentes varía. En uno de los cuarteles los emergentes están de 90 a 120 pies de separación mientras que en el otro se encuentran en grupos que están de 60 a 80 pies distantes con los árboles individuales espaciados de 15 a 30 pies. El espaciamiento de los subordinados es regularmente de 3 a 15 pies. Los arbustos y pies están uniformemente distribuídos con 5 a 10 pies de separación. Los ejemplares de *Thrinax wendlandiana* de 20 a 30 pies de altura tienen un espaciamiento de 15 a 20 pies.

Los árboles más grandes tienen los siguientes diámetros: (Véase la página 133.)

El estrato emergente está por lo general claramente definido entre 40 y 80 pies de altura. El estrato de copa, de 20 a 50 pies de altura es denso excepto en aquellos sitios donde el viento ha dejado claros de 10 a 30 pies cuadrados; no se distingue bien del estrato subordinado aunque por lo general los árboles de este último estrato tienen la copa menos desplegada. El estrato de los subordinados, de 18 a 30 pies de altura está poco definido. El estrato arbustivo, de 6 a 20 pies de altura puede distinguirse del de árboles subordinados por su mayor densidad y tamaño menor de la copa de sus constituyentes. Los estratos subarbustivos de 0 a 6 pies de altura se distinguen por la abundancia de *Cephaelis* spp. y *Thrinax wendlandiana.*

Fisionomía y Biotipos

Las lianas son generalmente comunes y ascienden hasta la corona de prácticamente todas las especies de copa, hasta una altura de 40 pies, creando así algún apiñamiento. También se encuentran lianas en la copa de subordinados y en el estrato arbustivo en los claros causados por la caída de árboles. Las enredaderas son comunes en los árboles coposos y ascienden hasta sus coronas. Variedades más pequeñas de enredaderas son numerosas en los subordinados y en los pies más pequeños. Los epifitos del tipo de las orquídeas se encuentran ocasionalmente en las ramas de especies de copa y subordinados. Tillandia sp. se encuentra ocasionalmente en emergentes y subordinados. Los biotipos presentes son:

1. Bejuco indeterminado de hoja grande y acorazonada creciendo en los emergentes y árboles de copa.

2. Bejuco de hoja grande, en forma de azada en los emergentes y árboles de copa.

3. Bejuco indeterminado, de hoja pequeña en forma de azada, creciendo sobre los árboles de copa, subordinados y pies más pequeños.

4. Enredaderas indeterminadas, del tipo de la vainilla creciendo sobre las especies subordinadas.

5. Tillandsia sp. creciendo sobre Podocarpus sp., Licania hypoleuca y Virola koschnyi.

6. Epifitos del tipo de las orquídeas creciendo sobre los árboles de copa y subordinados, con alguna zonación entre 15 y 30 pies.

7. Helechos indeterminados creciendo sobre Podocarpus sp. y Aspidosperma megalocarpon.

8. Musgos indeterminados sobre todos los fustes.

Virola koschnyi, Sloanea sp. y Lucuma belizensis tenían raíces columnares y se encuentran cerca de 20 de estos árboles por acre. Pourouma aspera y Symphonia globulifera tienen raíces zancos pero se encuentran pocos árboles grandes de estas especies. Euterpe panamensis tiene raíces aéreas modificadas. No hay troncos o ramas espinosas, plantas caulifloras, cortezas suberosas ni tampoco hojas o tallos suculentos. Entre los biotipos especiales encontramos palmas, Crysophylla argentea, y la rota Desmoncus. No hay bambú. La única especie decidua que existe allí es Aspidosperma megalocarpon, que sólo es decidua cuando está madura.

Los tamaños y tipos de las hojas aparecen en la Tabla 1. (Véase la página 134).

Los estratos subarbustivos y rasantes están caracterizados por la presencia de Cephaelis spp. y numerosos brinzales de árboles de madera dura y de palmas. No hay helechos ni yerbas altas pero pueden notarse musgos pequeños en tallos y troncos. No hay plantas anuales y aparentemente los estratos rasante y subarbustivo prevalecen durante todas las estaciones.

Reproducción

El Calophyllum produce gran cantidad de semilla y la reproducción es densa y en grupos. No se observó ninguna reproducción por brotes. La distribución de portagranos, latizales y brinzales en uno de los cuarteles aparece en la Tabla 2. (Véase la página 135)

Composición Florística

El estrato de emergentes contiene de 10 á 60 árboles por acre. Los más prominentes son: Licania hypoleuca, Aspidosperma megalocarpon, Lucuma belizensis y Xilopia hypoleuca.

El estrato de copa contiene de 80 á 120 árboles de madera dura por acre y en algunos sitios contiene además tanto como 90 palmas por acre. Las especies más prominentes son:

Podocarpus sp.	Thrinax wendlandiana
Pseudolmedia sp.	Euterpe panamensis
Pourouma aspera	Cupania sp.
Miconia sp.	Virola brachycarpa
Protium copal	Sloanea sp.

El estrato de subordinados está compuesto de 200 a 2,750 plantas por acre, incluyendo las palmas. Las especies más prominentes son:

Euterpe panamensis	Inga sp.
Simaruba glauca	Synechanthus sp.
Cephaelis sp.	Thrinax wendlandiana
Black Ridge Coffee	Miconia sp.
Mouriria sp.	White banak
Cassipourea podantha	Orbignya cohune

El estrato arbustivo contiene de 1,100 a 1,500 troncos entre los cuales los más comunes son: Melastomaceae, Thrinax wendlandiana y Cephaelis sp. Rinorea sp. está ausente u aparece raras veces. Otras especies que se encuentran allí son:

Calophyllum brasiliensis	Blue Ridge wild coffee
Synechanthus sp.	Black Ridge coffee
Mouriria sp.	Broken Ridge coffee
Matayba oppositifolia	Broken Ridge cacho
Xylopia frutescens	Inga sp.

El estrato subarbustivo contiene de 3,000 a 10,000 plantas por acre. Las especies más comunes son: Melastomaceae spp., Cephaelis spp., Chamaedorea sp. Los brinzales de Calophyllum brasiliense son abundantes. Otras especies que se encuentran en el estrato subarbustivo son:

Synechanthus sp.	Vochysia sp.

Black Ridge coffee	*Matayba oppositifolia*
Eugenia capub	*Orbignya cohune*

Un perfil general de esta asociación aparece en la Figura 1.

ASOCIACION FORESTAL CHICLE4/

Los cuarteles estudiados en esta asociación están ubicados entre Dry Creek y el río Sibun; la localidad se conoce como Area Dry Creek y está situada cerca del lindero este del Distrito Cayo.

Habitat

Los datos presentados en el artículo anterior en lo que concierne a temperatura, precipitación y viento se aplican también a estos cuarteles.

Suelo y Subsuelo

La roca madre es piedra caliza blanca de los cauces del río Dulce. El suelo, hasta una profundidad de 14 a 20 pulgadas es lómico, color pardo achocolatado, a veces con concreciones de hierro. Cerca de la base de esa capa el suelo se torna pegajoso y da paso a una arcilla amarillenta que contiene en algunos sitios fragmentos calizos en descomposición. Las raíces penetran hasta 3 pies de profundidad. La litera de hojarasca varía en espesor, a veces forma una cubierta completa con un horizonte F bien definido y en algunos sitios falta casi por completo. Su índice de desaparición es rápido. No existe información detallada sobre las relaciones suelo-agua pero el nivel freático parece ser alto, de 1 a 3 pies en la época de lluvias. La erosión es nula, el deslave insignificante y el drenaje libre.

Historia del Area

Existe poca información sobre este tópico y no hay indicios de cultivos previos.

Factores Bióticos

Los factores bióticos son los mismos que los de la asociación Broken Ridge.

Tamaño y Naturaleza de los Cuarteles

Los dos cuarteles estudiados tenían 1/2 x 3 cadenas. Ambos estaban ubicados en el mismo sitio donde se hicieron las calicatas para el estudio de los suelos y no existe evidencia alguna de modificación biótica. Los

---

4/ Esta descripción está basada en los datos recopilados por el autor y resumidos en la Estación de Experimentación Forestal Tropical.

cuarteles se dividieron en cuadrados de 1/2 cadena para las enumeraciones y las plantas más pequeñas se midieron sólo en una parte del área.

Uno de los cuarteles está a 150 pies y el otro a 220 pies sobre el nivel del mar. El sitio es llano y protegido.

Estructura y Composición

Estructura

El dosel es generalmente cerrado aunque a veces hay aberturas formadas por la caída de árboles. Del 10 al 20 por ciento de las especies subordinadas reciben luz directa.

La distribución de los emergentes parece ser bastante regular, con un espaciamiento de 30 a 80 pies, aunque a veces alcanza a 120 pies. En uno de los cuarteles no había estrato emergente. Los árboles de la copa tienen un espaciamiento regular, de 10 a 40 pies, mientras que el de los subordinados es de 3 a 20 pies.

Hay cierta uniformidad general en lo que se refiere al tamaño de los árboles maduros, que raras veces exceden de 24 pulgadas de diámetro aunque Achras sapote en ocasiones excede de 30 pulgadas. Los diámetros de algunos de los árboles más grandes son como sigue: (Véase la página 138).

La estratificación no está por lo general bien definida. Los emergentes sobresalen claramente y forman un estrato alto, discontinuo de los 90 a 100 pies. El estrato de copa, de los 35 a los 70 pies de altura no es fácil de distinguir del estrato de los subordinados aún a pesar de que es más alto y los árboles poseen copas más desplegadas y menos follaje. El estrato de subordinados, entre 15 y 35 pies es fácil de distinguir de los dos estratos subyacentes principalmente por el tamaño y número de los ejemplares. El estrato arbustivo y el subarbustivo son difíciles de diferenciar excepto por el número de ejemplares. El estrato subarbustivo contiene muchas palmas y generalmente es algo abierto.

Fisionomía y Biotipos

Las lianas aparecen de ocasional a comúnmente pero no afectan la copa de los árboles del estrato de copa o de los subordinados. "Cuerdas" cuelgan cerca del tronco de los árboles pero no afectan la vegetación inferior. Las enredaderas pequeñas abundan en un cuartel pero no desarrollan hojas grandes. A veces las enredaderas ascienden hasta 50 pies. Los bejucos en esta asociación son relativamente escasos. Tillandsia es común en los árboles grandes y prefiere la zona entre 20 y 50 pies. Los biotipos son los siguientes:

1. Bejuco indeterminado de hoja mediana en forma de azada que aparece ocasionalmente en el estrato de copa.

2. Enredadera indeterminada, pequeña, del tipo de la vainilla, aparece

raras veces en el estrato de copa y entre los subordinados.

3. Bejuco indeterminado de hoja pequeña y acorazonada que crece sobre los árboles subordinados y sobre los del estrato de copa y a veces sobre los arbustos.

4. Bejuco indeterminado de hoja grande, acorazonada y que crece a veces en los árboles de copa, de los 20 a los 30 pies de altura.

5. Epifito del tipo de las orquídeas, corriente en las ramas de los árboles subordinados, de los 25 a 55 pies de altura.

6. Desmoncus crece en los árboles de copa a una altura de 40 a 50 pies.

7. Musgos delgados y arbóreos son comunes en los troncos.

Terminalia amazonia y Swietenia macrophylla poseen raíces columnares y aparecen en un promedio de 8 árboles por acre. En uno de los cuarteles no aparecieron raíces columnares. No había tampoco raíces zancos aunque Caesalpinia sp. tiene un tronco acanalado. En los troncos de Crysophylla argentea aparecen espinas en forma de escamas. No hay neumatóforos ni tallos u hojas suculentas. La única planta cauliflora presente es un arbusto que no ha sido determinado. Cuando llegan a la madurez Metopium brownei, Caesalpinia sp., Terminalia amazonia, Swietenia macrophylla y Aspidosperma megalocarpon son deciduos. El 65 por ciento del estrato emergente, el 40 por ciento del estrato de copa y el 15 por ciento o menos del estrato subordinado es deciduo. Las hojas se desarrollan en marzo y caen en enero y febrero.

Los tipos y tamaños de las hojas aparecen en la Tabla 3,(página 140).

No hay helechos, yerbas ni musgos en el estrato rasante; sin embargo hay muchos brinzales de árboles de maderas duras y palmas. No se encontraron plantas anuales y se cree que el estrato subarbustivo prevalece en todas las estaciones del año.

Reproducción

Las principales especies en los dos cuarteles y su representación en portagranos, brinzales y latizales aparecen en la Tabla 4, página 140.

No se observó ninguna reproducción por brotes.

Composición Florística

El estrato emergente contiene aproximadamente 18 árboles por acre. Las especies más prominentes son: Terminalia amazonia, Swietenia macrophylla y Calophyllum brasiliense.

El estrato de copa contiene de 100 a 150 árboles de maderas duras por acre con cerca de 10 palmas adicionales que incluyen las siguientes especies: (Véase el texto en inglés, página 141).

El estrato de subordinados está compuesto de 175 a 225 árboles de maderas duras por acre y de 45 a 75 palmas por acre, que incluyen las siguientes especies: (Véase el texto en inglés, página 141).

El estrato arbustivo contiene de 575 a 750 árboles de maderas duras y de 300 a 400 palmas por acre. Rinorea sp. es muy común. Otras especies en ese estrato son: (Véase el texto en inglés, página 141).

El estrato subarbustivo superior contiene 680 brinzales de árboles de maderas duras por acre en un cuartel y 3,740 en el otro. Las palmas aparecen de 500 a 1,500 por acre. Las especies prominentes son: (Véase el texto en inglés, página 142).

El estrato subarbustivo inferior contiene 59,000 brinzales de árboles de maderas duras por acre en un cuartel, debido quizás a la producción de buena semilla durante ese año. En el otro cuartel hay 1,200 por acre. Hay de 300 a 400 palmas por acre. Las especies más numerosas son indeterminadas. Entre otras se encuentran también Thrinax wendlandiana y Crysophylla argentea.

El croquis de un perfil general de esta asociación aparece en la Figura 2.

ASOCIACION BAMBU[6]

El cuartel que se estudió en esta asociación está situado cerca del pase de camión Dry Creek-St. Thomas (Río Sibun), 20 cadenas al este de St. Thomas. La localidad se conoce como Area Dry Creek y queda en el lindero este del distrito Cayo.

Habitat

Los datos que aparecieron en el artículo anterior relativos a temperatura, precipitación y viento se aplican también a este cuartel.

Suelo y Subsuelo

La roca madre parece ser piedra caliza blanca de los cauces del río Dulce cubierta por piedras viejas del río. El suelo es limoso lómico fino, color pardo claro con trazas de mica. La contextura es constante hasta una profundidad de por lo menos 7 pies aunque las piedras de río están bastante dispersas a esa profundidad. La litera falta a menudo por completo. No hay información detallada sobre las relaciones suelo-agua. La profundidad del

6/ La descripción de esta asociación está basada en los datos recopilados por el autor y resumidos en la Estación Forestal Tropical.

nivel freático es más de 7 pies durante la época lluviosa. Existe un valle angosto a 2 cadenas del cuartel y 8 pies más abajo del mismo. La erosión y deslave son nulos.

Historia del Area

Hay poca información en lo que se relaciona a este tópico. No existe indicio alguno de cultivos previos.

Factores Bióticos

Iguales que los de la asociación Broken Ridge.

Tamaño y Naturaleza del Cuartel

El cuartel estudiado tiene 1/2 por 1/4 cadena y está ubicado en el sitio de una calicata hecha durante el reconocimiento de suelos. La vegetación parece ser típica de la localidad, sin ninguna modificación biótica aparente. Se contaron todas las especies del cuartel. La altitud del cuartel es de 200 pies sobre el nivel del mar. El sitio es plano y protegido.

Estructura y Composición

Estructura

El dosel es cerrado; el bambú y las enredaderas herbáceas forman un macizo denso de vegetación. La distribución de los árboles grandes es irregular y muy abierta, con un espaciamiento de 100 a 200 yardas. Los árboles más pequeños tales como Cecropia sp. e Inga sp. están bastante dispersos y a veces faltan en una o más acres. Tales árboles como Schizolobium parahybum y Pithecolobium sp. crecen hasta 3 pies de diámetro.

La vegetación no tiene una forma definida y los árboles están muy espaciados para justificar su incorporación en el perfil.

Fisionomía y Biotipos

No hay bejucos leñosos ni epifitos. Hay abundancia de enredaderas. Aproximadamente 1 árbol por acre posee raíces columnares (Schizolobium parahybum, Virola koschnyi y Pithecolobium sp.) y un promedio de 3 poseen raíces zancos. El bambú tiene troncos y ramas espinosas, y hay aquí aproximadamente 2,214 por acre. No hay neumatóforos, plantas caulifloras, cortezas suberosas ni hojas o tallos suculentos. Tampoco hay palmas ni helechos arbóreos.

De las especies leñosas el 98 por ciento son perennifolias. El Schizolobium parahybum pierde la hoja en enero y febrero y vuelve a cubrirse de follaje en marzo.

Composición Florística

Las especies arbóreas que se anotaron de un área bastante extensa incluyen:

Especie	Altura en pies
Schizolobium parahybum	120
Virola koschnyi	100
Zanthoxylum sp.	100-120
Pithecolobium sp.	100-120
Cecropia sp.	30
Inga sp.	30

La vegetación inferior tiene de 3 a 12 pies de altura. En los sitios donde escasea el bambú predominan las enredaderas tales como Heliconia sp. hasta los 12 pies y Heliconia aurantiaca hasta los 8 pies, apareciendo en manchones. El bambú abunda sobre toda la demás vegetación. El número total de individuos por acre es de 4,054.

Un croquis del perfil general de esta asociación aparece en la Figura 3.

La lista de especies, junto con los nombres comunes aparece en las páginas 145 y 147.

Résumé

Ce travail-ci décrit trois autres associations de l'Honduras Britannique, à savoir: Broken Ridge, Chicle et Bambou. Ils se trouvent aux contrées de Belize et Cayo, vers 200 pieds au-dessus du niveau de la mer. Les données relatives à température, chute pluviométrique et vitesse du vent exposées dans l'article précédent s'appliquent aussi à ces forêts.

L'association Broken Ridge est semblable à l'association Orbignya-Dialium-Virola et dans certains endroits se confond avec elle. La première est généralement moins haute et moins complèxe. Le sol est un lehm sablonneux qui contient des particules de quartz et le sous-sol est presque imperméable. Les arbres plus grands ou émergents ont 80 pieds d'hauteur. La voûte foliacée (ou dais) et la couche des subordinés ou retardataires ne sont pas bien définies que par leur hauteur. Les plantes grimpantes sont très communes. Les essences plus saillantes sont: Licania hypoleuca, Aspidosperma megalocarpon, Lucuma belizensis et Thrinax wendlandiana. Dans les pages 135 et 136 sont énumérées les autres essences y trouvées, par strates et la Fig. 1 montre un profil général de cette association. La majorité des arbres sont sempervirents et à feuilles simples.

L'association Chicle croît sur un lehm lourd dérivé de pierre à chaux. Les émergents ont une hauteur de 90-100 pieds et toutes les strates se confondent les unes avec les autres. Les strates inférieures ont beaucoup de

palmiers. Les plantes grimpantes y sont moins communes que dans l'association Broken Ridge. Les essences plus saillantes sont: Terminalia amazonia, Swietenia macrophylla et Calophyllum brasiliense. Dans les pages 143 et 144 sont énumérées les autres essences y trouvées, par strates et la Fig. 2 montre le profil général. La forêt est semi-décidue.

L'association Bambou est différente des autres ici décrites. Elle croit sur un sol d'alluvion, lehm profond et limoneux. Il n'y a pas de strates car la voûte foliacée se compose de denses massifs de bambou et seulement occasionnellement trouve-on un arbre à bois dur. Les arbres plus grands, comme Schizolobium parahybum et Virola koschnyi croissent jusqu'à 120 en hauteur et 3 pieds de diamètre. Les plantes grimpantes herbacées sont très abondantes. On trouve la liste du petit nombre d'arbres dans cette association à la page 144 et le profil général dans la Fig. 3.

---oOo---

CREACION DE UNA ESTACION DE AGROSTOLOGIA Y SILVICULTURA EN VENEZUELA

La fundación de la Estación de Agricultura y Silvicultura de Tovar, con el apoyo económico prestado por el Ministerio de Agricultura y Cría y el gobierno del Estado de Mérida en Venezuela representa un paso de avance en la solución de los problemas que se relacionan con la agricultura y la silvicultura. Esta Estación se considera la más importante del Estado, debido a las condiciones favorables del suelo en que funciona, apropiado para toda clase de experimentación.

Además de ofrecer datos sobre la explotación racional y económica del campo fomenta la conservación del suelo por medio de la utilización adecuada de los bosques existentes y la plantación de nuevos arbolados en aquellos suelos que sólo se adaptan para tal fin. Para facilitar esta labor de conservación la Estación reparte gratuitamente entre los agricultores arbolitos forestales tales como caoba, eucaliptos, cañafístolos, bracatingas, casuarinas, ceiba, etc.

El Caribbean Forester desea que la Estación vaya progresivamente logrando sus diversos objetivos.

NOTAS SOBRE LA NOMENCLATURA DE ALGUNAS PALMAS CUBANAS

J. P. Carabia
Cuba

Copernicia macroglossa Wendl. ex Becc. emend. León, Rev. Soc. Geogr. Cubana 4(2): 41. 1931.- C. macroglossa Wendl., Kerch. Palm. 241. 1878. (nomen).- C. macroglossa Wendl. ex Becc., Webbia 2:177. 1907 (pro parte).- C. burretiana León, Mem. Soc. Cubana, Felipe Poey. 10:208. 1936.

Discusión

El artículo 64 de las Reglas Internacionales de Nomenclatura Botánica dice: "El nombre de un grupo taxonómico debe ser rechazado si los caracteres de ese grupo proceden de dos o más elementos discordantes, especialmente si esos elementos fueron erróneamente interpretados como parte del mismo individuo". Discutir sobre éste u otros artículos de las Reglas Internacionales de Nomenclatura Botánica, sería acrimonioso y si llamo la atención sobre el presente artículo, es porque éste, a pesar de ser bien conocido entre los botánicos sistemáticos, casi nunca es aplicado y mucho menos después que el binomio en discusión haya sido enmendado satisfactoriamente. Cualquier persona que consulte monografías y otros artículos sobre nomenclatura botánica, notará rápidamente que el dicho artículo 64 raramente es tomado en consideración, y por el contrario, es frecuente encontrar especies enmendadas cuando los binomios originales fueron basados en el producto de una mezcla. Esta actitud fué la seguida por el mismo autor de Copernicia burretiana León en 1931, cuando propuso simultáneamente Copernicia torreana León y C. macroglossa Wendl. emend. León 1/. Si esta práctica no se siguiera, pocos binomios Linneanus podrían ser usados y en lo que respecta a Cuba, podemos decir que una gran parte de los binomios de Grisebach, publicados en su mayor parte en el Cat. Pl. Cub., 1866, pasaría a la sinonimia, pues bien conocido es el hecho, que el material de Wright, con el cual Grisebach propuso muchas especies, es desafortunadamente el producto de una mezcla.

Para evitar la enorme confusión que podría traer la aplicación del artículo 64, aumentando los binomios y sinonimias existentes y por tanto estableciendo una falta de orden en nuestra nomenclatura botánica, somos del parecer que por el presente y hasta que dicho artículo 64 se aclare, se conserven todos aquellos binomios originales basados en una mezcla, aplicando éste a la mejor parte del material tipo, siempre que la parte más importante de la descripción corresponda a una de las partes del material, lo cual es de esperarse; simultáneamente se debe proponer un nuevo binomio para el resto del material, si es que éste lo permite. En otras palabras, creemos que lo práctico y correcto en estos casos es conservar el binomio original para esa parte del tipo de donde se ha tomado la descripción de la flor y fruto, o en casos

1/ León, Hermano, Contribución al Estudio de las Palmas de Cuba, Rev. Soc. Geogr. Cubana 4(2): 10-11. 1931.

especiales, la descripción de las partes vegetativas, si es que éstas son muy características. El resto del material tipo será con el cual se establecerá el nuevo binomio y para el cual el autor tendrá más material que permita una descripción apropiada.

Acoelorraphe wrightii (Griseb. & Wendl.) Wendl. ex Becc., Webbia 2: 109. 1907.-Copernicia wrightii Griseb. & Wendl. in Griseb., Cat. Pl. Cub. 220. 1866.-Paurotis androsana O. F. Cook, Mem. Torr. Club 22:22. 1902.-Serenoa arborescens Sarg., Bot. Gaz. 27:90. 1899.-Acoelorraphe arborescens (Sarg.) Becc., Webbia 2:113. 1907.-Acoelorraphe wrightii var. novogeronensis Becc., Webbia 2:113. 1907-Paurotis wrightii (Griseb. & Wendl.) Britton, Torreya 8:239. 1908.-Acanthosabal caespitosa Prosch., Gard. Chron. ser. III 7: 91. 1925.

Discusión

De acuerdo con algunos autores, el género Acoelorraphe no fué legalmente publicado, opinión de la cual nosotros no participamos. En un reciente artículo, L. H. Bailey 2/ hace resaltar el hecho de que esa descripción del género Acoelorraphe es muy pobre, mencionando las propias palabras de Wendland, que dicen "Die Beschreibung dieser neuen Battung soll in Kurzem nachfolgen". Además, Bailey alega que la falta en designar un nombre específico y el no mencionar la localidad de dicha palma es suficiente para no reconocer el valor de ese género.

El artículo 42 de las Reglas Internacionales de Nomenclatura Botánica, dice, "Un nombre genérico no es válidamente publicado si no está acompañado por una descripción del género"; en otras palabras un género publicado con su descripción, es legalmente publicado y a pesar de que leemos todas las otras reglas y recomendaciones que pudieran afectar la legitimidad de un género, no encontramos nada que altere lo antes dicho en el artículo 42. Por esta razón, estimamos que el género Acoelorraphe Wendl., fué legalmente publicado en Bot. Zeit. 37(10) : 147. 1879., donde encontramos una llave analítica para las palmas afines al género Sabal y de donde entresacamos los siguientes párrafos que afectan al género Acoelorraphe: "Márgenes de los pecíolos cubiertos de espinas - Lámina de las hojas partidas en el nervio de unión de los segmentos - Los segmentos no se prolongan hasta el raquis - Lámina de la hoja más o menos de forma circular - El raquis de las hojas se hace breve en contacto con el limbo - Pecíolos con los bordes poco espinosos - Los nervios secundarios no libres a lo largo del ápice de las hojas - La base de los nervios y nervios principales de las hojas sin espinas - Márgenes de las hojas y lóbulos desnudos (sin lana), lígula delgada seca." A esta descripción podemos agregar el nombre del género Acoelorraphe, que es por sí descriptivo y significa, semillas con un hueco.

No dejamos de considerar la opinión de Bailey y en realidad este género fué publicado de una forma muy informal, no obstante, la validez del

2/ L. H. Bailey, Acoelorraphe vs. Paurotis, Gentes Herbarium 4(10): 361-365. 1940.

género no fué afectada. Es notable el descuido de Wendland al no proponer un nombre específico ni mencionar la localidad de esa palma; no obstante, todos sabemos que ese autor se refería a una palma de Cuba y la cual, él con Grisebach, habían publicado anteriormente como Copernicia wrightii. Este asunto sobre la identidad del género Acoelorraphe fué aclarado hace tiempo por Beccari, cuando este autor publicó la combinación Acoelorraphe wrightii en Webbia 2:108. 1907. Según el mismo Bailey, el material original en que Wendland se basó para proponer el género Acoelorraphe se encuentra en Europa y ha sido examinado por Beccari y Burret.

Acrocomia crispa (H.B.K.) C. F. Baker ex Becc., Pomona College Jour. Econ. Bot. 2:364. 1912.-Cocos crispa H.B.K., Nov. Gent. et Sp. Pl. 1:302. 1815.-Acrocomia cubensis Lodd. ex Wendl., Ind. Palm. Cycad. 1. 1854. - Gastrococos armentalis Morales in Poey Repert. 1:57. 1866. Astrocaryon armentalis (Morales) Wendl. ex Sauvalle, Anal. Acad. Cienc. Habana 7:563. 1871.- Astrocaryon crispa (H.B.K.) Maza, Noc. Bot. Sist. 50. 1893.- Acrocomia armentalis (Morales) Bailey, Gentes Herb. 4:462. 1941.

Discusión

Esta especie fué publicada por Humboldt, Bonpland y Kunth como perteneciente al género Cocos, en el Nova Genera et Species Plantarum vol. 1, p. 302. 1815., y la descripción de la misma dice: "Cocos caudice ventricoso, inermis; frondibus pinnatis; foliolis lanceolato-linearibus, apice crispis - Palma barrigona incolarum - Crescit in insula Cubae inter Havanam et Regla. h..- Fructificat Februario.-Caudex quadri-aut sexorgyalis, ventricosus, inermis. Frondes pinnatae; foliolis lanceolato-linearibus, approximatis, apice crispis. Spadix semiorgyalis, Calyx sexpartitus; laciniis tribus exterioribus majoribus. Drupa sphaerica, depressa; matura flava, unilocularis, monosperma; nuce trigona, supra angulus perforata".

Es indudable que con esta descripción podríamos fácilmente identificar una palma cubana conocida como Acrocomia crispa, y si fuéramos a la propia localidad señalada por los autores, casi seguro, que encontraríamos las mismas palmas donde Humboldt colectó el material tipo. El argumento usado por Bailey al proponer una nueva combinación para dicha especie (op. cit), fué el mismo argumento de Morales para proponer el binomio Gastrococos armentalis y lo cual es una errónea interpretación de la descripción original.

Como he dicho anteriormente, esa descripción se adapta perfectamente a una palma conocida como Acrocomia crispa, y el argumento usado sobre la altura de la palma, es desafortunadamente un error, pues la descripción dice con respecto a la altura, "caudex quadri-aut sexorgyalis"; lo cual quiere decir, la altura de cuatro o seis hombres (un orgalis es igual a seis pies). Sobre el asunto de que la palma fué descrita como inermis, no tenemos tampoco la menor duda, pues palmas de esa altura son bastante viejas y generalmente inermis en su base. No creemos sea necesario prolongar esta discusión, pues la descripción original se adapta perfectamente a esa palma, Acrocomia crispa (H.B.K.) C. F. Baker.

(Translation of previous article)

NOTES ON THE NOMENCLATURE OF SEVERAL CUBAN PALMS

Copernicia macroglossa Wendl. ex Becc. emend. León, Rev. Soc. Geogr. Cubana 4(2) : 41. 1931.- C. macroglossa Wendl., Kerch. Palm. 241. 1878. (nomen). - C. macroglossa Wendl. ex. Becc., Webbia 2:177, 1907 (pro parte). - C. burretiana León, mem. Soc. Cubana, Felipe Poey. 10:208. 1936.

Discussion

Article 64 of the International Rules on Botanical Nomenclature states that: "The name of a taxonomic group must be rejected if the characters of that group were derived from two or more entirely discordant elements, especially if those elements were erroneously supposed to form part of the same individual". To discuss this or any other article of the International Rules on Botanical Nomenclature would be bothersome and I only mention this particular article due to the fact that although widely known among systematic botanists, it is almost never taken into consideration, even less so after the binomial has been satisfactorily amended. Anyone who consults monographs or any other paper on botanical nomenclature will notice at once that article 64 is but rarely taken into consideration and, on the contrary, it is frecuent to find amended species whose original binomials were based on a combination. This same attitude was followed by the author of Copernicia burretiana León, in 1931 when he proposed simultaneously Copernicia torreana León and C. macroglossa Wendl. emend. León. If this practice were followed, few Linnean binomials would be used and as regards Cuba, we may add that a large part of Grisebach's binomials, published mostly in Cat. Pl. Cub., 1866 would in this way be regarded as synonyms for it is widely known that Wright's material as used by Grisebach to propose many new species is unfortunately the result of a combination.

To avoid confusion that may start from applying article 64 thru increasing binomials and synonyms and thus creating disorder in our systematic nomemclature it seems advisable at present and until said article 64 is clarified, to retain all those original binomials based on a combination, ascribing it to the best part of the type specimen, as long as the most important part of the descriptions corresponds to one of the parts of the material, which is certainly to be expected; simultaneously, a new binomial should be proposed, if possible, for the rest of the material. In other words, we think that it is practical and correct in these cases to retain the original binomial for that part of the specimen corresponding to the description of the flower and fruit or in special cases to the description of vegetative parts if these be very characteristic. The rest of the type specimen may then be used to establish the new binomial for which the author should have more material for a complete and adequate description.

Acoelorraphe wrightii (Griseb. & Wendl.) Wendl. ex Becc., Webbia 2 : 109. 1907.- Copernicia wrightii Griseb. & Wendl. in Griseb., Cat. Pl. Cub. 220. 1866.- Paurotis androsana O. F. Cook, Mem. Torr. Club 22:22. 1902.-

Serenoa arborescens Sarg., Bot. Gaz. 27:90. 1899.- Acoelorraphe arborescens (Sarg.) Becc., Webbia 2:113. 1907.-Acoelorraphe wrightii var. novogeronensis Becc., Webbia 2:113. 1907.- Paurotis wrightii (Griseb. & Wendl.) Britton, Torreya 8:239. 1908.- Acanthosabal caespitosa Prosh., Gard. Chron. ser. III 7:91. 1925.

Discussion

According to several authors genus Acoelorraphe was not legally published, opinion which we do not share. In a recent article L. H. Bailey points out the fact that the description of genus Acoelorraphe is very poor and mentions Wendland's textual words "Die Beschreibung dieser neuen Gattung soll kurzem nachfolgen". Besides, Bailey asserts that failure to designate a specific name and omission of the locality of that palm is sufficient reason for not recognizing the validity of this genus.

Article 42 of the International Rules on Botanical Nomenclature states that: "A name of a genus is not validly published unless it is accompanied by a description of the genus"; in other words, a genus published with its description is legally published and on reading all other rules or recommendations dealing with the validity of a genus we find nothing whatsoever that may alter article 42. For this reason, we believe that genus Acoelorraphe Wendl. was legally published in Bot. Zeit. 37(10): 147. 1879., where we find an analytical key to all-palms allied to genus Sabal and from which we quote the following lines refering to genus Acoelorraphe: Margins of petioles covered with spines - Leaf-blades parted at the vein uniting the segments - segments not reaching rachis - leaf-blade somewhat orbicular - leaf-rachis tapering from base, petioles with few spines on margins, secondary veins not free near leaf apex - base of veins and midrib without spines - leaf-blade and lobe margins naked (not pubescent), thin, dry ligule. To this description we may add that the descriptive generic name Acoelorraphe means seed with a hole.

We do not fail to consider Bailey's opinion since, certainly, this genus was published in a rather informal way, nevertheless its validity was not affected. Wendland's failure to propose a specific name and to mention the locality of this palm is rather surprising; nevertheless we all know that he was referring to a Cuban palm which he had published previously with Grisebach as Copernicia wrightii. This matter over the identity of Acoelorraphe was made clear by Beccari when he published the combination Acoelorraphe wrightii in Webbia 2:108. 1909. As Bailey himself says, the original material used by Wendland to propose genus Acoelorraphe is in Europe and has been examined by Beccari and Burret.

Acrocomia crispa (H.B.K.) C. F. Baker ex. Becc., Pomona College Jour. Econ. Bot. 2:364. 1912.- Cocos crispa H.B.K., Nov. Gen. et Sp. Pl. 1:302. 1815.-Acrocomia cubensis Lodd. ex. Wendl., Ind. Palm. Cycad. 1. 1854.- Gastrococos armentalis Morales in Poey Repert. 1:57. 1866.- Astrocaryon armentalis (Morales) Wendl. ex. Sauvalle, Anal. Acad. Cienc. Habana 7:563. 1871.- Astrocaryon crispa (H.B.K.) Maza, Noc. Bot. Sist. 50. 1893.- Acrocomia armentalis (Morales) Bailey, Gentes Herb. 4:462. 1941.

Discussion

This species was published as pertaining to genus Cocos by Humboldt, Bonpland, and Kunth in Nova Genera et Species Plantarum vol. I, p. 302. 1815., and the description states: "Cocos caudice ventricoso, inermis; frondibus pinnatis; foliolis lanceolato-linearibus, apice crispis - Palma barrigona incolarum - Crescit in insula Cuba inter Havanam et Regla. h. - Fructificat Februario.- quadriaut sexorgyalis, ventricosus, inermis. Frondes pinnatae; foliolis lanceolato-linearibus, approximatis, apice crispis. Spadix semiorgyalis, Calyx sexpartitus; laciniis tribus exterioribus majoribus. Drupa sphaerica, depressa; matura flava, unilocularis, monosperma; nuce trigona, supra angulos perforata".

No doubt that with this description we can easily identify a Cuban palm known as Acrocomia crispa and if we go to the locality mentioned by the authors we would, almost for sure, find these palms where Humboldt collected his type specimen. The argument used by Bailey to propose a new combination for this species (op. cit) was the same one presented by Morales when he proposed the binomial Gastrococos armentalis, and which is an erroneous interpretation of the original description.

As I said before the original description suits the palm known as Acrocomia crispa perfectly and the argument against it regarding height is an error since the description says "caudex quadri-aut sexorgalis" which means the height of four or six men (an orgalis is equal to six feet). On the subject that the palm was described as "inermis" we have no doubt about it being that way since palms that high are rather old and generally unarmed. We do not think it necessary to prolong this discussion, since the original description fits perfectly to this palm Acrocomia crispa (H.B.K.) C. F. Baker.

Résumé

L'auteur veut démontrer dans cet article que le nom scientifique Copernicia macroglossa Wendl. doit être conservé car on ne doit pas rejeter les binômes originaux comme l'a fait l'auteur de Copernicia burretiana León. Cette attitude jetera la confusion et le bouleversement sans avantages dans la nomenclature botanique.

Carabia défend aussi la cause du nom Acoelorraphe wrightii pour le palmier cubain en se basant sur le fait que la description de Wendland était correcte et pour cela le nom a été valablement publié.

L'auteur considère que le binôme Acrocomia crispa (H. B. K.) C. F. Baker doit être conservé. La proposition d'un binôme nouveau pour cette essence manque de fondement car la description originale était correctement employée.

COMENTARIOS SOBRE EL ARTICULO DE J. P. CARABIA: "NOTAS SOBRE LA NOMENCLATURA DE ALGUNAS PALMAS CUBANAS"

Hermano León
Director Colegio La Salle
Habana, Cuba

En la primera parte de su artículo, Carabia pasa a la sinonimia Copernicia burretiana, establecida en mi "Segunda Contribución al estudio de las Palmas de Cuba", publicada en las Memorias de la Sociedad Cubana de Historia Natural (no Soc. Cubana Felipe Poey, como dice Carabia), y vuelve al status adoptado por mí en mi "Primera Contribución": C. macroglossa Wendl. ex Becc. emend. León, publicada en la Revista de la Sociedad Geográfica de Cuba (no Rev. Soc. Geogr. Cubana, como dice Carabia). Doy a continuación un breve resumen del asunto.

En mi estudio del género Copernicia, había observado que el binomio Copernicia macroglossa Wendl. estaba basado en una mezcla de dos especies distintas, la una con hoja peciolada, la otra representada por la inflorescencia, pero con hoja sin pecíolo. En las Reglas Internacionales de Nomenclatura, adoptadas por el Congreso de Cambridge (1930), encontramos el art. 64 referente al caso, y dice: "El nombre de un grupo taxonómico debe ser desechado, cuando los caracteres de este grupo fueren derivados de dos elementos enteramente discordantes, especialmente si el autor supuso erróneamente que aquellos elementos formaban parte del mismo individuo". El mismo art. 64 llama "nomina confusa" los nombres desechados por esta razón. A pesar de ésto, en el caso que nos ocupa, primeramente pensé, como otros botánicos en tal caso, que para salvar la claridad, era suficiente establecer un binomio nuevo para una de las dos especies y conservar el binomio original para la otra, y así lo hice: la especie sin pecíolos se llamó C. torreana, y la especie con pecíolos C. macroglossa emend. Posteriormente, habiendo encontrado la localidad de la especie con pecíolos, - desconocida hasta entonces - recolecté buen material, y pude comparar flores frescas de ambas especies. Además, habiendo pedido un ejemplar isotipo, al Gray Herbarium si recuerdo bien, noté una segunda mezcla, es decir, inflorescencias de ambas especies en la misma hoja de herbario, aumentando así la confusión. Habiendo preguntado al Dr. Burret si también había esta nueva confusión en el tipo existente en el Jardín Botánico de Dahlem, me contestó afirmativamente, y es cuando me decidí a aplicar del todo el art. 64, desechando el binomio C. macroglossa como "nomen confusum", no sin tener la aprobación del citado Dr. Burret, palmólogo de fama mundial, quien aceptó que el nuevo binomio C. burretiana le fuera dedicado, estando lejos de pensar que habría alguien para reducir dicho binomio a la sinonimia. De modo que, en esta primera parte del artículo de Carabia, se da el caso insólito, quizás nuevo en nomenclatura, de pasar a la sinonimia un nombre específico, por haber sido establecido de completo acuerdo con las reglas vigentes, como lo es el art. 64.

En la segunda parte de su artículo, Carabia trata de demostrar la validez del género Acoelorrphe H. Wendl., en contra de Paurotis O. F. Cook.

Esta cuestión ha sido discutida y bien aclarada por Beccari en "The Palms Indigenous to Cuba", Pomona College Journal of Economic Botany, Vol. III, I, p. 391 (no en Webbia como está indicado en el artículo que se comenta); en Webbia es donde Beccari publicó la combinación de Wendland, Acoelorrhaphe wrightii. En Gentes Herbarum (no Herbarium de Carabia) 4. 10. 361. 1940, Bailey defiende la validez de Paurotis O. F. Cook. Ahora, cualquier botánico que necesite referirse a este género de palmas puede escoger entre la opinión de Beccari y la de Bailey. Es muy admisible que Carabia nos dé su opinión personal, y es muy posible que tenga razón en este problema de difícil solución.

La tercera parte del artículo de Carabia, tampoco carece de interés; en ella pasa a la sinonimia el recién establecido nombre del "corojo" corriente de Cuba, Acrocomia armentalis (Morales) Bailey, volviendo al nombre usado anteriormente A. crispa (H. B. K.) C. F. Baker ex Becc.

Humboldt y Bonpland dicen haber visto la palma que describe Kunth entre La Habana y Regla, y que los cubanos la llaman "palma barrigona". Varios botánicos desde entonces, entre ellos J. A. Shafer y los botánicos actuales trataron de encontrarla en el lugar indicado, pero sin éxito, aunque la palma discutida no deja de crecer en otros lugares de las cercanías de la capital. S. A. Morales quien estudió a fondo este asunto, afirma que nunca hubo corojales entre La Habana y Regla. Carabia no se cercioró de ello personalmente, sin embargo, nos dice que si fuéramos a aquel lugar, ¡casi seguro! encontraríamos dicha palma. En cuanto al nombre vernacular "palma barrigona", pertenece a una especie de otro género, y hace poco menos de un siglo, Pichardo, en su Diccionario Provincial de Voces Cubanas, dijo que en toda la Isla, la palma en cuestión se llama corojo. Sea lo que fuere de la localidad y del nombre vulgar, para que un binomio sea válido, debe ir acompañado de una descripción, que, por supuesto, pueda aplicarse a la especie de que se trata, lo cual no sucede en la descripción de Kunth, a pesar de que Carabia afirma y repite que dicha descripción se aplica perfectamente al corojo común.

Bien es verdad, como lo hace constar Carabia, que los autores del "Nova Genera et Species Plantarum", I, 242, (1815), entre ellos Kunth, dan a la palma referida una altura de 4 a 6 brazas (quadri-aut sex orgyalis), pero, más tarde, Kunth en su "Enumeratio Plantarum...", III, 287, (1841), le da sólo 4 a 6 pies (4-6 pedalis). Sin duda, la medida que vale es la de la descripción original. ¿Cómo explicar tal disparidad de parte de un autor como Kunth? ¿Quizo rectificar la primera medida, o tenemos que atribuirlo a un lapsus? Quizás lo último sea lo más probable; no lo sabemos de fijo, y esta diferencia tan notable entre las dos medidas no hace sino agregar a la confusión que resulta de una descripción inexacta, si se quiere referirla al corojo corriente.

Dejando a parte, en la breve descripción original, los caracteres comunes a otras muchas especies de palmas, y concretándonos a los pocos que son más propios de la especie discutida, tenemos entre otros caracteres:

"Caudice...inerme".- El corojo común, en estado silvestre, crece por lo regular en colonias, con individuos, por supuesto, de todas edades, la mayoría espinosos. Lo propio del corojo no es de ser inerme, sino muy espinoso, "conspicuously spiny, until weathered by age", dice Bailey en su descripción del corojo; aún las hojas son espinosas, de modo que, el decir "caudice inerme" es dar una falsa idea del corojo; para ser exacta la descripción debía de haber observado que la mayoría de estas palmas son muy espinosas.

"Calyx 6-partitus", lacinias 3 esterioribus majoribus". - Por "calyx 6-partitus", Kunth se refiere al periantio, y dice que las 3 partes exteriores o cáliz son mayores, pero no toma la precaución de decirnos si se refiere al cáliz masculino o femenino. Es verdad que el cáliz de la flor femenina es un poco más largo que la corola, pero en la flor masculina ocurre todo lo contrario, los pétalos son mucho mayores y más largos que los sépalos, lo cual contradice la descripción y trae confusión.

"Drupa...depressa".- En realidad, con material en la mano, se puede decir, como lo afirma Morales, que el fruto es globoso, no deprimido, o a lo más "globose to depressed-globose" como dice Bailey.

"Nux trigona, supra angulos perforata".- En nuestros ejemplares de corojo común, la nuez no es trígona. Tenemos sí material de una especie de Camaguey, del género Acrocomia, probablemente no descrita, con el fruto más pequeño, y la nuez algo trígona, pero no perforada sobre los ángulos, los tres orificios se encuentran entre los ángulos, a igual distancia de ellos.

¿A que especie se refiere la descripción del "Nova Genera"? No lo sabemos. En Cuba existen muchas palmas exóticas y a menudo, se encuentran cultivadas en parques y jardines de la Habana, no sólo especies exóticas, sino también especies indígenas traídas del interior. Actualmente, en Cuba pueden verse cuatro especies si no más del género Acrocomia publicadas, sin hablar del material recolectado, de especies inéditas.

La descripción citada, no pudiendo referirse al corojo común, trata posiblemente de otra especie cultivada entre La Habana y Regla, y existen, a mi parecer, suficientes razones para considerar al "nomen dubium" Cocos crispa H.B.K. como "nomen confusum", y mantener en la sinonimia de Acrocomia armentalis (Morales) Bailey, el Acrocomia crispa C.F. Baker ex Becc.

(Translation from previous article)

COMMENTS ON J. P. CARABIA'S ARTICLE ON "NOTES ON THE NOMENCLATURE OF SEVERAL CUBAN PALMS"

In the first part of his article Carabia regards Copernicia burretiana, proposed in my "Second Contribution to the Study of the Cuban Palms", published in the Memoirs of the Sociedad Cubana de Historia Natural (not Soc. Cubana Felipe Poey as Carabia states), as a synonym and goes back to the name I adopted in my First Contribution; that is, C. macroglossa Wendl. ex Becc. emend. León, published in the Revista de la Sociedad Geográfica de Cuba (not Rev. Soc. Geogr. Cubana, as Carabia states). A brief summary of this case follows:

In my study of genus Copernicia I had noticed that the binomial Copernicia macroglossa Wendl. was based on a combination of two different species; one with petioled leaves, the other represented by the inflorescence but with sessile leaves. In article 64 of the Rules of Nomenclature adopted by the Cambridge Congress (1930), referring to one such case states that: The name of a taxonomic group must be rejected if the characters of that group were derived from two or more entirely discordant elements, especially if those elements were erroneously supposed to form part of the same individual". That same article refers to these names to be abandoned for the above-mentioned reason as "nomina confusa". At first I thought, as other botanists have done before, that in the present case, for the sake of clearness, the best thing to do was to establish a new binomial for one of the species and conserve the original for the other. This I did; the sessile species took the name of C. torreana and the petioled species the name of C. macroglossa emend. Later, upon finding the locality of the petioled species - unknown till then - I collected good material and was able to compare fresh flowers of both species. Besides, I asked the Gray Herbarium, if my memory does not fail me, for an isotype specimen and I noticed a second combination; that is, inflorescences of both species in the same herbarium sheet, thus adding to the confusion. Having asked Dr. Burret if that new confusion as regards the type existed in the Botanical Garden at Dahlem he answered in the affirmative and it was then that I decided to apply Article 64 wholly, rejecting binomial C. macroglossa as a "nomen confusum" not without first obtaining the approval of Dr. Burret, a palm specialist of recognized world standing, who accepted the new binomial C. burretiana to be named after him, never imagining that someone would later relegate it to the rank of a synonym. Therefore, in the first part of Carabia's article an unusual thing happens, perhaps new to nomenclature, where a specific name established in absolute accordance with a rule in force, namely art. 64. is regarded as a synonym.

In the second part of his article Carabia tries to demonstrate the validity of genus Acoelorraphe H. Wendl., against Paurotis O. F. Cook. This subject was fully discussed and made clear by Beccari in "The Palms Indigenous to Cuba", Pomona College Journal of Economic Botany Vol. III, I, p. 391 (not in Webbia as indicated in the article); it was in Webbia where Beccari published Wendland's combination, Acoelorraphe wrightii. In Gentes Herbarum (not Herbarium) 4. 10. 361. 1940, Bailey defends the validity of Paurotis O. F. Cook. Now then, any botanist referring to this palm genus may choose between Beccari's and Bailey's opinion. It is admissible for Carabia to give his personal opinion and it is most possible that he be right in this difficult problem.

The third part of Carabia's article is also not devoid of interest; for there he relegates the newly established name of Cuba's common "corojo", Acrocomia armentalis (Morales) Bailey to a synonym category, going back to the old A. crispa (H.B.K.) C. F. Baker ex Becc.

Humboldt and Bonpland stated that they had seen the palm described by Kunth, between Havana and Regla and that Cubans call it "palma barrigona". Since then several botanists, J.A. Shafer among them, and contemporary botanists have tried to locate it in that place without success, even though the palm in question grows in other places in the vicinity of the capital city. S.A. Morales, who has studied this matter thoroughly, asserts that "corojales" were never found between Havana and Regla. Carabia did not check this personally, and yet he says that if we were to go to that place, we would find that palm, almost for sure! As regards the vernacular name "palma barrigona", it belongs to a species from a different genus, and less than a century ago, Pichardo in his "Provincial Dictionary of Cuban Terms" stated that all through the island the palm in question was known as "corojo". Be the locality and common name as it may, in order to be valid, a binomial must be accompanied by a description that of course, must apply to the species dealt with, which is not the case with Kunth's description, although Carabia asserts and repeats that said description applies perfectly to the common "corojo".

It is true, as Carabia asserts, that the authors of "Nova Genera et Species Plantarum", I, 242, (1815), Kunth among them, refer to that palm as being 4-6 fathoms (quadri aut sex orgyalis), but later, in his "Enumeratio Plantarum...", III, 287, (1841) he states only 4-6 feet (4-6 pedalis). No doubt, the original measurement is right. How could one explain such a discrepancy in an author like Kunth? Was he trying to correct his previous measurement or must we attribute it to a "lapsus"? The latter is most probable but we do not know for sure, and this remarkable difference adds to the confusion of an already inaccurate description if one wants to refer it to the common "corojo".

In the brief original description, aside from the common characteristics peculiar to many palms and confining this discussion to those few peculiar traits typical to this species we may review the following;

"Caudice...inerme". - The common "corojo" usually forms colonies containing all-aged individuals, most of them spiny. As a rule, the "corojo" is not unarmed but very spiny as confirmed by Bailey; "most conspicuously spiny, until weathered by age"; and even the leaves are spiny. Therefore, to attribute to this palm a "caudice inerme" is to give an erroneous idea about the species; in order to be exact the description ought to have stated that most of these palms are very spiny. "Calyx 6- partitus, lacinias 3 exterioribus majoribus":- By "Calyx 6- partitus", Kunth is referring to the perianth, stating that the 3 external parts (or calyx) are greater but fails to explain if he is referring to the masculine or the feminine calyx. It is true that the calyx of the feminine flower is somewhat larger than the corolla but in the masculine flowers the contrary happens, the petals are larger and longer than the sepals; fact that contradicts this statement of the description and creates confusion.

"Drupa...depressa". - Verifying against good material at hand and as Morales asserts, the fruit is found to be globose not depressed, and at most, "globose to depressed-globose" as Bailey says.

"Nux trigona, supra angulos perforata". - In our specimens of common "corojo", the nut is not trigonoid. We do have material from a species in Camagüey belonging to genus Acrocomia, probably never described, whose fruit is smaller and the nut somewhat trigonoid, not perforated over the angles but between them and equidistant from them.

To what species does this description in "Nova Genera" correspond? We do not know. In Cuba there are many exotic palms, and often, not only exotic palms are cultivated in parks and gardens at Havana but some native brought from the interior. At present, four species and maybe more have been published belonging to the genus Acrocomia, from Cuba, and there are many specimens collected but as yet unpublished. Since the above-mentioned case cannot be referred to common "corojo", perhaps it does refer to another species under cultivation between Havana and Regla, and to my best knowledge, there are sufficient grounds on which to consider "nomen dubium"? Cocos crispa H.B.K. as "nomen confusum" and retain Acrocomia crispa C. F. Baker ex Becc. as a synonym under Acrocomia armentalis (Morales) Bailey.

Résumé

Dans cet article le frère León défend la cause du nom Copernicia burretiana León que Carabia a consideré comme un synonime de Copernicia macroglossa Wendl. Il argumente que selon les études qu'il a fait le nom de Copernicia macroglossa a été tiré de deux essences différentes et pour cela doit être rejeté comme "nomen confusum". Par conséquent il adopta le nouveau binôme Copernicia burretiana León pour désigner cette essence. Il expose aussi les motifs qui plaident contre la conservation du genre Acoelorraphe H. Wendl. et suggère que Paurotis O. F. Cook doit être adopté. L'auteur croit que la nomenclature d'Acrocomia armentalis (Morales) Bailey n'est encore clarifiée mais ajoute au'Acrocomia crispa C. F. Baker doit être considerée comme synonime.

THE CARIBBEAN FORESTER

El "Caribbean Forester", que se comenzó a publicar en julio de 1938 por el Servicio Forestal del Departamento de Agricultura de los Estados Unidos, es una revista trimestral gratuita dedicada a encauzar el mejor aprovechamiento de los recursos forestales de la región del Caribe. Su propósito es estrechar las relaciones que existen entre los científicos interesados en la Dasonomía y ciencias afines exponiéndoles los problemas confrontados, las políticas forestales vigentes, y el trabajo realizado hacia la culminación de ese objetivo técnico.

Se solicitan contribuciones de no más de 20 páginas escritas en maquinilla. Deben ser sometidas en el lenguaje vernáculo del autor, con el título o posición que éste ocupa. Es imprescindible también incluir un resumen corto del estudio efectuado. Los artículos deben dirigirse al "Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, P. R."

The Caribbean Forester, published since July 1938 by the Forest Service, U. S. Department of Agriculture, is a free quarterly journal devoted to the encouragement of improved management of the forest resources of the Caribbean region by keeping students of forestry and allied sciences in touch with the specific problems faced, the policies in effect, and the work being done toward this end throughout the region.

Contributions of not more than 20 typewritten pages in length are solicited. They should be submitted in the author's native tongue, and should include the author's title or position and a short summary. Papers should be sent to the Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, Puerto Rico.

Le "Caribbean Forester", qui a été publié depuis Juillet 1938 par le Service Forestier du Département de l'Agriculture des Etats-Unis, est un journal trimestrel de distribution gratuite dedié à l'encouragement du ménagement rationnel des forêts de la région caraïbe. Son but est entretenir des relations scientifiques de ceux qui s'intéressent aux Sciences Forestières, ses problèmes et systèmes mis à jour, avec les travaux faits pour réaliser cet objectif d'amélioration technique.

On sollicite des collaborations de pas plus de 20 pages écrites à machine. Elles doivent être écrites dans la langue maternelle de l'auteur en comprennant son titre ou position professionnel et un résumé de l'étude. Les articles doivent être adressés au "Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, Puerto Rico".


UNITED STATES
ATLANTIC
OCEAN
GULF OF
MEXICO
MEXICO
BAHAMA
ISLANDS
CUBA
JAMAICA
HAITI
DOMINICAN
REPUBLIC
PUERTO
RICO
GUADELOUPE
DOMINICA
MARTINIQUE
STA. LUCIA
TRINIDAD
BRITISH
HONDURAS
CARIBBEAN SEA
HONDURAS
GUATEMALA
SALVADOR
NICARAGUA
COSTA
RICA
PANAMA
VENEZUELA
BR.
GUIANA
COLOMBIA
PACIFIC
OCEAN

U.S.F.S., W.O.-1944

The Caribbean Forester

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TROPICAL FOREST EXPERIMENT STATION
RIO PIEDRAS, PUERTO RICO

VOL. 6, NO. 4

JULY 1945

CONTENTS

A NEWLY STATED PUBLIC FOREST LAND POLICY FOR PUERTO RICO

The Government of Puerto Rico, as early as 1917, enacted and put into effect a comprehensive Forest Law, which was improved by amendments in 1921. It created the Puerto Rico Forest Service in the Department of Agriculture and Commerce and in addition, set up the general conditions and broad objectives under which and by which the Insular Forests were to be created, administered, managed, and utilized by the Forest Service under the direction of the Commissioner of Agriculture and Commerce.

Section 4, Subsection 8 thereof provides that it shall be the duty of the Commissioner of Agriculture and Commerce to make rules and regulations and to amend the same from time to time, in his discretion, "for and concerning the activities of the Service as a whole and the administration, preservation, protection, extension, occupancy and use of the forests and forest-reserve areas, and of the timber, wood, and other forest products and resources thereon in particular".

Pursuant to that section, the Commissioner of Agriculture and Commerce, the Honorable Luis A. Izquierdo, has recently issued as an up-to-date official directive to the Chief of the Insular Forest Service, a Statement of Policy and Objectives Governing the Forest Lands Belonging to The People of Puerto Rico. This Statement is quoted in full below for the information of the readers of The Caribbean Forester.

* * *

STATEMENT OF POLICY AND OBJECTIVES
GOVERNING THE FOREST LANDS OF THE PEOPLE OF PUERTO RICO

The Commissioner of Agriculture and Commerce, pursuant to the authority vested in him by the Forest Law (Act No. 22 approved November 22, 1917 as amended by Act No. 8 approved April 27, 1921), hereby declares that the Insular Forest Service, shall, under his general direction and supervision, administer, protect, develop, manage, and promote the utilization of the forest lands, now owned by the People of Puerto Rico and those hereafter to be acquired, and designated as Insular Forests, in accordance with the following prescribed policies and objectives, until and unless modified, revoked, or suspended by the Commissioner.

GENERAL FOREST POLICY

Insular Forests

All timber and lands within the Insular Forests, now or to be established, shall be dedicated and used for their highest purpose and shall be made to return to the people the greatest social benefits including maximum opportunities for local employment. To that end the Forest Service shall, within the limits of its available personnel and facilities, administer, protect, manage, and utilize the Forests so as to:

1. Provide at all times adequate protection from fire and all unauthorized use of timber, land, and other resources.

2. Assure proper protection to those watersheds which are valuable for power, irrigation, and domestic water supplies.

3. Employ all available practical and technical means to grow maximum amounts of forest products on a sustained yield basis and make them available for commercial and public use by sale or otherwise.

4. Establish a suitable forest cover on denuded and understocked lands through the operation of nurseries, field planting, and plantation care.

5. Authorize, under formal permit, the occupancy or use by individuals or others of those parcels of land within the Forests which in the discretion of the Forest Service are more valuable for purposes other than the growing of timber and the protection of watersheds.

6. Provide protection to and encourage the maintenance of wildlife and fish within the Forests.

7. Take the initiative in examining, appraising, and negotiating with owners of those forest lands, adjoining or located near the present Insular forests, which are chiefly valuable for forest purposes and can be purchased within the current statutory limit per cuerda; and make appropriate recommendations to the Commissioner for their survey by the Department of the Interior, their acquisition by the People of Puerto Rico, and their subsequent addition to the present Insular forests.

Forestry Cooperation, Assistance, and Education

The forest Service shall, within the limits of its legal authority, available personnel and facilities,

1. Assume the leadership in forestry throughout Puerto Rico and its adjoining islands.

2. Assist and cooperate with private individuals and landowners in improving the productiveness of their forests and woodlands or the extension by tree planting of forest growth on waste and other lands, for wood production, for protection against soil erosion, as wildlife refuges, for shade and roadside beautification, and for other beneficial purposes; and in the same manner shall cooperate with other bureaus, departments, and institutions of the Insular Government, and with the various agencies of the Federal Government on all matters coming within the scope of the Forest Law.

3. Encourage public interest in forestry and in the proper protection, management and utilization of the forest lands both public and private through correspondence, periodicals, motion pictures, publications, and the delivery of lectures and talks before social, educational, and commercial gatherings, schools, and colleges.

Forest Investigations and Studies

The Forest Service shall cooperate with the Forest Service of the U. S. Department of Agriculture and participate within the limits of its personnel and facilities, in the conduct of research on all problems connected with the establishment, protection, management, and utilization of forests and forest lands in Puerto Rico.

PROTECTION OF THE FORESTS

Pursuant to Objectives 1, 2, and 6 of the General Forest Policy, the Forest Service shall, within the limits of its available personnel and facilities, set up and employ effective methods for the protection of the Forests from fire, damage to and unauthorized cutting of Timber or other woody growth, use and occupancy of forest land for any unauthorized purpose, the pasturing or grazing of livestock, illegal hunting and fishing, and of Government property from damage and theft, including monuments, markers, signs, etc., through such means as:

1. Demarcation of forest boundaries by clearing of vegetation, establishment of monuments, and posting of signs.

2. Regular patrol and policing of Forest lands to prevent trespass, fire, and other injurious and illegal acts.

3. Maintenance of tools and equipment for use in fighting forest fires.

4. Education of the public on all provisions of the Forest Law.

5. Denouncement and prosecution of all trespassers and other violators, under the Forest Law and the civil codes applicable to

public property, utilizing where necessary the services of the Legal Division of the Department.

6. Combating, where practical, any attacks of forest diseases and insects.

MANAGEMENT AND UTILIZATION OF TIMBER AND ARTIFICIAL REFORESTATION

Pursuant to Objectives 2, 3, and 4 of the General Forest Policy, the Forest Service shall, as rapidly as facilities are made available for the purpose, engage in surveys to determine the quantity and quality of the existing timber and woodland within present Insular forests, and of those lands in need of reforestation in whole or in part, and prepare and submit for the approval of the Commissioner comprehensive plans for the proper management and utilization upon a sustained yield basis of all existing forested lands and the reforestation of all denuded or understocked lands within the Insular forests which should be dedicated to the growing of forest products. Meanwhile and utilizing the most reliable technical data available on proper silvicultural management, forest utilization, and artificial reforestation, the Forest Service shall:

1. Encourage the sale of and shall sell to individuals, including artificial persons, such timber and other products of the forest as in the judgement of the Forest Service may be removed from the forest stand without injury to watershed values or to the future reproductive or growing capacity of the forest, or its rate of growth in quantity and quality, at stumpage rates to be approved by the Commissioner, but all sales whose value exceeds $300 shall first be advertised for bids in two newspapers.

2. Grant under free permit to deserving individuals, and to artificial persons not organized for profit, who reside in or near the Insular forests, or who are dependent thereon, for fuel and house and farm timbers, and solely for and not in excess of their personal and domestic needs, and not for resale, those classes of forest products whose removal from the forest will improve the quality and productive character of the remaining forest stand but the removal of which cannot be accomplished by sale as provided in paragraph 1 hereof; and in addition may grant free permits for like materials under similar conditions to public agencies where their use of the materials will be clearly of general public benefit.

3. Conduct timber stand improvement operations, to the extent that public funds are available for that purpose, in those forest stands which are in need of silvicultural improvement but from which the material that should be removed cannot be cut and disposed of through the sale or free use of forest products, as provided in paragraphs 1 and 2 hereof.

4. Shall engage in the collection, or procurement by other means, of forest tree seed and shall establish and maintain suitable forest tree nurseries on lands under its supervision, or under leases approved by the Commissioner and propagate therein forest tree seedlings and transplants for the purpose of:

   (a) Planting, or direct seeding, of understocked and denuded Insular forest lands.

   (b) Distribution to owners and tenants of farm land for establishing windbreaks, shelterbelts, and woodlots on denuded or non-forested farmlands in cooperation with the Agricultural Extension Service or other authorized Insular and Federal agencies pursuant to the cooperative agreement, under the Clarke-McNary and Norris-Doxey Acts, between the Commissioner of Agriculture and Commerce of Puerto Rico and the Secretary of Agriculture of the United States.

   (c) Growing and furnishing forest-tree, fruit-tree, and shade-tree seedlings and transplants to other Insular and Federal agencies, upon request and at their expense, for duly authorized reforestation, shade tree, and beautification projects.

5. Shall establish forest plantations on all denuded or otherwise non-productive lands within the Insular Forests which are dedicated to forest growing, and shall provide the necessary subsequent plantation care and maintenance.

Note: The term forest products as used in this section shall be considered as including any timber, wood, gum or other forest products, forage, stone, earth, or any other product on or being of the land except minerals.

MANAGEMENT AND USES OF LAND

Pursuant to Objectives 2 and 5 of the General Forest Policy, the Forest Service shall and as rapidly as facilities are made available for the purpose, engage in the necessary surveys and prepare a plan, for the approval of the Commissioner, for those lands within the Insular forests which are more valuable for the cultivation of food and cash crops, the production of natural forage for livestock, public recreation, or other public purposes. Meanwhile and utilizing the most reliable land-use data available, the Forest Service shall:

1. Grant to individuals, and to artificial persons not organized for profit, who reside within or are dependent upon, and who do not own land outside the Insular forests, the permission to reside on or occupy and use those lands determined to be suitable for the purpose in question without detriment to forest, soil, or watershed values, or the economical administration of the

Forests, under conditions to be prescribed and at reasonable charges as recommended by the Forest Service and approved by the Commissioner, said charges to be in the form of lawful money or, upon the specific request of and a showing of need by the individual, for an equivalent amount of labor on authorized Forest work (subject to the approval also of the Commissioner of Labor).

2. Have the authority to remove those individuals who are now residing on and cultivating parcels of land which in the discretion of the Forest Service are not suitable therefor without substantial injury to forest, soil and watershed values; provided, however, that the permittee shall be given a reasonable time in which to harvest his crops and to locate another residence or farm site in which the Forest Service shall render all possible assistance.

3. Provide, as funds are made available for the purpose, comfortable, economically constructed houses on those parcels within the Forests which can be cultivated for the growing of food crops continuously without injury to forest, soil, or watershed values; or at locations distant from established communities for laborers required in forest improvement work; and in addition assist in providing school buildings where now lacking in established forest communities.

4. Grant to public agencies the right to use or occupy Forest lands not in excess of their needs at reasonable charges to be determined upon in each individual case, or without charge if the benefits of said use or occupancy will accrue to the general public.

5. Survey, determine the values thereof, establish, and improve with the approval of the Commissioner, areas of high scenic and recreational values within the Insular forests for the free use of the public at large.

ACQUISITION OF FOREST LAND

Pursuant to Objective 7 of the General Forest Policy, the Forest Service shall take all steps necessary to the acquisition of additional forest lands, and in its surveys and appraisals of and in its recommendations to the Commissioner for the purchase of such lands, other conditions permitting, the Forest Service shall give preference to those forest lands which:

1. By reason of their topographic and geographic location, are necessary for the protection of watersheds above existing or proposed power, irrigation, and domestic water reservoirs.

2. Are now being injured, denuded, or destroyed by their present owners.

3. Either lie within, or adjoin, or are located near the boundaries of the present Insular Forests and can be economically protected and administered by present personnel and facilities.

4. Support timber of merchantable and saleable quality.

5. Provided said lands can be bought within the statutory limit per cuerda currently in effect.

(Traducción)

NUEVO ESBOZO DE LA POLITICA FORESTAL PUBLICA PARA PUERTO RICO

Ya en 1917 el gobierno de Puerto Rico había promulgado y puesto en vigor una Ley Forestal comprensible, mejorada posteriormente por las enmiendas hechas en 1921. El Servicio Forestal de Puerto Rico fué creado y adscrito al Departamento de Agricultura y Comercio por dicha ley que exponía también las condiciones generales y objetivos que debía cumplir, según los cuales los bosques insulares debían ser establecidos, administrados, ordenados y utilisados por el Servicio Forestal, bajo la dirección del Comisionado de Agricultura y Comercio.

El artículo 4, inciso 8 de dicha ley dispone que el Comisionado de Agricultura y Comercio debe formular las reglas y reglamentos y enmendarlos de tiempo en tiempo, a su discreción, "para los trabajos del servicio en general y para la administración, conservación, protección, extensión, ocupación y uso de los bosques y áreas de reserva forestal; de la madera de construcción, madera y otros productos forestales y riquezas sobre los mismos en particular."

En cumplimiento de ese artículo el Comisionado de Agricultura y Comercio, Hon. Luis A. Izquierdo, ha redactado recientemente una guía oficial al día dirigida al jefe del Servicio Forestal Insular exponiéndole las Normas y Objetivos que Rigen en lo Concerniente a las Tierras Forestales del Pueblo de Puerto Rico. Más abajo aparece dicha exposición que servirá de información a los lectores del Caribbean Forester.

* * *

EXPOSICION DE LAS NORMAS Y OBJETIVOS QUE RIGEN EN LO

CONCERNIENTE A TIERRAS FORESTALES DEL PUEBLO DE PUERTO RICO

El Comisionado de Agricultura y Comercio, con la autoridad que le confiere la Ley de Bosques (Ley Núm. 22 aprobada el 22 de noviembre de 1917 según fué enmendada por la Ley Núm. 8 aprobada el 27 de abril de

1921), por la presente declara que el Servicio Forestal Insular, bajo su superintendencia y dirección general, administrará, protegerá, desarrollará, dirigirá y fomentará la utilización de las tierras forestales que actualmente o en el futuro fueren propiedad del Pueblo de Puerto Rico y que han de ser denominadas Bosques Insulares, se regirán de acuerdo con las siguientes normas y objetivos, hasta tanto y a menos que sean modificadas, revocadas o suspendidas por el Comisionado.

POLITICA FORESTAL GENERAL

Bosques Insulares

Todas las tierras y la madera de los Bosques Insulares presentes o futuros deberá dedicarse a su uso óptimo y hacer que rinda al pueblo los mayores beneficios sociales, incluyendo oportunidades máximas de empleo local. A ese respecto el Servicio Forestal, dentro de los límites de su personal y facilidades disponibles, administrará, protegerá, dirigirá y utilizará los bosques a fin de:

1. Proporcionar en todo momento protección adecuada contra fuegos y todo uso desautorizado de los árboles, terrenos y demás recursos.

2. Asegurar la protección adecuada de las cuencas hodrográficas que surten energía, agua para riego y para abastecimiento doméstico.

3. Emplear todos los medios técnicos y prácticos disponibles para producir cantidades máximas de productos forestales a base de rendimiento continuo y hacerlos asequibles para uso comercial y público por medio de ventas o demás.

4. Establecer una cubierta forestal apropiada en tierras desnudas o de vegetación escasa, mediante el funcionamiento de viveros, siembra en el campo y cuidado de plantaciones.

5. Autorizar bajo permiso formal la ocupación o uso de aquellas parcelas dentro del Bosque, que a juicio del Servicio Forestal son de más valor para otros fines que el de producir madera o proteger cuencas hidrográficas.

6. Proporcionar protección a y fomentar la conservación de peces y vida silvestre dentro de los Bosques.

7. Tomar la iniciativa de examinar, tasar y negociar con los dueños de las tierras forestales que colindan con o se encuentran cerca de los Bosques Insulares actuales y que son valiosas para fines forestales y pueden comprarse al precio por cuerda establecido por ley; y hacer recomendaciones apropiadas al Comisionado para que estas tierras sean examinadas por el Departamento del Interior, adquiridas por el Pueblo de Puerto Rico y agregadas a los actuales Bosques Insulares.

Cooperación, Ayuda y Educación Forestal

El Servicio Forestal, dentro de los límites de su autoridad legal, personal y facilidades disponibles:

1. Asumirá la dirección de todo Puerto Rico e islas adyacentes en lo relativo a la dasonomía.

2. Ayudará y cooperará con los individuos particulares y terratenientes en cuanto a mejorar la productividad de sus bosques y arbolados o en la regeneración de terrenos baldíos o demás, por medio de la siembra o plantación para producir madera, proteger el suelo contra la erosión, servir de albergue a la vida silvestre, para sombra y embellecimiento de las carreteras y para otros fines beneficiosos; y de la misma manera cooperará con otros negociados, departamentos e instituciones del Gobierno Insular y con las diversas agencias del Gobierno Federal en todos los asuntos comprendidos en la Ley de Bosques.

3. Fomentará el interés público en la dasonomía y en la protección apropiada, ordenación y utilización de las tierras forestales tanto públicas como privadas por medio de correspondencia, periódicos, exhibiciones cinematográficas, publicaciones y conferencias dadas ante grupos sociales, educacionales y comerciales, escuelas y colegios.

Investigaciones y Estudios Forestales

El Servicio Forestal cooperará con el Servicio Forestal del Departamento de Agricultura de Estados Unidos y participará, dentro de los límites de su personal y facilidades, en la dirección de las investigaciones sobre los problemas relacionados con el establecimiento, protección, ordenación y utilización de los bosques y tierras forestales en Puerto Rico.

PROTECCION DE LOS BOSQUES

De acuerdo con los objetivos 1, 2 y 6 de la Política Forestal General, el Servicio Forestal, dentro de los límites de su personal y facilidades disponibles, organizará y empleará medios efectivos para la protección de los Bosques contra fuegos, daños y cortes desautorizados de árboles y demás vegetación arbórea, uso y ocupación de terreno forestal para cualquier fin desautorizado, pastoreo o apacentamiento del ganado, caza o pesca ilegal y protegerá la propiedad del gobierno incluyendo puntos de colidancia, indicadores, cartelones, etc., contra daño y robo por medio de:

1. Demarcación de linderos forestales mediante la remoción de la vegetación, el establecimiento de puntos de colindancia y la fijación de cartelones.

2. Patrullaje y servicio policíaco regular en tierras forestales para evitar transgresiones, incendios y otros actos perjudiciales e ilegales.

3. Conservación de herramientas y equipo necesario para combatir incendios forestales.

4. Educación del público sobre todas las disposiciones de la Ley de Bosques.

5. Denuncia y enjuiciamiento de todos los transgresores y demás contraventores, conforme a la Ley de Bosques y los códigos civiles sobre propiedad pública, utilizando en caso necesario los servicios de la División Legal del Departamento.

6. Combatir donde sea práctico, cualquier enfermedad o cualquier plaga de insecto forestal.

ORDENACION Y UTILIZACION DE MADERA Y REGENERACION ARTIFICIAL

De acuerdo con los objetivos 2, 3 y 4 de la Política Forestal General, el Servicio Forestal, tan pronto como se disponga de las facilidades necesarias, hará reconocimientos para determinar la cantidad y calidad de los bosques y arbolados existentes dentro de los actuales Bosques Insulares y de aquellas tierras que necesitan reforestarse total o parcialmente, y preparará y someterá para la aprobación del Comisionado, planes extensivos para la ordenación y utilización adecuada, a base de rendimiento continuo, de todas las tierras arboladas y para la reforestación de todas las tierras desnudas y escasas de vegetación dentro de los Bosques Insulares que deben dedicarse al cultivo de productos forestales. Mientras tanto y utilizando los datos técnicos fidedignos disponibles sobre la ordenación silvicultural apropiada, la utilización forestal y la regeneración artificial, el Servicio Forestal:

1. Fomentará la venta, y venderá a individuos, incluyendo personas jurídicas, a precios que habrán de ser aprobados por el Comisionado, aquella madera u otro producto del bosque que a juicio del Servicio Forestal pueda ser removido del rodal sin perjudicar el valor de las cuencas hidrográficas o la futura capacidad productiva o de crecimiento del bosque, o su índice de crecimiento en calidad y cantidad; pero todas las ventas de más de $300 deberán efectuarse mediante subasta que se anunciará previamente en dos periódicos.

2. Otorgará bajo permiso especial a individuos merecedores y a personas jurídicas que no tengan negocio establecido, que residan en o cerca de los Bosques Insulares o que dependan de ellos para combustible y madera y sólo para sus estrictas necesidades personales y domésticas y no para revender, aquellos productos forestales cuya remoción mejore la calidad y carácter productivo

del resto del rodal pero que no puedan removerse por venta de acuerdo con el párrafo Núm. 1. Además podrá otorgar permisos especiales por materiales parecidos bajo condiciones similares a agencias públicas, cuando el uso de tales materiales es de evidente beneficio público.

3. Llevará a cabo operaciones de mejora, hasta donde lo permitan los fondos públicos disponibles, en aquellos rodales que necesiten tratamiento silvicultural pero que debido a inaccesibilidad o falta de demanda no puede disponerse del material cortado ni por venta ni por concesión según estipulado en los párrafos 1 y 2.

4. Recogerá o conseguirá semilla de árboles forestales y establecerá y mantendrá viveros forestales apropiados en terrenos bajo su jurisdicción o bajo arrendamiento aprobado por el Comisionado para obtener semillones forestales y arbolitos de trasplante con el propósito de:

   (a) Plantar o sembrar directamente en tierras forestales insulares desnudas o escasas de vegetación.

   (b) Distribuir entre dueños o arrendatarios de terrenos agrícolas para establecer rompevientos y arboledas en terrenos denudados o baldíos, en cooperación con el Servicio de Extensión Agrícola u otras agencias insulares o federales autorizadas, en conformidad con el acuerdo cooperativo bajo las leyes Clarke-McNary y Norris-Doxey, entre el Comisionado de Agricultura y Comercio de Puerto Rico y el Secretario de Agricultura de los Estados Unidos.

   (c) Producir y suministrar mediante solicitud y a su costa, arbolitos forestales, frutales y de sombra y arbolitos de transplante a otras agencias insulares y federales para proyectos debidamente autorizados de reforestación, sombra y embellecimiento.

5. Establecerá plantaciones forestales en todos los terrenos denudados o improductivos en los bosques insulares que se dedican al cultivo de árboles forestales y proporcionará el subsiguiente cuidado y conservación necesaria.

Nota: El término "productos forestales" según se usa en esta sección incluye cualquier madera de construcción, madera, goma u otro producto forestal, forraje, piedra, tierra, o cualquier otro producto sobre el terreno o del terreno, con excepción de los minerales.

ORDENACION Y USO DEL TERRENO

De acuerdo con los objetivos 2 y 5 de la Política Forestal General, el Servicio Forestal, tan pronto como las facilidades al efecto lo permitan, efectuará los reconocimientos necesarios de aquellas tierras dentro de los bosques insulares que sean de más valor para el cultivo de productos agrícolas para el consumo y para la venta, la producción de forraje natural para el ganado, recreación pública u otros propósitos públicos y preparará un plan para la aprobación del Comisionado. Mientras tanto, y utilizando datos más fidedignos disponibles sobre el uso de Terreno, el Servicio Forestal:

1. Otorgará a individuos y a personas jurídicas que no tengan negocio establecido, que residan en o dependan del bosque y que no posean terreno fuera de los bosques insulares, permiso para residir en y utilizar las tierras propias para tal fin sin detrimento del bosque, suelo, o valor protector de las cuencas, o a la administración económica del bosque, bajo condiciones a ser prescritas y mediante rentas razonables según sean recomendadas por el Servicio Forestal y aprobadas por el Comisionado, dichas rentas pagaderas en dinero o en trabajo en proyectos forestales autorizados (sujeto también a la aprobación del Comisionado del Trabajo) mediante deseo expreso del individuo y prueba de insolvencia.

2. Tendrá autoridad para mandar a desocupar a los individuos que estén viviendo en o cultivando parcelas cuyo cultivo, a juicio del Servicio Forestal, perjudique substancialmente el bosque, el suelo y el valor de las cuencas; con la condición, sin embargo, de que al parcelero se le dará tiempo razonable para cosechar sus productos y para conseguir otra parcela, en lo cual el Servicio Forestal le ayudará en todo lo que le sea posible.

3. Proveerá, según lo permitan los fondos, casas cómodas, construídas económicamente, en aquellas parcelas forestales que puedan ser cultivadas para la producción continua de frutos menores sin perjudicar el bosque, el suelo, o el valor protector de las cuencas; para los obreros que se necesiten en los trabajos de mejora forestal en sitios lejos de centros de población; y además, ayudará a proporcionar edificios para escuelas en comunidades forestales establecidas donde actualmente hagan falta.

4. Otorgará a las agencias públicas el derecho de utilizar y ocupar tierras forestales que no excedan sus necesidades, mediante renta razonable según cada caso individual, o gratis si el beneficio de dicha utilización redunda en favor del público en general.

5. Hará reconocimientos de las áreas de gran valor escénico y re creativo dentro de los bosques insulares, determinará su valor, las establecerá y mejorará con la aprobación del Comisionado y para el uso del público en general.

ADQUISICION DE TERRENO FORESTAL

De acuerdo con el objetivo Núm. 7 de la Política Forestal General, el Servicio Forestal dará todos los pasos necesarios para la adquisición de terreno forestal adicional, y en sus reconocimientos y tasaciones, y en las recomendaciones al Comisionado para la compra de tales tierras el Servicio Forestal dará preferencia a aquellos terrenos forestales que:

1. Por razón de su situación topográfica y geográfica son necesarios para la protección de cuencas que surtan embalses existentes o futuros que provean energía eléctrica, riego y abastecimiento de agua.

2. Ahora se están perjudicando, denudando o destruyendo a manos de sus actuales dueños.

3. Queden en o colinden o estén situados cerca de los linderos de los actuales bosques insulares y puedan ser protegidos y administrados por el personal y facilidades existentes.

4. Contienen madera de calidad cortable y vendible.

5. Puedan comprarse al precio por cuerda establecido por la ley en vigor.

(Traduction)

POLITIQUE FORESTIERE PUBLIQUE NOUVELLEMENT EXPOSEE A PUERTO RICO

Déjà en 1917 le gouvernement de Puerto Rico avait édicté et mis en vigueur une Loi Forestière compréhensible qui fut ameliorée par les amendements faits en 1921. Elle créa le Service Forestier de Puerto Rico dans le Département d'Agriculture et Commerce et aussi éxposa les conditions généraux et les tâches qu'il devait remplir selon lesquelles les forêts insulaires devaient être établies, administrées, aménagées et utilisées par le Service Forestier, sous la direction du Commissaire d'Agriculture et Commerce.

L'article 4, incise 8 de ladite loi dispose que le Commissaire d'Agriculture et Commerce doit formuler les règles et règlements et les amender de temps en temps, à sa discretion, "pour et en ce qui concerne les activités de tout le Service Forestier, et la surveillance, administration, entretien, protection, extension, possession et utilisation des forêts et réserves forestières et aussi du bois et d'autres produits et ressources forestières, là-dessus en particulier."

Conforme à cet article, le Commissaire d'Agriculture et Commerce, l'honorable Luis A. Izquierdo a presenté au Chef du Service Forestier

Insulaire, comme guide officiel mis à jour, une Constatation de la Politique et Tâches ayant Affaire aux Forêts qui Appartiennent au Peuple de Puerto Rico. Nous citons ici cet aperçu complet, comme information pour les lecteurs du Caribbean Forester.

* * *

CONSTATATION DE LA POLITIQUE ET TACHES AYANT AFFAIRE AUX FORETS QUI APPARTIENNENT AU PEUPLE DE PUERTO RICO

Le Commissaire d'Agriculture et Commerce conforme à l'autorité que lui accorde la Loi Forestière (Loi 22 du 22 novembre 1917, amendée par la loi 8 du 27 avril, 1921) par ces présentes déclare que le Service Forestier Insulaire doit, sous sa direction et surveillance générale, administrer, protéger, développer, aménager et fomenter l'utilisation des forêts qui appartiennent aujourd'hui et celles à être acquises et désignées comme Forêts Insulaires, en accord avec les politiques et objectifs suivants, jusqu'à et à moins qu'ils ne soient modifiés, revoqués ou abrogés par le Commissaire lui-même.

POLITIQUE FORESTIERE GENERALE

Forêts Insulaires

Les forêts et les terrains y compris, proprieté du gouvernement insulaire déjà ou à l'avenir, seront dediés et utilisés suivant leur plus haute aptitude et on devra faire que ces forêts rendent au peuple les meilleurs profits sociaux y compris le fournissement d'opportunités de travail aux habitants locaux. Pour accomplir ce but le Service Forestier doit, selon les limites de personnel et facilités, administrer, protéger, aménager et utiliser les forêts pour:

1. Fournir en tout temps la protection des forêts contre l'incendie et l'usage illégal des forêts, terre à bois et autres réssources.

2. Assurer la protection éfficace des sections de forêts reconnues essentielles à la protection des pouvoirs d'eau, irrigation, et approvisionnement domestique d'eau.

3. Employer toutes les mesures pratiques et techniques disponibles en vue d'obtenir les quantités maxima en produits forestiers mais à rendement soutenu, et les mettre à la disposition du commerce et du public par voie de ventes et autrement.

4. Etablir une couverture forestière adéquate sur les terrains denudés ou trop clairsemés et les mettre en valeur avec l'aide de pepinières, reboisements et soins donnés aux peuplements.

5. Autoriser, par l'octroi des permis formaux, l'occupation ou utilisation par personnes ou autres des parcelles enclavées dans les forêts, que le Service Forestier considère comme mieux propres à la culture agricole qu'à la culture forestière et la protection des cours d'eau.

6. Protéger et encourager le maintien de la vie sylvestre et des poissons dans les forêts.

7. Commencer l'inspection, évaluation et négotiations avec les propriétaires de terrains avoisinant ou prochains aux forêts et qui ne servent que pour la culture forestière et qui peuvent être achetés aux prix établis pour l'acre; faire au Commissaire les recommendations pour leur arpentage à être fait par le Département de l'Intérieur, leur acquisition par le Peuple de Puerto Rico et leur subséquente addition aux forêts insulaires présentes.

Coopération, Assistance et Education Forestière

Le Service Forestier doit, sujet aux limites de son autorité, personnel et facilités disponibles:

1. Assumer la direction dans le cadre des Sciences Forestières dans tout Puerto Rico et îles voisines.

2. Aider et collaborer avec les simples particuliers et propriétaires à améliorer la productivité de leur forêts et terres à bois ou l'extension des forêts par le boisement des terrains incultes et autres, pour la production de bois de chauffage et de construction, pour protéger le sol contre l'érosion, comme refuge de la vie sylvestre, pour l'ombrage et l'embellissement des routes et aussi pour d'autres buts bénéficiels; et de la même façon le Service Forestier doit coopérer avec les autres bureaux, départements et institutions du gouvernement insulaire et avec les diverses agences du gouvernement fédéral intéressées en ce qui concerne les buts de la Loi Forestière.

3. Encourager l'intérêt et gagner le grand public à la cause de l'économie forestière et ces grands buts, à savoir ceux de la protection, aménagement et utilisation de la forêt aussi privée que publique au moyen de correspondance, journaux, représentations cinématographiques, publications, causeries et conférences dans les milieux sociaux, didactiques ou économiques, écoles et collèges.

Recherches et Etudes Forestières

Le Service Forestier Insulaire doit collaborer avec le Service Forestier du Département de l'Agriculture des Etats-Unis et participer, compte tenue des limitations en personnel et facilités, à effectuer les recherches relatives aux problèmes de l'établissement, protection, aménagement et utilisation des forêts et terres à bois de Puerto Rico.

PROTECTION DES FORETS

Conforme aux Objectifs 1, 2 et 6 de la Politique Forestière Générale, le Service Forestier, doit selon le personnel et facilités disponibles, formuler et employer méthodes efficaces pour protéger les forêts contre le feu, contre les endommagements et coupes illégaux du bois et de la végétation forestière, contre l'emploi et occupation des terres forestières pour remplir aucun but illégitime, abus commis en forêts, pacage et pâturage en forêt, chasse et pêche illégale, dégâts et vols des proprietés du gouvernement y compris les monuments, marques, bornes, signes, etc. de la manière suivante:

1. Démarcation ou bornage des limites des forêts par l'eclaircissement de la végétation autour des forêts, l'établissement des monuments ou bornes et en plaçant des signes ou placards dans les lieux convenables.

2. Régulariser les patrouilles de vigilance et surveiller les forêts pour éviter les transgressions, l'incendie et toutes les actions nuisibles et illégaux.

3. Conserver toujours les outils et équipements en état de combattre les incendies forestiers.

4. Education du public et lui faire connaître les dispositions de la Loi Forestière.

5. Persécuter et dénoncer les contrevenants et transgresseurs, en se basant sur la Loi Forestière et les Codes Civils relatifs à la proprieté publique et employant, s'il le faut, les services du Bureau Légal du Département.

6. Combattre, s'il est nécessaire au point de vue pratique, les maladies forestierès et les insectes nuisibles.

AMENAGEMENT ET UTILISATION DU BOIS ET LA REGENERATION ARTIFICIELLE

Conforme aux Objectifs 2, 3 et 4 de la Politique Forestière Générale, le Service Forestier doit, aussi rapide que possible avec les facilités disponibles à ce sujet, faire les inventaires pour déterminer la quantité et qualité des bois déjà existants et enclavés dans les forêts insulaires et des terrains denudés qui ont besoin de reboisements complets ou en partie et preparer et présenter à l'approbation du Commissaire des plans et idées pour l'aménagement et utilisation avec rendement soutenu des bois et terrains denudés ou peu peuplés enclavés dans les forêts insulaires et qui doivent être dediés à la culture forestière. Cependant et en prennant les mesures efficaces et toutes les données disponibles sur l'aménagement sylvicole, l'utilisation forestière et la régénération artificielle, le Service Forestier doit:

1. Encourager les ventes et vendre aux individus y compris les personnes juridiques, le bois et produits forestiers que selon l'avis du Service Forestier peuvent être enlevés des peuplements sans endommager la protection des cours d'eau ou sans diminuer la faculté de réproduction, l'accroissement (quantité) et l'amélioration (qualité) de la forêt, tout en assurant son renouvellement normal, aux prix sur pied à être approuvés par le Commissaire, mais toutes les ventes de plus de $300 doivent se mettre à l'enchère après être annoncées dans deux journaux.

2. Octroyer des permis gratuits, aux personnes méritantes et aux personnes juridiques qui n'en obtiennent des profits, qui résident près des forêts insulaires et qu'en dépendent pour obtenir la matière première indispensable pour la construction et réparation de leur bâtiments, de leurs clôtures, pour obtenir leur bois de chauffage et seulement pour remplir leur besoins mais non pour vendre, tous ces produits dont l'enlèvement sert pour améliorer la qualité et le caractère productif des peuplements mais dont l'enlèvement ne peut pas être accompli par voie de ventes en accord avec le paragraphe 1 susmentionné; et aussi octroyer des permis gratuits pour pareils produits et sous conditions similaires aux agences publiques qui veulent les employer au profit du grand public.

3. Faire les opérations forestières d'amélioration des peuplements, avec les frais disponibles pour cette enquête, dans ces peuplements qui ont besoin de coupes d'amélioration mais dont les produits enlevés ne peuvent être coupés et distribués ni par vente ni par des permis gratuits conforme aux paragraphes 1 et 2 de ce topique à cause de leur inaccessibilité et manque de demande.

4. Recueillir ou obtenir par d'autres moyens les graines forestières et conserver les pepinières forestières établies sur des emplacements appropriés de la propriété forestière sous la direction du Service Forestier ou prises à bail par le Commissaire et pour y obtenir les brins de semences et plants à repiquer ou transplanter à fin de les:

   (a) Planter ou ensemencer les terres forestières insulaires clairsemées ou denudées.

   (b) Distribuer parmi les propriétaires et cultivateurs pour la création de brise-vents, rideaux protecteurs et parcelles boisées ou lots à bois sur les terrains détériorés ou déboisés, en collaboration avec le Service d'Extension Agricole et autres agences fédéraux et insulaires autorisées en conséquence des accords coopératives en vertu des lois Clarke-McNary et Norris-Doxey, entre le Commissaire de l'Agriculture et Commerce de Puerto Rico et le Secrétaire de l'Agriculture des Etats-Unis.

(c) Faciliter aux autres agences insulaires et fédéraux, à leur demande et à leur propre depense les plants ou graines d'arbres forestiers, fruitiers et d'ombre pour les projets autorisés de réboisement, embellissement et production d'ombrage.

5. Doit établir des peuplements forestiers sur les terrains dénudés ou non cultivés enclavés dans les forêts insulaires et doit les conserver et éxécuter les soins culturaux nécessaires aux peuplements.

Note: Le terme "produits forestiers" y employé renferme le bois de construction, de chauffage, gommes, fourrage, pierre, terre et tous les produits sur ou du terrain, à l'exception des minéraux.

AMENAGEMENT ET UTILISATION DES TERRES

Conforme aux Objectifs 2 et 5 de la Politique Forestière Générale et aussi rapidement que possible avec les facilités disponibles à ce sujet, le Service Forestier doit entreprendre les inventaires et enquêtes et préparer un plan d'ensemble à être presenté à l'approbation du Commissaire pour déterminer les superficies propres à la culture agricole, production de fourrage, récréation publique et autres. Cependant et sur la base des données bien fondées relatives à l'utilisation des terrains, le Service Forestier doit:

1. Octroyer aux individus et personnes juridiques pas organisées pour profiter, qui habitent dans et dépendent des forêts et qui ne possèdent pas de terrains, permis pour occuper et utiliser ces terrains que le Service avait déterminé comme propres à quelqu'un des buts énumérés sans provoquer détriment à la forêt, sol, cours d'eau ou à l'administration économique des forêts, sur la base des conditions établies et frais raisonnables selon les récommandations du Service Forestier et après l'approbation du Commissaire, dit frais à être payés en argent ou en faisant des travaux culturaux (approuvés par le Commissaire des Travaux Publics) dans la forêt, dans le cas où l'individu l'en sollicite et peut démontrer qu'il ne peut pas payer en argent.

2. Etre autorisé pour déloger ces individus qui occupent et cultivent aujourd'hui les parcelles qu'à l'avis du Service Forestier ne sont pas propres à la culture agricole car sa cultivation intervient avec la conservation des cours d'eau, du sol et des forêts; pourvu que les permissionaires aient un espace de temps

raisonnable pour la récolte et pour trouver avec toute l'aide possible du Service Forestier un autre emplacement ou habitation.

3. Bâtir, sur base des fonds disponibles à ce sujet, des logements économiques dans les parcelles enclavés dans les forêts et qui peuvent être cultivées d'une manière permanente sans préjudicier les valeurs des forêts, sols et cours d'eau; ou pour les ouvriers forestiers dans ces endroits éloignés des communautés établies; et aussi établir des écoles parmi les communautés forestières oú ils font défaut.

4. Octroyer aux agences publiques le droit pour utiliser ou occuper les terres forestières mais seulement celles qu'ils en ont besoin et à frais raisonnables selon les divers cas particuliers ou exempt de charges s'il s'agit du bien-être publique.

5. Faire l'enquête et en déterminer les charges, établir et conserver avec l'approbation du Commissaire, réserves avec possibilités récréatives et esthétiques dans les forêts insulaires et les rendre à la disposition du grand public.

ACQUISITION DES TERRAINS FORESTIERS

Conformément à l'Objectif 7 de la Politique Forestière Générale le Service Forestier doit prendre les mesures nécessaires pour acquérir des terrains forestiers additionels; et dans les enquêtes, inventaires et recommandations au Commissaire pour l'achat de terrains, ainsi que les circonstances le permettront, le Service Forestier doit préférer les terres dont:

1. Dû à leur situation topographique et geographique sont indispensables pour la protection des pouvoirs d'eau, irrigation et réservoirs domestiques.

2. Sont l'objet d'explotations visant à les endommager, dénuder et détruire.

3. Sont situées près ou avoisinant les limites actuelles des forêts insulaires et peuvent être économiquement administrées avec le personnel et facilités disponibles à present.

4. Sont couvertes de peuplements utilisables.

5. Pourvu que ces terrains puissent être achetés au prix l'acre établi et en vigueur.

WOOD UTILIZATION IN PUERTO RICO

A comprehensive study of forest production and wood utilisation in Puerto Rico was made late in 1944 by Messrs. Laurence V. Teesdale, Principal Forest Products Engineer, Forest Products Laboratory, Madison, Wisconsin, and James W. Girard, Principal Logging Engineer of the Forest Service, Washington, in company with members of the staff of the Tropical Forest Experiment Station at Rio Piedras. This study was conducted in cooperation with, and Messrs. Teesdale and Girard were brought to the island by the Puerto Rico Development Company to determine the possibilities of industrial development in the manufacture of lumber and wood products. The findings of this project have been published under the above title as Bulletin No. TP-21 (mimeographed) of the Forest Products Laboratory. A limited supply of copies are available for distribution upon request.

Estimates of forest resources were made on the basis of all available data. It was determined that the total forested area of Puerto Rico is about 528,000 acres, or about 24 per cent of the surface of the island; the present wood volume in all trees on the island is approximately 150,000,000 board feet of sawtimber and 15,000,000 cords of smaller material; the annual growth in sawtimber 3,000,000 board feet and in other tree growth 800,000 cords; the annual drain on local forests 2,110,000 board feet of sawtimber and 1,103,000 cords of posts, fuelwood, etc. It is apparent, therefore, that the total estimated present drain is 30 per cent in excess of total estimated growth, with increased future drain anticipated. It is believed, however, that intensive forest management will greatly increase production.

Other findings were that at present there is insufficient merchantable sawtimber at any one location to justify the establishment of a sawmill, and hence that whipsawing and skidding with oxen are cheaper and provide closer utilization of the forest. The local requirements of wood for fuel and agricultural uses canbe expected to increase. The bulk of the industrial and construction requirements will continue to be supplied by imports of lumber. Furniture wood requirements will increase. And finally the depleted condition of the existing forests precludes any real opportunity for developing or expanding industries wholly dependent upon a local supply of lumber for some time to come although there is an opportunity for the expansion of the local furniture and millwork industries based upon lumber imported from nearby countries.

FORESTS AND FOREST INDUSTRIES IN CHILE[1/]

I. T. Haig, Director
Appalachian Forest Experiment Station
U. S. Forest Service

The forests of Chile, including natural woodland and plantation, cover about 1/5 of the Republic's land surface or some 16 million hectares. High forests of commercial character, however, cover only about 5-1/2 million hectares, of which better than one million is in second growth stands or in cutovers or deforested burns. This high forest area -- over 90 percent hardwoods -- consists of trees typically Chilean, including coigüe, Nothofagus dombeyi; tepa, Laurelia serrata; raulí, Nothofagus procera; roble, Nothofagus obliqua; laurel, Laurelia aromatica; olivillo, Aextoxicon punctatum; ulmo, Eucryphia cordifolia; lingue, Persea lingue, with fine but limited coniferous forests, chiefly araucaria, Araucaria araucana; alerce, Fitzroya cupressoides; and ciprés, Libocedrus sp. These forests are usually dense and luxuriant with heavy undergrowth. The trees range in height from 25 to 35 meters and commonly up to 100 centimeters or more in diameter, except for alerce, which frequently grows to great size. Although the forest currently contains many species, the bulk of the merchantable timber is usually found in 2 to 5 species, coigue and tepa making up over half of the saw-timber volume in commercial stands. Chile is particularly rich in virgin old growth saw timber having, for example, about three times as much of this desirable type of forest on a per capita basis as the United States. Net volume in the virgin saw-timber stands of Chile averages about 37,000 board feet per hectare, with stands north of Puerto Montt averaging 53,000 board feet per hectare. The total is estimated at about 104 billion board feet.

In addition to the high forest described above, Chile has substantial area of woodland, intensively cut over for fuel and farm use, and a small, but important, plantation area consisting chiefly of eucalyptus, E. globulus and monterey or insignis pine, Pinus radiata. Alamo, Populus nigra italica is also grown for match stock, farm use, and rough lumber such as concrete forms. Almost all of the plantation area and a great deal of the dry, accessible woodland type is in the great central region where the major cities of Santiago and Valparaiso are located and where lives 4/5 of Chile's population.

The true high forest area occurs chiefly between the Bio Bio and Aysen Rivers. Relatively little cutting has been done south of Puerto Montt,

---

1/ This article is based upon a report prepared by members of the U. S. Forest Service under a cooperative project with the Corporación de Fomento de la Producción, an instrumentality of the Chilean Government.

except for clearing for agriculture on the Island of Chiloe; but north of Puerto Montt, the end of the main line railroad and the most southerly deep water port, land clearing for agriculture has removed the forest from most of the central valley area and the stands still remaining are largely in the coastal or Andes ranges. Many competent agriculturists in Chile now believe that most of the land suitable to agriculture has been cleared, and that Chile's agricultural future will depend primarily on intensification of agriculture on land already available. Broadly speaking, therefore, the forest area now left is Chile's permanent forest land and should be so handled in the long-time interests of the Republic.

This forest resource now supports a small but varied forest industry. It is not only the major source of fuel for over 80 percent of Chile's people (coal supplies are substantial but used mostly for industrial needs, while oil has not been found in commercial quantities) but also furnishes a substantial amount of material for construction, for the boxing and crating of agricultural goods and industrial products, for furniture, plywood, fencing, mine timbers, ties, pulp and numerous other miscellaneous uses in agriculture and industry. There are some 600 to 700 sawmills in Chile, most of them cutting not over 5,000 board feet per day. However, the forest industries, including sawmills, planing and remanufacturing plants, furniture, cooperage, boxing, sash and door, and carpentry industries, and the allied secondary industries, dependent upon forest products for their basic raw material, as for example, the plywood, pulp, match wood, distillation, and tanning industries, represent an investment of over 1,000 million pesos and produce goods valued at over 1,360 million pesos, employ some 44,000 part and full time workers, exclusive of those engaged in cutting fuel wood and manufactured miscellaneous agricultural products, and pay salaries and wages of over 280 million pesos annually. This is exclusive of indirect contributions to other industries such as the railroads, which draw about 1/7 of their income from the transportation of forest products.

Chile now consumes, largely in home markets, about 300 million board feet plus 158 million cubic feet annually. Most of the cubic foot cut is used for fuel either as wood or charcoal, though substantial amounts are also used in the round for fencing and miscellaneous agricultural uses and for mine timbers. A small amount of plantation-grown Pinus radiata, about one million cubic feet, is now ground annually in pulp production. About 2/3 of the board foot cut (209 million board feet) is used as lumber, over half of it for construction and the remainder for box, furniture, etc. Substantial amounts are also used in the form of hewn or sawn ties and as mine timbers, with a relatively small amount being cut as rotary or slash veneer. Roughly, 55 percent of the total cubic cut is used for fuel, 27 percent for lumber, 6 percent for ties and mine timbers, respectively, and the remainder for poles and fencing, plywood, pulp, and miscellaneous products.

Depletion of the forest by cutting, however, represents less than 15 percent of the total depletion in cubic feet of material taken from live, standing trees, the remainder being lost through fire, windfall, insects and disease. Fire is the most destructive agency in Chilean forests, a natural consequence of the lack of organized fire protection in the entire natural forest zone. Thus the recent annual loss of timber killed by fire has averaged 682 million cubic feet, equivalent to slightly more than one percent of Chile's total stand, or 4 times the saw-timber drain caused by cutting. Obviously such destruction is an extremely serious obstacle to the development of larger forest industries on a permanent pattern. If Chile's fire loss can be reduced to about 1/5 of present losses, however, which would seem entirely feasible under proper organization (for the forest area is in general well watered and reasonably accessible), then Chile's forests could support over 2 to 3 times as much industry permanently as is now based upon them.

The present situation grows out of the fact that although the manufacture of lumber and other forest products is in one sense one of the oldest industries in Chile, the early colonists having put native woodlands and forests to good use in the production of charcoal and fuelwood and in the construction of crude habitations, furniture, boats and similar articles, the organized exploitation of timber lands in Chile as a primary business is relatively new. Lumber operations in Chile are still essentially land-clearing operations, the natural outgrowth of the effort to clear the forests from the fertile lands of the central valley and make them available for agriculture and grazing.

In the true forest area this is a relatively recent effort, for only in the early 1880's, when araucanian resistance was finally broken by Chilean troops fresh from the Pacific war (1879-1883) were these lands opened fully to white occupation. Early efforts were almost entirely devoted to clearing the land for agriculture and grazing, the forest being regarded as an impediment to be cleared away as rapidly as possible. Gradually, however, as a market developed for lumber and other forest products, timber-land owners brought in and operated small, portable mills on their own holdings, using farm labor in slack seasons. Accordingly, there grew up in Chile a logging and sawmilling industry operated largely by men whose primary training and interest were in agriculture and to whom logging and milling operations were merely an attractive adjunct to the main business of farming or stock raising. Under these circumstances, few operations were well planned or efficiently conducted. Operations were seasonal, timed to use labor, insofar as feasible, when farm activities were slack. Fire was frequently employed, both to provide pasturage for work animals and as a direct aid in logging and land clearing. These fires were very destructive, not only killing and injuring the trees left in the cutting area -- often containing up to 70 or 80 per cent of the original stand volume, for cuts were light and highly selective -- but also spreading far outside the cut-over area to adjacent uncut stands.

The great majority of current logging and sawmilling operations in Chile still follow this historical pattern. Operations are seasonal; local farm hands furnish the bulk of the labor; the equipment is simple, representing a minimum of capital investment; waste and inefficiency in woods and mill are largely ignored; and fire is still employed with the earlier recklessness and indifference, little concern being shown as long as lives, or mills and similar property, are not endangered.

On the typical operation, logging begins in the fall at the close of the harvest and continues through the winter rainy season. Trees are felled, limbed, and chopped into logs with the axe. Hauling is customarily done on a two-wheeled cart or bummer drawn by two, occasionally four, oxen. Hauling distances are short, rarely over one mile, and the mills are portable and moved as necessary to keep them close to the cutting area. Logs are taken direct to the mill, if possible, log ponds being virtually unknown in Chile and log storage space scarce. Hauling and felling are almost always confined to the dry summer season, October to November. Mills rarely operate over 100 days a year, often less. After milling, the lumber is hauled to the railroad station by ox-cart or truck and there piled in space provided for the purpose to await purchase and shipment by the lumber dealer or remanufacturer. Milling equipment is usually relatively light and the smaller mills produce only limited sizes and grades, with further finishing and remanufacture, including resawing into thinner boards, done elsewhere. Piling practices are usually substandard and, as is to be expected under these conditions, the quality of lumber is poor grade, grade recovery low, and stain and other defects common. Although a growing appreciation of timber values has changed the picture appreciably in recent years, one competent authority estimates that not over 1/5 of the logging operations now under way in Chile are well organized operations aimed, primarily, at timberland exploitation. Even the larger operations are seasonal, with land clearing as accepted objective.

Nevertheless, the type of small mill operation developed in Chile is not without its merits. Small portable mills involve a minimum of capital investment and risk, can be moved frequently to minimize log hauling distances, and, if properly handled, constitute an economical method of logging, particularly in hardwood stands. The type of "hot logging" now practiced, in which logs are brought directly to the log deck with a minimum of log storage is one of the most efficient of small mill practices. High fuel and low labor costs tend to compensate for some of the disadvantages of ox-carts vs truck and tractor. In any event, it is evident that the small mill will remain an important factor in log production in Chile for many years to come and every effort should be made to obtain practical improvements in operations and marketing. The Corporacion de Fomento has already taken a step in this direction through the organization of a producers cooperative, through which mill owners can market their product, receive help in grading and inspection, and guidance and aid in the purchase of machinery and equipment.

A great deal can be done in Chile to improve logging operations by the introduction of such simple devices as the crosscut saw and a simple coupling device of chain or tongs to avoid the waste in notching the log for skidding. In larger operations, tractors might be employed for skid and concentration, although in the smaller trees the traditional ox-cart methods are probably satisfactory and acceptable. The short hauls now common, involving direct delivery to the deck with a minimum of storage, are very effective. Milling operations could also be materially improved by more attention to mill layout to eliminate excessive handling and to utilize rollers and other mechanical means, where possible, in place of sheer manpower.

However, the most important factor in greater production is probably the power available to the head saw and most mills in Chile are badly underpowered so that material improvement here must await the installation of new and better mills or replacement of existing machinery. Small mill experts recommend a steam engine boiler of around 100 h.p. capacity, weighing about 8 or 9 tons, and capable of cutting about 1000 board feet per hour. A truck and trailer capable of hauling about 8-1/2 tons per load on reasonably good roads could be efficiently employed with such a mill for hauling lumber to the railroad station or other concentration points. Such small mill operations, particularly if furnished adequate credit, good logging engineering guidance, and proper marketing facilities, as through a producers cooperative, could do a great deal in overcoming the disadvantages of small mill operations, and in increasing the quality and quantity of output per man hour. One very important thing, however, in Chile would be the need for job training in the use of new tools and modern equipment. Chilean labor now displays great skill in the use of the simple tools and devices already employed, as, for example, the heavy single-bitted Chilean axe and the two-wheel cart employed for hauling, but modern machinery would necessitate additional training and adequate managerial supervision.

In addition to the small mill, however, somewhat larger permanent band mills, at least in sufficient numbers to bring about a reasonable balance between small and large mill operations, would seem desirable. Such mills would offer a better opportunity, also, of furnishing the basis for integrated industries, particularly those based on the utilization of wood and mill waste. There are a considerable number of locations in Chile capable of supporting medium sized band mills on a permanent basis.

In addition to the sawmilling industry, Chile also supports a considerable variety of other forest industries. There are, of course, a considerable number of planing mills turning out such standard products as stripping, flooring, window sash and frames, interior finish and trim, exterior siding, etc. Some of these mills are run in conjunction with a sawmill operation, some in log concentration yards, and some in the main industrial cities. The quality of the products of these mills is generally rather high but the methods and operations and types of machines used are, in most cases, inefficient and costs unnecessarily high. Furniture factories are also common, though the great bulk of furniture produced in Chile is made in small shops and on a handicraft basis. Such conditions encourage manufacturers to limit their output to the higher priced items where labor costs are less important, and in consequence a large and important market is inadequately supplied with suitable goods at a fair and reasonable price. The manufacture of box shooks and completed boxes is also an important industry in Chile where the wooden box is widely used as a shipping container for such manufactured products as sugar, ceramics, canned goods, bottled wine and fruits and vegetables. About 1/5 of the lumber cut goes into boxes. Some of the boxes are very well made but too many are improperly constructed, wasteful of material and made of improperly seasoned lumber.

Chile also has a well established and flourishing plywood industry which has attained its present growth since 1940. There are three companies producing rotary cut veneer, over 50 per cent of which is exported, possibly to Argentina, Peru, and Bolivia, with domestic consumption increasing rapidly. In contrast to most of the other woodworking industries, the plants producing rotary veneer are well laid out as to production line methods, use labor-saving devices and equipment, and have reasonably adequate work space for the various operations. Plywood in Chile is now being produced almost entirely in 3-ply stock, most of which is going into furniture. Accordingly, the market for plywood should continue to expand as other thicknesses and types are manufactured. For the present, however, plant capacity is considerably in excess of domestic requirements.

Considerable quantities of wood in Chile also go into ties, mine timbers and poles, most of the ties being hand hewn from roble, a very suitable species for this purpose because of its high natural durability. A considerable number of wood shingles are also cut in Chile, largely from alerce and cipres. Shingles are used almost exclusively as a roofing material in the Southern Provinces. Both ties and shingles are most often produced in small operations by local woodsmen, roble hand-hewn ties, in particular, frequently being brought into railroad stations or other concentration points a few at a time by boat or cart. The manufacture of wooden farm carts and wagons is also an important home industry in Chile where a shortage of trucks and the relatively high price and present shortage of gasoline have retarded the development of faster methods of transportation.

One of the most important and widespread activities based upon a forest resource, however, is the production of charcoal for fuel. Chile, with no domestic supply of oil and a limited supply of coal, consumes an enormous quantity of charcoal annually for industries and domestic fuel. In addition to domestic needs, charcoal is consumed industrially in the production of pig iron and black powder, in gasogenes and by small artisans as tinners, plumbers, and blacksmiths. National consumption is estimated at not less than 150,000 tons annually and may well be considerably more. Except for the limited output of two small distillation plants, not over 2 to 3 per cent of the total, charcoal is produced in primitive pits and beehive ovens without recovery of the by-products. The principal by-products, methanol and acetic acid, important commercial solvents, are not now available in ample supply from domestic sources. Accordingly, a hardwood distillation industry of adequate size, would seem a desirable and feasible addition to Chilean industries. Chile has an abundance of suitable hardwood species giving excellent yield of charcoal and by-products and the production cost price situation looks favorable.

In the field of paper and pulp, Chile now has productive capacity for paper production roughly equivalent to present domestic requirements. In the past most of the pulp has been imported but during the last three years a considerable amount of ground pulp has been produced from araucaria and plantation-grown Insignis (monterey)pine, particularly the latter. In addition, several native hardwoods, such as olivillo, are suitable for the preparation of bulky pulps such as those used in book and other high-grade printing papers. It would seem probable, therefore, that in the future Chile will be able to produce most of her pulp requirement from domestic sources through the establishment of a sizeable sulphate mill based primarily on insignis pine. Plantation-grown wood is now becoming available in sufficient quantity and other basic materials, such as lime, salt cake and bleaching powder, are available in sufficient to abundant quantities. Some interest is also being shown in the possible production of rayon, various types of insulation and hardboard, and alcohol and protein feed from Chilean species. In some cases additional knowledge and study will be needed before the prospects for such developments can be adequately clarified.

In any event, Chile has in her natural forests, woodlands, and plantations a valuable resource, capable of considerable additional development. Just how far this can go depends on the ingenuity and skill with which Chileans can develop new and expanded forest industries, some of which look immediately feasible and practical. Chile's forest resource, on a per capita basis, is now relatively large; her use moderate to small. Domestic markets should grow greatly with a rising standard of living and the export markets needed to use her forest resource to the full may be obtainable with increasing efficiency in industrial operations. Full use of the forest resource will not come quickly, but it is attainable if the proper managment, skill, and business acumen can be applied.

However, if forest industries are to be sustained on a permanent basis, Chile must develop and execute a forest policy of broad scope. A good start has already been made in the basic forest law of June 1931 and subsequent forest legislation. A policy formulating body already exists in the National Forestry Council recently set up under executive decree. An adequate forest policy, however, would require that existing legislation be broadened and adequately implemented to do the following: (1) provide for adequate forest protection, particularly from fire, and (2) provide for adequate management of forest lands, both public and private.

Chile has already shown, in the intensive management and adequate fire protection given her plantation area, that such steps are feasible where forest values are appreciated and fully exploited. Measures of this kind, more difficult it is true, need to be applied to the natural forest area. A good forest program would require the organization of an adequately manned and financed forest service, responsible for the protection and management of public forest lands and the administration of public programs applicable to private forest lands; and a program of public aid to forest owners, including State aid on forest protection, adequate credit facilities, and support of adequate programs of forest education, forest planting, and research and extension.

(Traducción del artículo anterior)

LOS BOSQUES Y LAS INDUSTRIAS FORESTALES DE CHILE 1/

Los bosques de Chile, incluyendo los montes naturales y las plantaciones, forman cerca de la quinta parte de la superficie total de la república o sea unos 16 millones de hectáreas. Sin embargo, los montes altos de valor comercial comprenden sólo cerca de 5 millones y medio de hectáreas de las cuales más de un millón incluyen ya rodales de especies generalmente inferiores que crecen después de las cortas sin regimen, ya montes tumbados o desforestados por las quemas. Más del 90 por ciento de este área de monte alto está compuesta de árboles típicamente chilenos, de maderas duras, entre los que encontramos el coigue, Nothofagus dombeyi; tepa, Laurelia serrata; raulí, Nothofagus procera; roble, Nothofagus obliqua; laurel, Laurelia aromatica; olivillo, Aextosicon punctatum; ulmo, Eucryphia cordifolia; lingue, Persea lingue junto con buenos pero escasos bosques de coníferas principalmente araucaria, Araucaria araucana, alerce, Fitzroya cupressoides; y además ciprés, Libocedrus sp. Estos bosques son por lo general densos y exuberantes, con mucha vegetación subyacente. La Altura de los árboles fluctúa entre 25 y 35 metros y el diámetro llega a 100 centímetros o más con excepción del alerce que frecuentemente crece más. Aunque de ordinario el bosque contiene muchas especies, la mayoría de la madera se obtiene de 2 a 5 especies. El coigue y la tepa suministran más de la mitad del volumen de madera aserrable en los rodales comerciables. Chile es particularmente rico en madera aserrable proveniente de bosques vírgenes antiguos, ya que, por ejemplo, posee per capita por lo menos tres veces más que los Estados Unidos en lo que respecta a ese deseable tipo de bosque. El volumen neto en los rodales vírgenes de madera aserrable en Chile equivale a un promedio de 37,000 pies tablares por hectárea, con rodales al norte de Puerto Montt que poseen unos 53,000 pies tablares por hectárea El volumen total se estima en cerca de 104 billones de pies tablares.

Además del monte alto antes descrito, Chile tiene un área substancial de arbolado que ha sido intensamente tumbado para uso agrícola y combustible y una pequeña pero importante área de plantaciones consistentes principalmente de eucalipto, E. globulus y pino monterey o insigne, Pinus radiata. También se cultiva el álamo, Populus nigra italica para fabricar fósforos, para uso en la finca y para madera en bruto tal como la que se usa en moldes de hormigón. Casi todo el área en plantaciones y una gran parte del tipo de arbolado accesible y seco está situado en la región central donde están localizadas las ciudades de Santiago y Valparaíso y donde habitan 4/5 partes de la población de Chile.

1/ Este artículo está basado en un informe preparado por los miembros del Servicio Forestal de los EE. UU. que trabajaron en un proyecto en colaboración con la Corporación de Fomento de la Producción, agencia del gobierno chileno.

La verdadera área de monte alto se encuentra principalmente entre los ríos Bío Bío y Aysen. Al sur de Puerto Montt se han efectuado relativamente pocas cortas, excepto algunos claros hechos para dedicarlos a la agricultura en la isla de Chiloe; pero al norte de Puerto Montt, que constituye el final del trayecto del ferrocarril principal y además es el puerto hondo más al sur, las roturaciones del terreno ocasionaron la eliminación del bosque en casi todo el valle central y los rodales que quedan están situados en su mayoría en las cordilleras costaneras o en los Andes. Muchos agrónomos competentes de Chile creen que casi todo el área adecuada para la agricultura ha sido roturada y que el futuro agrícola de Chile depende primordialmente de la intensificación de las prácticas agrícolas en terrenos ya disponibles para tal fin. En términos generales, puede decirse que el área forestal que resta en Chile como tal es en sí tierra forestal permanente y así mismo debe tratarse para beneficio de los intereses venideros de la república.

Este recurso forestal es hoy día la fuente de una pequeña pero variada industria forestal que suple no sólo el combustible vegetal para más del 80 por ciento de los habitantes de Chile (el carbón mineral abunda pero se usa principalmente en las industrias y no hay petróleo en cantidades comerciales) sino que también una cantidad substancial de maderas de construcción, de embalaje de productos agrícolas y productos industriales, ebanistería, chapas, para postes, maderaje en las minas, traviesas, pulpas y demás usos misceláneos en la agricultura y la industria.

Hay de 600 a 700 aserraderos en Chile y la mayoría de ellos no cortan más de 5,000 pies tablares por día. Sin embargo, las industrias forestales, incluyendo aserraje, desbaste y elaboración, ebanistería, tonelería, embalaje, fabricación de bastidores y puertas, carpintería y demás industrias accesorias que dependen del bosque para obtener su materia prima básica tales como fábricas de terciados, de pulpa, fósforos, destilación y tenerías representan una inversión de más de mil millones de pesos y producen mercancía valorada en más de 1,360 millones de pesos, emplean cerca de 44,000 obreros ya sea en trabajos consecutivos o provisionales, sin incluir aquellos que cortan la leña para combustible y fabrican productos agrícolas misceláneos. Por ende, se pagan por concepto de salarios y jornales más de 280 millones de pesos al año. Estas cifras no incluyen tampoco las contribuciones indirectas que se ofrecen a otras industrias tales como la de transportación ferroviaria que deriva la séptima parte de sus ingresos del transporte de productos forestales.

Chile consume hoy día mayormente en los mercados locales, cerca de 300 millones de pies tablares más 15.8 millones de pies cúbicos al año. La mayor parte de la madera cubicada se usa para combustible como leña o carbón a pesar de que también se usan cantidades substanciales de madera rolliza para empalizada y usos agrícolas misceláneos y para las minas. Una pequeña cantidad de cerca de 1 millón de pies cúbicos de Pinus radiata obtenido de plantaciones se macera anualmente para la producción de pulpa de madera. Cerca de 2/3 de los pies tablares cortados (209 millones de pies tablares) se usa como madera, la mitad de esta cantidad en construcciones y el resto en embalaje, muebles etc. Cantidades substanciales se usan también en forma de traviesas y madera para las minas y una cantidad relativamente pequeña se usa en chapas de corte rotativo o longitudinal. El 55 por ciento más o menos del total de madera rolliza se usa para combustible, 25 por ciento para madera de construcción, 6 por ciento para traviesas y madera de minas respectivamente y el resto para postes, espeques, terciados, pulpa y productos misceláneos.

Sin embargo, el agotamiento de los recursos forestales por medio de la corta de material vivo y en pie representa menos del 15 por ciento del agotamiento total en pies cúbicos; el resto se pierde por fuegos y azotes del viento, insectos y enfermedades. El agente más destructor de los bosques de Chile es el fuego, consecuencia natural de la falta de protección organizada contra el fuego en toda la región boscosa natural. El promedio en pérdidas anuales de madera destruída por el fuego en tiempos recientes es de 682 millones de pies cúbicos lo cual equivale a un poco más del 1 por ciento de la cantidad total en los rodales chilenos o cuatro veces la cantidad de madera de sierra que se extrae en las cortas. Es obvio que esa destrucción es un obstáculo extremadamente serio al desarrollo de grandes industrias de carácter permanente. Si se pudieran reducir las pérdidas ocasionadas por el fuego a solamente la quinta parte de las pérdidas actuales, lo cual es factible por medio de organización apropiada (ya que el área forestal está en general bien provista de agua y razonablemente accesible), entonces los bosques de Chile podrían sostener permanentemente más del doble o el triple de la industria maderera que hoy día sostienen.

La situación actual surge del hecho de que a pesar de que la obtención de madera y demás productos forestales es en cierto sentido una de las industrias más antiguas de Chile y a pesar de que los primeros colonizadores usaron los bosques para producir carbón vegetal y combustible y en la construcción de viviendas rústicas, muebles, embarcaciones y demás, la explotación organizada de los montes chilenos como un negocio de primera categoría está relativamente en sus comienzos. Las operaciones madereras en Chile se limitan aún a las limpias, resultado natural del esfuerzo hecho para librar a los terrenos fértiles del valle central de los bosques y poderlos asi dedicar a la agricultura y al sustento del ganado.

En el área verdaderamente forestal ese esfuerzo es relativamente reciente pues hasta que la resistencia araucana no fué finalmente aniquilada por tropas chilenas acabadas de salir de la guerra en el Pacífico (1879-1883) no comenzó la ocupación completa de esas tierras por los blancos. Los primeros esfuerzos tendían únicamente a limpiar la tierra boscosa para dedicarla a la agricultura y pastoreo y el bosque se consideraba como un impedimento que había que eliminar lo más pronto posible. Gradualmente, según se iba desarrollando el mercado para la madera y demás productos forestales, los dueños de las tierras boscosas trajeron y pusieron a trabajar pequeños aserraderos portátiles en sus terrenos utilizando los obreros de la industria agrícola entre cosechas. De tal manera nació la industria maderera en Chile, en manos de hombres cuyo principal objetivo, habilidad e intereses eran para la agricultura y para quienes el aserrío y acarreo era sólo un suplemento de la agricultura y ganadería.

Bajo estas circunstancias, pocas de las operaciones eran bien planeadas y eficientemente llevadas a término. Las cortas sólo se efectuaban en épocas flojas de pocos trabajos agrícolas. Se usaba el fuego a menudo para poder proveer sustento al ganado de trabajo y como ayuda directa del mejor acarreo y las limpias. Estos fuegos eran muy destructivos, matando y dañando no sólo los árboles que quedaban en el área de corta - los que incluían hasta el 70 u 80 por ciento del volumen original del rodal pues las cortas eran ligeras y muy selectivas - sino que también se esparcía por los rodales adyacentes que aún no habían sido cortados.

La gran mayoría de las operaciones de acarreo y aserrío en Chile aún sigue ese histórico patrón. Las operaciones se efectúan por épocas, se emplean los mismos obreros agrícolas, el equipo es simple, que no acarrea gastos, no se toman en cuenta los desperdicios en el bosque ni en los aserraderos y aún se quema con la misma avidez e indiferencia, mostrándose poco interés mientras no se pone en peligro vida ni hacienda.

En las operaciones típicas la corta comienza en el otoño después de recoger las cosechas agrícolas y continúa a través del lluvioso invierno. Los árboles se tumban, desmochan y trozan con el hacha. El acarreo se hace en carretas de dos ruedas tiradas por 2 y a veces 4 bueyes. Las distancias de acarreo son cortas, raras veces exceden de 1 milla pues los aserraderos son portátiles y se llevan lo más cerca posible del área de corta. Las trozas se llevan directamente al aserradero, no se conocen en Chile las maderadas ni los aguaderos. Los sitios de almacenaje de trozas son escasos. La tumba y acarreo de árboles se efectúa casi siempre durante la época seca del verano, de octubre a noviembre. Los aserraderos raramente trabajan más de 100 días al año y a menudo menos. Después de aserrar la madera se lleva a la estación del tren en carros de bueyes o en camiones y se apila en determinados sitios hasta que se vende al negociante o al fabricante de diversos productos. El equipo de aserrar es casi siempre relativamente liviano y los aserraderos más pequeños producen tablas sólo de algunas dimensiones y grados y los demás procesos de acabado como fabricación de tablas más finas se hace en otros sitios. Las prácticas de apilamiento son por lo general sub-standard y como es de esperar en estas condiciones la calidad de la madera obtenida es pobre, el porcentaje de grados buenos es bajo y los vicios y defectos de las maderas son más comunes de lo que habrían de ser si se fabricase y apilase mejor. A pesar de que al ir creciendo la debida apreciación del valor de la madera el cuadro ha cambiado favorablemente en años recientes, una autoridad chilena competente estipula que no más de la quinta parte de las operaciones madereras que se efectúan hoy día en Chile están bien organizadas y van encauzadas hacia una explotación forestal ordenada. Aún las operaciones mayores tienen lugar en determinada época, con miras hacia el descuaje de los terrenos.

Sin embargo, el tipo de aserrado desarrollado en Chile no carece de méritos. Los aserraderos pequeños, móviles y transportables de un punto a otro permiten una empresa prolija, económica, sin riesgos que, adecuadamente manipulada constituye un método práctico de corte y acarreo, principalmente en los rodales de maderas duras. Esta "extracción relámpago" que hoy se practica, en la cual las trozas se traen directamente a los molinos, con estacionamiento mínimo es una de las prácticas más eficientes de los aserraderos pequeños. Como compensación de las desventajas de los carros tirados por bueyes vs. camiones y tractores podemos citar el costo alto del combustible para estos vehículos y los jornales altos del obreraje. De todas maneras, es evidente que los aserraderos pequeños habrán de continuar siendo por muchos años un importante factor en la industria maderera chilena y por lo tanto no deben escatimarse esfuerzos en mejorar prácticamente las operaciones madereras y el mercadeo. La Corporación de Fomento ya ha dado los primeros pasos hacia dicho objetivo por medio de la organización de una cooperativa de productores por la cual todos los dueños de aserraderos pueden lanzar sus productos al mercado, reciben ayuda al clasificar y revisar la madera y son además asesorados y ayudados al comprar maquinaria y equipo.

Mucho puede hacerse para mejorar las prácticas de corte y acarreo de la madera en Chile introduciendo herramientas simples tales como las sierras tronzadoras y acoplo de cadenas y tenazas o ganchos que evitan el tener que hacerle los conos o "recuellos" para arrastrar las trozas. El arrastre por distancias cortas que hoy impera y que comprende la entrega directa a la plataforma del aserrío, con un estacionamiento mínimo, es muy efectivo. Las operaciones en el aserradero pueden mejorarse esencialmente prestándole más atención a la disposición básica de instrumental y obreraje para evitar manipulaciones excesivas y utilizar en lo posible rodillos y otros utensilios mecánicos en vez de mero trabajo manual.

Sin embargo, el factor más importante para lograr mayor producción es probablemente el de la energía que se suministra a la sierra maestra. La mayoría de los aserraderos de Chile tiene poca energía de manera que para hacer estas mejoras es preciso esperar a que se instalen nuevos y mejores aserraderos o que se reemplace la maquinaria existente. Los expertos recomiendan una caldera de vapor de 100 caballos de fuerza, de 8 ó 9 toneladas y capaz de cortar 1,000 pies tablares por hora. Un camión con remolque capaz de cargar 8 1/2 toneladas por viaje en carreteras razonablemente buenas puede utilizarse eficientemente con un aserradero de esa naturaleza para cargar la madera de la estación del tren o de cualquier otro punto de estacionamiento. Si a tales operaciones de aserraje se le proporciona el debido crédito, la dirección de ingenieros competentes y mercado apropiado valiéndose de una cooperativa de manufactureros podrían vencerse las desventajas de las operaciones en pequeña escala y mejorar la calidad y el rendimiento por hora. Debemos considerar, sin embargo, que en Chile es de primordial importancia entrenar al trabajador en el uso de nuevas herramientas y equipo moderno. Los obreros chilenos son muy diestros en el uso de las herramientas simples que hoy se emplean allí como por ejemplo el hacha pesada de un solo filo y los carros de dos ruedas, pero la maquinaria moderna necesita preparación adicional y supervisión adecuada para su debido funcionamiento.

Además de los aserraderos pequeños, sería conveniente tener un número razonable de aserraderos más grandes, de carácter permanente, con sierras de cinta sin fin, que equiparasen la falta de aserraderos grandes.

Con dichos aserraderos habría más oportunidades para formar industrias integrales, particularmente las que se basan en la utilización de los despojos de aserrío. En Chile se pueden establecer estos tipos de aserraderos en muchos sitios, donde se puede sostener una industria permanente.

En Chile, además de la industria de transformación de la madera de monte en madera escuadrada existe una considerable diversidad de industrias forestales. Desde luego, existen numerosos aserraderos que elaboran productos acabados standard como listones, tabloncillo, marcos de puertas y ventanas, armaduras, tabiques, interiores, etc. Algunas de estas industrias trabajan junto con los aserraderos, algunas en los sitios de estacionamiento de trozas y algunos en las ciudades más industriales. La calidad de los productos de estos aserraderos de acabado es por lo general superior pero los métodos, procedimientos y tipos de maquinaria usados son en la mayoría de los casos ineficientes e innecesariamente costosos. Las fábricas de muebles abundan también, a pesar de que en Chile la mayoría de los muebles son hechos por artesanos en pequeños talleres. Tales condiciones estimulan a los manufactureros a limitar su producción a los artículos más caros donde es menos importante el aporte hecho a los trabajadores y como consecuencia, un mercado extenso e importante se ve inadecuadamente suplido con productos adecuados, con precios equitativos y razonables. La fabricación de embalajes es también una industria importante en Chile donde se usan mucho las cajas de madera para embalar azúcar, objetos de cerámica, productos enlatados, botellas de vino, frutas y vegetales. Cerca de la quinta parte de la madera que se corta se invierte en cajas. Algunas de estas cajas van bien hechas pero muchas están mal construídas y desperdician material que muchas veces está mal secado.

En Chile prospera también la industria de madera multilaminar, la cual ha logrado su actual auge desde 1940. Hay tres compañías que manufacturan chapas en máquinas laminadoras circulares, y se exporta más del 50 por ciento de la producción a Argentina, Perú y Bolivia aunque el consumo local aumenta día a día. En contraste con las demás industrias forestales las plantas que producen chapas circulares están bien equipadas y dirigidas y tienen amplio espacio para las diversas operaciones a efectuarse. La madera multilaminar de Chile se elabora casi por completo en forma de madera terciada, la mayor parte de la cual se usa para la fabricación de muebles. Por consiguiente se preconoce que el mercado de madera multilaminar continuará en ascenso según se vayan manufacturando compensados de más chapas o láminas y de diversos tipos. Sin embargo, por el presente, la capacidad de las plantas está considerablemente por encima de los requerimientos domésticos.

Gran cantidad de la madera chilena se usa también para traviesas, maderaje de minas y postes. La mayoría de las traviesas se fabrican a mano, de madera de roble, especie muy apropiada para este propósito debido a su gran durabilidad natural. Un número considerable del tejamaní de Chile se fabrica de alerce y ciprés. El tejamaní se usa casi exclusivamente en las provincias meridionales como material de techar. Tanto las traviesas como el tejamaní se fabrican en pequeña escala por madereros locales, en particular las traviesas de roble cortadas a mano que frecuentemente se llevan por grupos a las estaciones del ferrocarril u otros sitios de estacionamiento en jangadas o en carros de bueyes. La fabricación de carros de bueyes y vagones es también una industria local importante en Chile donde la escasez de camiones y el precio relativamente alto a la par que la escasez de gasolina han retardado el establecimiento de métodos más rápidos de transporte.

Sin lugar a dudas una de las actividades forestales más importantes y difundidas es la producción de combustible vegetal. Como el país no posee recursos petrolíferos locales y tan sólo una fuente limitada de carbón mineral, es imprescindible que consuma al año una enorme cantidad de carbón vegetal tanto en las industrias como en usos domésticos. Además del uso doméstico el carbón se consume industrialmente en la producción de hierro en lingotes, pólvora negra, gasógeno y para el uso de artesanos tales como hojalateros, plomeros y herreros. El consumo nacional se calcula en no menos de 150,000 toneladas al año y puede que sea mucho más. Excepción hecha del limitado rendimiento del 2 a 3 por ciento del total en dos pequeñas plantas de destilación de madera, el carbón se fabrica por métodos primitivos sin utilización de los productos secundarios. Los principales productos secundarios metanol y ácido acético, disolventes comerciales importantes, no están ampliamente disponibles en fuentes domésticas. Por lo tanto la destilación de maderas duras sería una nueva industria ventajosa y factible en Chile. Ese país tiene abundancia de especies de maderas duras que dan excelentes rendimientos en carbón y productos secundarios y el costo de producción también parece ser favorable.

En el campo de la fabricación de papel y pulpa Chile tiene hoy día una capacidad productiva que equivale al abastecimiento de los mercados locales. En pasados tiempos se importaba la pulpa pero durante los últimos tres años se ha obtenido gran cantidad de pulpa macerada de araucaria y pino monterey (insignis) de plantaciones, particularmente de este último. Además, varias maderas duras indígenas como el olovillo sirven para fabricación de las pulpas abultadas usadas en la confección de libros y papel de imprenta de alta calidad. Parece probable que en el futuro Chile podrá fabricar la pulpa para su consumo doméstico estableciendo fábricas grandes que utilicen el método del sulfato con el pino monterey. La madera de plantaciones se hace cada día disponible en mayores cantidades y otros materiales básicos para esa industria tales como cal, sulfato de sodio y cloruro de calcio también pueden obtenerse en abundancia. También existe algún interés en la utilización de especies chilenas para fabricar rayón, varios tipos de material aislador, alcohol y alimento protéico. En algunos casos se necesita conocimiento del asunto y es necesario investigar para poner en claro las perspectivas de tales posibilidades.

De todas maneras, Chile posee un valioso recurso en bosques naturales, arbolados y plantaciones, que puede ser considerablemente desarrollado. El provecho que se derive de ese desarrollo depende de la capacidad y destreza con que los chilenos puedan fomentar nuevas y extensas industrias, algunas de las cuales parecen, de immediato, factibles y prácticas. Hoy día el recurso forestal de Chile per capita es relativamente grande y su utilización del mismo sólo de moderada a poca. Los mercados domésticos deberán crecer considerablemente según crece el nivel de vida de sus habitantes y los mercados de exportación que se necesitan para utilizar en pleno sus recursos forestales los puede obtener aumentado la eficiencia de sus operaciones industriales. La utilización en pleno de los recursos forestales no procederá con rapidez pero se podrá obtener si se efectúa con la ordenación, habilidad y agudeza comercial adecuada.

Más, si las industrias forestales han de sostenerse permanentemente, Chile debe delinear y poner en práctica una política o norma forestal de amplios alcances. La ley básica de junio del 1931 y la legislación subsiguiente forman ya la piedra angular de tal pauta. Un cuerpo debidamente organizado para formular dicha política lo constituye el Consejo Forestal Nacional, recientemente creado por orden ejecutiva. Una política forestal adecuada habrá de requerir la implantación y expansión de los siguientes objetivos: (1) proveer protección adecuada de los bosques en especial contra el fuego y (2) proveer adecuada ordenación dasocrática tanto a las tierras forestales fiscales como a las privadas.

Ya Chile ha demostrado que tales pasos de avance son factibles donde el valor del bosque es debidamente apreciado y plenamente explotado como lo indica la ordenación intensiva y la protección efectiva contra el fuego que ha podido lograrse en las áreas de plantaciones. Es preciso hacer extensivas al área de bosque natural todas esas medidas, aunque es cierto que su realización es más difícil en este respecto. Un programa forestal plausible requeriría la organización de un servicio forestal con personal y fondos suficientes que sea responsable de la protección y ordenación de los bosques gubernamentales, la administración de programas fiscales aplicables a los bosques privados y la orientación de un programa de ayuda pública a los terratenientes forestales incluyendo ayuda suministrada por el estado en lo relativo a protección forestal, crédito adecuado y fomento de programas didácticos de divulgación sobre el bosque en general, métodos de siembra, investigaciones y extensión.

Résumé

Les forêts du Chili, y compris la végétation naturelle et les peuplements plantés, couvrent une superficie de 16 millions d'hectares, ce qui correspond à 20% de la superficie totale de la république. Mais, les bois d'haute futaie, qui représentent une valeur industrielle positive, ne couvrent que 5 1/2 millions d'hectares desquels plus d'un million est occupé par des peuplements secondaires formés sur l'emplacement d'anciennes forêts appauvries après les coupes imprévoyantes, par des terrains deboisés ou par des brulures. Ces superficies de bois d'haute futaie -- plus du 90% en bois durs -- se composent d'arbres propres du Chili y compris coigüe, Nothofagus dombeyi, tepa, Laurelia serrata; raulí, Nothofagus procera; roble, Nothofagus obliqua; laurel, Laurelia aromatica; olivillo, Aextoxicon punctatum; ulmo, Eucryphia cordifolia; lingue, Persea lingue et aussi un nombre limité mais excellent de forêts de conifères représentées surtout par l'araucaria, Araucaria araucana; l'alerce, Fitzroya cupressoides et le ciprés, Libocedrus sp. Ces forêts, d'ordinaire denses et exubérantes, possèdent un sous-bois touffu. La hauteur moyenne des arbres est de 25 jusqu'à 35 mètres,

sauf l'alerce qui est généralement plus élevé, et les diamètres sont souvent de 100 cm. et peut-être plus. Bien que la forêt possède beaucoup d'essences différentes la plus grande partie du bois provident de 2 à 5 essences. Le coigüe et le tepa comprennent plus de la moitié du volume de bois scié trouvé dans les peuplements utilisables. Le Chili est particulièrement riche en forêts vierges et primitives, remplies d'arbres propres à l'industrie du sciage. La quantité totale de bois de sciage dans ces forêts est peu près 104 billions de "board feet".

En outre des forêts d'haute futaie on rencontre au Chili une superficie substantielle couverte de terre à bois, qui avait été fortement coupée pour en obtenir bois de chauffage et bois pour employer dans les fermes et aussi, une superficie petite, mais importante, couverte de plantations nouvelles, principalement d'eucalyptus, E. globulus, et pin monterey, Pinus radiata. On plante l'alamo, Populus nigra italica pour la fabrication d'allumettes, l'emploi dans les fermes et pour bois brut. Presque toute la superficie des plantations et une grande partie du type sec et accessible de terres à bois est située dans la zone centrale, la oú se trouvent les importantes cités de Santiago et Valparaiso et oú habitent 4/5 de la population du Chili. La zone des bois d'haute futaie proprement dite se trouve principalement entre les rivières Bio Bio et Aysen. Relativement peu de coupes ont été pratiquées au sud de Puerto Montt, exception faite des défrichements faits dans l'île de Chiloe.

Cette réssource forestière constitue le source d'une industrie sur une petite échelle mais très variée. Elle est non seulement la source principale de bois de chauffage pour 80% de la population du Chili mais fournit une quantité substantielle de bois d'oeuvre, bois de caisserie pour la construction de caisses d'emballage des produits agricoles et industriels, bois d'ébénisterie, contreplaqués, bois de mine, piquets de clôtures, traverses, pâte de bois, et d'autres diverses usages. Il y a entre 600 et 700 scieries au Chili dont la majeure partie ne scie plus de 5,000 "board feet" de bois journellement.

Les incendies en forêt constituent le plus dangereux et destructif ennemi des forêts, dû à l'absence de protection organisée pour lutter contre ce ravageur dans toute la région des forêts naturelles. Les pertes annuelles subies dans des périodes récentes à cause des incendies peuvent être estimées à 682 millions de pieds cubes, l'équivalent d'un peu plus de 1% de la superficie forestière totale du Chili et quatre fois la consommation en bois scié.

En outre de l'industrie des scieries il y a aussi un nombre considérable d'usines de bois raboté. Les fabriques des meubles sont abondantes aussi mais la majeure partie échappe à la statistique parce que cette industrie présente un caractère artisanal, les marchandises étant élaborées dans des petits ateliers. La fabrication de caisses d'emballage est considerée comme une industrie importante de la transformation du bois au Chili oú les caisses de bois sont largement utilisées pour l'exportation de toutes sortes de produits comme le sucre, objets de céramique, marchandises en boites, bouteilles de vin, fruits et végétaux.

Le Chili possède aussi une industrie florissante de transformation du bois en contreplaqués. Il y en a trois compagnies qui fabriquent feuilles de placages d'élaboration rotative. Une quantité considérable du bois est transformée en traverses, bois de mine et poteaux. Presque tous les traverses sont élaborées manuellement, utilisant le roble, essence qui se prête la mieux à cause de sa durabilité naturelle.

L'industrie de bois d'éclisse tient aussi une importante place au Chili et provient au long de l'alerce et le ciprés. La fabrication de charrettes et wagons de bois est aussi une industrie domestique importante au Chili oú le manque de camicns avait retardé le développement d'une méthode de transportation plus rapide. La consommation domestique annuelle en charbon de bois y est énorme. En outre des usages domestiques les industries utilisent le charbon de bcis pour diverses besoins économiques. Dans le cadre de l'utilisation de papier et pâte à papier, le Chili possède la capacité précise pour produire le papier nécessaire pour la consommation locale. Au cours des trois dernières années une quantité considérable de pâte à papier avait été produite de l'Araucaria et principalement du Pinus radiata (monterey) obtenu des nouvelles plantations forestières. D'autres bois durs comme l'olivillo, Aextoxicon punctatum, servent pour l'elaboration d'une pâte de bois plus grosse, utilisée dans la fabrication de livres et papier de qualité supérieure.

En tout cas, le Chili possède, parmi ses forêts naturelles, terres à bois et boisements artificiels, une réssource de grande valeur, susceptible d'être développée dans un vaste champ d'activité mais d'une manière réglée et avec l'aide d'une main-d'oeuvre rationnellement éduquée. Cependant, pour remplir le but de rendement soutenu et permanent des industries forestières, le Chili doit développer et exécuter une politique forestière de vaste étendue. Les forestiers du Chili ont prouvé avec l'aménagement intensif mais réglé et la protection adéquate des plantations forestières que ces mesures sont faisables aussi dans les peuplements naturels des contrées oú la valeur des forêts est appréciée et méthodiquement explcitée.

FORESTRY IN THE WINDWARD ISLANDS

A very interesting and informative 183-page report on the present forestry situation and the forestry needs of the islands of Grenada (including Carriacou and the Grenadines), St. Vincent, St. Lucia, and Dominica by the Conservator of Forests, Trinidad and Tobago, after preliminary visits by J. S. Beard1/. Some of the conclusions follow:

The total area of the islands considered is 823 square miles. Population density varies from 177 persons per square mile on Dominica to 750 persons per square mile on Grenada. All of the islands are mountainous.

St. Vincent is the least forested, with an estimated 12 per cent covered with woody growth. Dominica, on the other hand, is approximately 75 per cent forested. Substantial quantities of forest products are imported each year, even to Dominica. On all of the islands the Crown owns substantial acreages of forest land, although in St. Lucia 15,000 acres of unalienated must be surveyed before the Crown obtains legal title.

Protection and administration of Crown forest lands is unsatisfactory in all of the islands. Laws are generally inadequate, often placing the responsibility upon an official charged with numerous other unrelated duties and often with no personal interest in forestry. On some of the islands a Forestry Board has been created, but these boards are generally ineffective, either because of lack of interest upon the part of their membership, or because their capacity is merely advisory.

Recommendations for improved forest management include the selection, demarcation and protection of public reserves in all the islands. In Dominica particularly there is need for basic studies of probable future agricultural needs before this can be done. Following establishment of reserves they should be inventoried and management policies and plans prepared. Proper development of forestry will require educational programs and research.

1/ Bulletin No. 11, Development and Welfare in the West Indies, Advocate Co., Ltd., Bridgetown, Barbados.

FOREST RESOURCES AND FOREST TYPES OF THE PROVINCE OF EL ORO, ECUADOR

Eugene F. Horn
Ecuador

The Ecuadorian Province of El Oro adjoins the Peruvian Department of Tumbez and the Ecuadorian Province of Loja on the south, the provinces of Loja and Azuay on the east, the province of Guayas and the Canal de Jambelí on the north and the Gulf of Guayaquil and the Canal de Jambelí on the west.

Topography and Geology

The chief topographic features of the province are the coastal plain and the Andean foothills. About one-third of the area of the province is occupied by the coastal plain - the remaining two-thirds being occupied by the Andean foothills whose altitude ranges from 100 to 1,000 meters above sea level. There is, however, a range of mountains on the boundary with the province of Azuay called the Cordillera de Chilla whose altitude attains 3,000 meters.

The geology of the province of El Oro is exceedingly simple. The sediments of the coastal plain are of Quaternary age while the Andean foothills are formed of crystalline rocks, chiefly porphyry, andesite, diorite, and other igneous rocks, which appear to have been intruded into rocks of Archaean age such as granite, syenite, gneiss, as well as mica, chlorite and other crystalline schists. These ancient crystalline rocks are exposed everywhere from the border of the coastal plain at the town of Arenillas to the Provinces of Loja and Azuay on the east. The famous gold mines in the canton of Zaruma have their origin in auriferous quartz veins and lodes occuring in the quartz poryphyritic rocks so widely distributed in this region. It is probable that other minerals will be discovered in this province since the region has never been thoroughly prospected except for gold, silver and copper. Hot springs of highly mineralized water are known to occur at two points in the Andean foothills of this province and no doubt they will eventually be developed as "spas" since the climate and elevation are ideal for year-round health resorts. Road construction in the Andean foothills is exceedingly difficult owing to the rough nature of the topography and to the abundance and the crystalline nature of the rock outcrops. The development of the forest and the agricultural resources alone will not warrant the construction of roads. Therefore, the full development of the forest resources of this region will have to await the discovery of new mineral deposits or to the development of the hot springs as health resorts.

Soils

The coastal plain bordering on the Canal de Jambelí and the Gulf of Guayaquil is characterized by dark colored heavy textured soils and plastic subsoils. Further inland on the alluvial plains bordering the Santa Rosa and Jubones Rivers and their tributaries the soil is of a sandy nature layered with silt. The deep sandy loam soils of these valleys have a high water table, are very fertile, and therefore support a luxuriant humid forest vegetation in their natural state. They are, however, largely devoted to agriculture producing excellent crops of coffee, tobacco, corn, plantains, and, to a limited extent, cacao. The soils of the Andean foothills are heavy textured shallow red and yellow lateritic and are usually somewhat plastic below the surface. Owing to the mountainous topography and to the nature of the soils the vegetative cover is less dense than if the land were more level.

Climate

Like the rest of western Ecuador there are two seasons in the Province of El Oro, namely, a wet season extending from November to June and a dry season extending from July to November. The rainfall is very scanty along the coast increasing as one travels inland until the foothills of the Andes are reached. Metereological data collected by the South American Exploration Co. at their mines at Portovelo show that the annual rainfall has varied from 40 to 90 inches during the past ten years. The greatest variation in temperature occurred in 1937 with an average maximum temperature of 85.88°F and an average minimum temperature of 64.72°F. The dry season occurs during the months of lower mean temperature which reduces the moisture loss by evaporation. A further tempering effect of the dry season is the almost daily occurrence of "garúa". The name "garúa" is applied to a very heavy fog or a fine drizzle which is very common throughout the "verano", or summer months, of the year in western Ecuador. The "garúa" comes in the early morning and persists until 9 or 10 o'clock. It varies in intensity and frequently changes into a drizzling rain. Approximately ten percent of the annual rainfall occurs during the dry season. The daily occurrence of cloudy weather certainly lessens the effect of low rainfall during the summer (verano) months of June to November. Overcast skies, falling mist and occasional light showers help to keep the Andean foothills green during the long dry season. The moisture holding capacity of the soils of this forested belt is also an important factor to be considered as well. These forests are therefore more humid and the vegetation more luxuriant than the amount and distribution of the annual rainfall would indicate.

Transportation

The Province of el Oro borders on the Gulf of Guayaquil and the Canal de Jambelí which are both navigable to large motor launches and small motor ships. However, much of the land adjacent to these bodies of water is occupied by tidal marshes covered with impenetrable mangrove thickets and there are few ports which are connected by roads or railroads to the interior of the Province. The principal port is Puerto Bolívar situated on the Canal de Jambelí. Puerto Bolívar is connected with the interior by two railroads of different gauge. One, having a 42-inch gauge, has its terminus at Pasaje - a town of about 1,500 inhabitants situated on the Jubones River twenty five kilometers from Puerto Bolívar. The other, a 30-inch gauge road, extends its lines to Piedras - a distance of 75 kilometers from Puerto Bolívar. From this point an excellent gravel-dressed auto road extends fifty nine kilometers in a southeasterly direction to the gold mines at Portovelo which belong to the South American Exploration Co.

Forest Types

The lowlands and tidal flats bordering on the Gulf of Guayaquil and the Canal de Jambelí are covered with mangrove thickets whose arching roots form impenetrable tangles. The chief species of these mangrove thickets are mangle colorado, Rhizophora mangle, also called mangle de concha and mangle pecho de pava; mangle blanco, Laguncularia racemosa; mangle geli, Conocarpus erecta; mangle salado, mangle negro, or mangle iguanero, Avicennia nitida. Mangle gelí is found only along the edge of the mangrove swamps and does not possess aereal roots.

The rest of the coastal plain, excepting the alluvial lands adjacent to the larger rivers, is or was originally, covered with a dry type of forest. Near the coast where the rainfall is scanty and where arid or semi-arid conditions prevail during at least five or six months of each year there is a belt covered with thorny scrub, branching cacti, spreading algarrobo trees, Acacia, and stunted ceiba trees, Ceiba. Further inland the vegetation takes on a different aspect. The ceiba trees are much larger and taller with characteristic swollen trunks. Associated with them are guayacán, Tabebuia chrysantha, cascól, Libidibia corymbosa, ébano, Zizyphus thyrsiflora, and coquito, Erythroxylon glaucum,- all yielding hard dense woods - along with the yellow flowered bototillo, Cochlospermum vitifolium, and laurel, Cordia. The guayacán tree of the dry forest region of western Ecuador resembles in general appearance, leaves, bark, wood, and the color of its flowers to ipe amarillo or ipe tobaco which is found growing in dry forests in the State of Sao Paulo, Brazil. This dry forest extends a short distance into the lower rocky foothills of the Andes. However, on the clayey foot-hills six kilometers east of the town of Arenillas the presence of palo de vaca, Alseis eggersii, colorado, Lucuma obovata, matapalo, Ficus and other species commonly found in the Evergreen Wet Forest Type is noted. Here, then, is the transition zone between the dry forest of the coastal plain and the humid forest of the Andean foothills. The alluvial plains adjacent to the Santa Rosa and Jubones Rivers and their tributaries possess deep, friable, medium textured soils with a high water table and support an entirely different type of vegetation. Here are found such herbaceous plants as the platanillo, Heliconia, caña brava, Gynerium sacharoides, and bijao, Calanthea lutea, along with such forest trees as guarumo, Cecropia, palo prieto, Erythrina, matapalo, Ficus, guachapelí, Lisiloma guachapele, and caucho, Castilla elastica. These alluvial river plains may be considered as tongues of the Evergreen Wet Forest Type which extends into the coastal plain supporting a dry type of forest.

The Evergreen Wet Forest of the Andean foothills in the Province of el Oro is not so luxuriant as the lowland forest farther north in the valley of the Guayas River. The trees on these sharp ridges and steep slopes are slender and of medium height forming a very light somewhat open forest.

Nonetheless, the sheltered coves possessing a deep soil support the herbaceous plants mentioned above along with the palma real, Cocos butyracea, pambil, Euterpe chaunostachys, Fernan Sanchez, Triplaris guayaquilensis, and the matapalos Ficus and Coussapoa. Other important trees occurring in this type are palo de vaca, Alseis eggersii, palo de rosa, cauje, Pouteria caimito, tillo blanco, balsamo, Myroxylon balsamum, ajo, Gallesia sp., moral fino, Chlorophora tinctoria, balsa, Ochroma lagopus, moral bobo, Sideroxylon sp., and, higher up in the mountains, amarillo, Centrolobium ochroxylon, cedro, Cedrela sp., figueroa, Carapa guianensis, and balsa blanca, Heliocarpus popayanensis. The presence of bálsamo, ajo and balsa blanca here is noteworthy since these three species are found growing in the western part of the State of Sao Paulo, Brazil. In Brazil, balsa blanca is called jangada (raft) owing to the lightness of the wood which renders it suitable for this purpose while ajo is called pau d'alho (garlic tree) owing to the strong garlic odor emitted by the freshly crushed leaves or freshly cut bark. In Brazil, the ridges upon which these two species are found growing are selected for planting coffee since their presence indicates well drained soils of the best quality. The garlic tree (ajo) has also been encountered by the writer in the Chiquitos highlands in eastern Bolivia some 400 kilometers west of Corumbá, Brazil. Since bálsamo also occurs in Acre Territory, Brazil and northeastern Perú it is interesting to speculate as to the geographical route which serves as a connecting link for these species between the humid forests of the western foothills of the Andes in Ecuador and the tropical hardwood forests of Brazil, Perú, and Bolivia on the east side of the Andes as well as the far away Paraná Basin in Brazil. Guayacan, Tabebuia chrysantha, which has been previously mentioned as the most common tree occurring in the dry forests of the Ecuadorian coastal plain, also deserves mention in this connection owing to its resemblance to the ipe amarillo, Tabebuia crysotricha, of the State of Sao Paulo, Brazil, with the above exceptions, the humid forest flora of the Province of El Oro resembles the humid tropical flora of Central America more than the upland rain-forest flora of the Amazon valley. Such species as those mentioned above along with cedro, Cedrela sp., moral fino, Chlorophora tinctoria, laurel, Cordia sp., and figueroa, Carapa guianensis, which are common in the Evergreen Wet Forests of western Ecuador, are connected with the Amazonian flora through Colombia, Venezuela and the Guianas. The humid tropical flora of Central America therefore has its southern limit, on the Pacific side of the Andes, in the Province of El Oro, Ecuador.

Forest Industries

The forest resources of this province have not been greatly developed except locally. The only forest products exported are balsa lumber, guayacán and coquito crossties, and mangrove bark. The guayacán crossties are cut from small crooked trees possessing very little heartwood. Crosscut saws are not used either to fell the trees or cut the trunk into proper lengths for crossties - the axe being used exclusively. Furthermore, many of them are badly hewn or crooked and this, combined with the unequal ends, gives them a very poor appearance indeed. Owing to its durability, red mangrove is one of the chief construction timbers in western Ecuador. The bark, which is rich in tannic acid, is removed and shipped to the tanneries near Guayaquil.

There are two small sawmills at Piedras and one at Pasaje which produce balsa lumber for export. Considerable lumber is whipsawed out all over the province for local construction purposes.

The mining industry is the largest consumer of timber in the province. Both round and square timbers are used. The best mine timbers from the standpoint of strength and durability are sanón colorado, amarillo, moral fino, guayacán, and nogal. However, in the vicinity of the Portovelo mine the local supply of guayacán, amarillo and moral fino has been exhausted. The complete utilization of these forests will largely depend upon the further development of the mineral resources of the Province.

(Traducción del número anterior)

RECURSOS FORESTALES Y TIPOS

FORESTALES DE LA PROVINCIA DE EL ORO, ECUADOR

La provincia ecuatoriana de El Oro linda por el sur con el departamento peruano de Túmbez y la provincia ecuatoriana de Loja; por el este, con las provincias de Loja y Azuay; por el norte, con la provincia de Guayas y el Canal de Jambelí y por el este con el Golfo de Guayaquil y el Canal de Jambelí.

Topografía y Geología

Los caracteres topográficos principales de la provincia son la planicie costanera y las colinas andinas. La meseta de la costa ocupa cerca de un tercio del área de la provincia, los otros dos tercios comprenden la zona ocupada por las colinas andinas cuya altura fluctúa entre 100 y 1,000 metros sobre el nivel del mar. Sin embargo, en los lindes con la provincia de Azuay se encuentra una cadena de montañas conocida como la Cordillera de Chilla cuya altura alcanza hasta 3,000 metros.

La geología de la provincia de El Oro es excesivamente simple. Los sedimentos de la planicie costanera son de la Epoca Cuaternaria mientras que las colinas andinas están formadas por rocas cristalinas principalmente porfídicas, andesíticas, dioríticas y demás rocas ígneas las que parecen haberse introducido dentro de rocas de la Epoca Arqueana tales como granito, sienita, gneis, así como mica, clorita y demás esquistos cristalinos. Estas rocas cristalinas antiguas están expuestas desde el confín de la meseta costanera en la ciudad de Arenillas hasta las provincias de Loja y Azuay en el este. Las famosas minas de oro en el cantón de Zaruma se originaron de las venas y filones de cuarzo aurífero que se encuentran en las rocas porfídicas de cuarzo, tan abundantes en esta región. Es probable que se descubran otros minerales en la provincia ya que los minerales, con excepción del oro, plata y cobre nunca han sido rebuscados a fondo en esta región. Se conoce la existencia de dos manantiales de aguas calientes, altamente minerales en dos sitios en las colinas andinas y sin duda se establecerán allí "balnearios" pues el clima durante todo el año y la altitud son ideales para sitios de solaz y recreo. La construcción de carreteras en las colinas andinas es excesivamente difícil debido a la naturaleza tan accidentada de la topografía y a la abundancia y naturaleza cristalina de las afloraciones rocosas. Por lo tanto, el desarrollo en pleno de los recursos forestales de la región no se efectuará hasta tanto no se descubran nuevos depósitos minerales o se establezcan balnearios en los manantiales calientes.

Suelos

La meseta costanera que bordea el Canal de Jambelí y el Golfo de Guayaquil está caracterizada por suelos pesados, de color obscuro y subsuelos plásticos. Más hacia adentro, en las planicies aluviales que bordean los ríos Santa Rosa y Jubones y sus tributarios respectivos, el suelo es de naturaleza arenosa, con superficie limosa. Los profundos suelos lómico-arenosos de estos valles tienen un nivel freático alto, son muy fértiles y por lo tanto prospera en ellos la exuberante vegetación del bosque higrofítico (húmedo) en su estado natural. Sin embargo, la mayor parte de estos suelos se han dedicado a la agricultura, produciendo excelentes cosechas de café, tabaco, maíz, plátanos, y algún cacao. Los suelos de las colinas andinas son de textura pesada, someros y lateríticos rojos y amarillos. Casi siempre son algo plásticos bajo la superficie. Debido a la topografía montañosa y a la naturaleza de los suelos, la cubierta vegetal es menos densa de lo que sería en suelo más llano.

Clima

Como el resto de la parte occidental del Ecuador, la provincia de El Oro posee dos estaciones: una época lluviosa que se prolonga de noviembre a junio y una época seca que se prolonga de julio a noviembre. La precipitación es muy escasa en la costa pero va aumentando según se penetra tierra adentro hasta llegar a las colinas andinas. Los datos metereológicos registrados por la South American Exploration Co. en sus minas en Portovelo indican que la precipitación anual fluctuó entre 40 y 90 pulgadas durante los últimos diez años. La variación más grande en la temperatura tuvo lugar en el 1937 cuando se registró una temperatura máxima promedio de 85.88°F y una temperatura mínima promedio de 64.72°F. La época seca coincide con la de temperatura promedio más baja lo cual reduce la pérdida de humedad por evaporación. Otro efecto atenuante en la época seca es el garúa. Este nombre se aplica a una niebla pesada o llovizna fina que es corriente durante los meses de verano en el occidente del Ecuador. El garúa empieza temprano en la mañana y persiste hasta las 9 ó 10. Varía en intensidad y frecuentemente se torna en lluvia menuda. Aproximadamente el diez por ciento de la precipitación anual tiene lugar durante la época seca. La presencia diaria de nubes mitiga el efecto de la escasez de lluvia durante los meses de verano de julio a noviembre. Los cielos nublados, el rocío y las lluvias ocasionales ayudan a mantener el verdor en las colinas andinas durante la prolongada época seca. La capacidad de los suelos para retener humedad es también un factor importante en este caso. Sin lugar a dudas los bosques son más húmedos y la vegetación más exuberante de lo que parecería indicar la cantidad y distribución de la precipitación anual.

Transportación

En el golfo de Guayaquil y el Canal de Jambelí que bordean la Provincia de El Oro pueden navegar lanchas grandes de motor y barcos pequeños de motor. Sin embargo, las costas de estas extensiones de agua están ocupadas por pantanos de marea llenos de manglares impenetrables y hay pocos puertos que se comuniquen con el interior de la provincia por carretera o por ferrocarril. El puerto principal es Puerto Bolívar situado en el Canal de Jambelí. El Puerto Bolívar se comunica con el interior por dos ferrovías, de diferente entrevía. Una de ellas, con una entrevía de 42 pulgadas termina en el pueblo de Pasaje, situado en el río Jubones a veinticinco kilómetros de Puerto Bolívar y con una población de 1,500. La otra, con una entrevía de 30 pulgadas llega hasta Piedras, situado a 75 kilómetros de Puerto Bolívar. Desde este sitio se extiende una carretera excelente, cubierta de grava, que corre 59 kilómetros en dirección sudeste hasta llegar a las minas de oro de Portovelo que pertenecen a la South American Exploration Co.

Tipos Forestales

Las bajuras y los llanos de marea que dan al golfo de Guayaquil y al Canal de Jambelí están ocupados por mangles, cuyas raíces tortuosas forman impenetrables madejas sobre el suelo. Las principales especies de estos mangalres son: mangle colorado, *Rhizophora mangle*, también llamado mangle de concha y mangle pecho de pava; mangle blanco, *Laguncularia racemosa*; mangle gelí, *Conocarpus erecta* y mangle salado o mangle negro *Avicennia nitida*, también conocido como mangle iguanero. El mangle gelí se encuentra a lo largo de los bordes del manglar y no tiene raíces aéreas.

El resto de la meseta, con excepción de los terrenos de aluvión adyacentes a los ríos grandes, está o estaba originalmente cubierto de bosque xerofítico. Cerca de la costa, donde la lluvia es escasa o donde prevalecen condiciones áridas o semiáridas durante los últimos 5 ó 6 meses del año existe una faja de vegetación caracterizada por la presencia de arbustos espinosos, cactos, árboles aparasolados de algarrobo, *Neltuma* spp. y árboles achaparrados de ceiba, *Ceiba* spp. Más hacia el interior la vegetación toma otro aspecto diferente. Los árboles de ceiba son mucho más grandes, altos y con sus característicos troncos henchidos. Asociados con éstos últimos están los siguientes árboles que suministran maderas duras y densas: guayacán, *Tabebuia chrysantha*, cascól, *Libidibia corymbosa*, ébano, *Zizyphus thyrsiflora* y coquito, *Erythroxylon glaucum*; junto con el bototillo *Cochlospermum vitifolium* de flores amarillas y el laurel, *Cordia* spp. El árbol de guayacán de la región xerofítica del Ecuador occidental se asemeja por su aspecto general, hojas, corteza, madera y por el color de sus flores al ipe amarillo o ipe tabaco que crece en los bosques xerofíticos en el estado de Sao Paulo, en Brasil. Este bosque xerofítico se extiende hacia alguna distancia en las colinas rocosas más bajas de los Andes. Sin embargo, en las colinas arcillosas seis kilómetros al este del pueblo de

Arenillas se nota la presencia de palo de vaca, Alseis eggersii, colorado, Lucuma obovata, matapalo Ficus spp. y demás especies típicas del bosque mesofítico perennifolio. Esta es pues la zona de transición entre el bosque xerofítico de la meseta costanera y el bosque higrofítico de las colinas andinas. Los llanos aluviales adyacentes a los ríos Santa Rosa y Jubones junto con sus tributarios respectivos poseen suelos profundos, friables, de contextura mediana, con nivel freático alto en los que crece un tipo de vegetación completamente distinto. Aquí se encuentran tales plantas herbáceas como plantanillo, Heliconia spp., caña brava, Gynerium sachariodes y bijao, Calanthea lutea junto con árboles forestales tales como guarumo, Cecropia spp., palo prieto, Erythrina spp., matapalo, Ficus spp., guachapelí, Pseudosamanea guachapele y caucho, Castilla elastica. Estas mesetas ribereñas aluviales pueden considerarse como prolongaciones del tipo de bosque mesofítico perennifolio que se extiende hasta los llanos costaneros en los cuales encontramos un tipo de bosque xerofítico.

El bosque mesofítico perennifolio de las colinas andinas de la provincia de El Oro no es tan exuberante como los bosques de la bajura más al norte, en el valle del río Guayas. Los árboles de estos riscos accidentados y colinas inclinadas son de fuste estrecho, de altura mediana formando un bosque ligero algo abierto. Las abras protegidas que poseen un suelo profundo están cubiertas por las plantas herbáceas arriba mencionadas junto con palmas reales, Cocos butyracea, pambil, Euterpe chaunostachys, Fernán Sánchez, Triplaris guayaquilensis y los matapalos Ficus spp. y Coussapoa spp. Otros árboles importantes que se encuentran en este tipo de bosque son palo de vaca Alseis eggersii, palo de rosa, cauje, Pouteria caimito, tillo blanco, bálsamo Myroxylon balsamum, ajo, Gallesia sp., moral fino, Chlorophora tinctoria, balsa, Ochroma lagopus, moral bobo, Sideroxylon spp. y, más arriba en las montañas se encuentra amarillo, Centrolobium ochroxylon, cedro, Cedrela spp., figueroa, Carapa guianensis y balsa blanca, Heliocarpus popayanensis. La presencia aquí de bálsamo, ajo y balsa blanca es digno de mención ya que también se encuentran en el oeste del estado de Sao Paulo, en el Brasil. En este último país la balsa blanca se conoce con el nombre de jangada (balsa) por lo liviano, factor que la hace adecuada para dicho uso y al ajo se le llama pau d'alho debido al olor que despiden sus hojas o corteza fresca al macerar y que es parecido al de dicha planta. En el Brasil, los cerros donde crecen estas dos especies se seleccionan especialmente para café pues la presencia de estos árboles indica suelos drenados, de la mejor calidad. El autor también encontró palos de ajo en las montañas de Chiquitos al oeste de Corumbá, Brasil. Como el bálsamo también se encuentra en el territorio de Acre, Brasil y en el nordeste del Perú resulta interesante especular en cuanto a la ruta geográfica que, en lo relativo a estas especies, sirve de lazo de unión entre los bosques higrofíticos de las colinas occidentales de los Andes en el Ecuador y los bosques tropicales de maderas duras del Brasil, Perú y Bolivia, en el lado oriental de los Andes así como en la cuenca del Paraná en Brasil. El guayacán, Tabebuia chrysantha, que se mencionó anteriormente como el árbol más común de los bosques xerofíticos de la meseta ecuatoriana también merece mención en lo que se relaciona a este aspecto debido a su semejanza con ipé amarillo Tabebuia crysotricha del estado de Sao Paulo, en Brasil. Excepción hecha de estas peculiaridades la flora forestal higrofítica de la provincia de El Oro se asemeja más a la flora tropical higrofítica de América Central que a los bosques lluviosos de los altos del Amazonas. Tales especies como las arriba mencionadas junto con el cedro, Cedrela spp., moral fino, Chlorophora tinctoria, laurel, Cordia spp. y figueroa, Carapa guianensis que son comunes en los bosques mesofíticos perennifolios del occidente del Ecuador se entrelazan con la flora amazónica a través de Colombia, Venezuela y las Guayanas. La flora tropical higrofítica de la América Central tiene su límite sur por lo tanto en el lado Pacífico de los Andes, en la provincia de El Oro en el Ecuador.

Industrias Forestales

Los recursos forestales de esta provincia sólo se han explotado localmente. Los únicos productos forestales que se exportan son balsa, traviesas de guayacán y coquito y corteza de mangle. Las traviesas de guayacán se cortan de árboles pequeños y torcidos que tienen poco duramen. No se usan sierras ni para cortar los árboles ni para trozarlos a sus debidos largos; sólo se usa el hacha. Además, muchos de ellos se cortan mal y son tan torcidos, lo que junto con sus extremos desiguales les da una apariencia muy pobre. Debido a su durabilidad, el mangle colorado es una de las principales maderas de construcción en el oeste del Ecuador. La corteza, rica en ácido tánico es removida y enviada a las tenerías de Guayaquil.

Existen dos aserraderos en Piedras y otro en Pasaje que producen balsa para exportar. Mucha madera se sierra longitudinalmente para usarse en construcciones locales en toda la provincia.

La industria minera es el más grande consumidor tanto de madera rolliza como aserrada en toda la provincia. Las mejores maderas para usar en las minas desde el punto de vista de fuerza y durabilidad son: sanón, colorado, amarillo, moral fino, guayacán y nogal. Sin embargo, cerca de la mina de Portovelo la fuente de guayacán, amarillo y moral se ha agotado. La completa utilización de estos bosques depende en gran parte del futuro desarrollo de las industrias mineras de la provincia.

Résumé

La province de "El Oro" est située dans le coin sud-ouest de la République de l'Équateur. Un tiers de la superficie de cette province est constitué par la plaine côtière composée de sédiments quaternaires. Le reste se compose de collines formées de roches cristallines. Comme cette superficie est si accidentée, la construction de routes est difficile.

Près de la côte les sols ont une contexture lourde et une couleur obscure mais dans les plaines d'alluvion de l'intérieur ils sont des lehms sablonneux aujourd'hui dediés à l'agriculture. Les sols des collines sont lourds, rouges et jaunâtres, lateritiques et un peu plastiques sous la surface. La précipitation atmosphérique est légère de long de la côte mais selon on procède dans l'intérieur vers les Andes elle augmente graduellement. La saison pluvieuse dure à partir du mois de novembre jusqu'en juin.

Presque tous les jours pendant l'été, un brouillard matinal envahie le long de la côte, apaisant l'effet de la chaleur. Des halliers impénétrables de palétuviers couvrent les basses terres côtières. Dans le reste de la plaine se trouvent les forêts xérophytiques y compris les brousses épineuses et rabougries, cactiers et arbres d'Acacia et Ceiba. Un peu dans l'intérieur sous des conditions moins sèches on trouve un bon nombre d'arbres xérophytiques qui produisent bois durs et denses. Parmi ceux on peut nommer: Tabebuia chrysantha, Libidibia corymbosa, Zizyphus thrysiflora et Erythroxylon glaucum. Les forêts hygrophytiques des collines des Andes s'étendent vers les plaines côtières seulement le long des rivières oú le niveau d'eau est élevé. Les arbres des collines ne croissent si hauts comme dans les meilleurs endroits de la plaine côtière. Parmi eux nous trouvons Cocos butyracea, Euterpe chaunostachys, Triplaris guayaquilensis, Ficus spp., Alseis eggersii, Pouteria caimito, Myroxylon balsamum, Chlorophora tinctoria, Ochroma lagopus, Sideroxylon sp., Centrolobium ochroxylon, Cedrela sp., Carapa guianensis et Heliocarpus popayanensis.

Les industries forestières de la province de "El Oro" n'ont pas été développées que pour la consommation locale, exception fait du bois flot ou Ochroma, les traverses et l'écorce de manglier. Comme l'abatage et la préparation des produits forestiers est faite avec haches, l'utilisation du bois renferme des pertes. Il y a trois petites scieries pour la transformation du bois d'Ochroma. Le bois de construction est généralement scié à main. L'industrie de l'exploitation des mines constitue le plus grand consommateur de bois.

---oOo---

LA INAUGURACION DE LA SOCIEDAD CUBANA DE BOTANICA

La Sociedad Cubana de Botánica inició el 14 de julio de 1944 sus actuaciones encaminadas hacia las finalidades de contribuir al estudio de las Ciencias Botánicas en todos sus aspectos, proteger la flora cubana, despertar en la juventud la afición al estudio de los vegetales, estimular el amor a las plantas divulgando su conocimiento mediante conferencias, concursos, etc., contribuir al desarrollo de la agricultura y ciencias afines, prestar ayuda a toda labor de mejoramiento de plantas medicinales, industriales, etc., colaborar con la repoblación forestal de Cuba y en la utilización de las valiosas especies de su flora y procurar mantener estrechas relaciones con todos los científicos interesados y con las entidades similares.

En vista de tan loables objetivos y del tesonero esfuerzo de los miembros de esta sociedad, no dudamos del éxito que el futuro le tiene reservado a la institución científica que vemos arraigar en el fecundo suelo cubano. El Caribbean Forester felicita a los iniciadores por su elevada misión educadora y espera que la Sociedad Cubana de Botánica forme un lazo más de unión entre todos los países que laboran por el engrandecimiento y progreso de la zona del Caribe.

THE POTENTIALITIES OF FORESTRY ON MONA ISLAND

Frank H. Wadsworth, Forester
Tropical Forest Experiment Station
José A. Gilormini, Planting Specialist
Insular Forest Service
Puerto Rico

Since the close of CCC in July 1942 no forestry work projects have been in progress in the Mona Insular Forest. Because of the investment in plantations and the need for planning of post-war forestry work the writers were sent in September 1944 to the island to determine the present situation and to study the island in the light of its forestry possibilities. This report contains the findings and the conclusions reached.[1]

The Site

Site factors place very definite limitations upon the suitability of Mona island for different purposes. It seems well, therefore, to describe these factors before considering the forests and forestry possibilities.

Location

Mona island is located in Latitude 18°05' North and Longitude 67°55' West. It is approximately 45 miles west of Mayaguez, Puerto Rico and 40 miles east-southeast of Point Espada, Dominican Republic. On a clear day both Hispaniola and Puerto Rico are visible from the higher parts of the island. Three miles north-northwest lies Monito island.

Area

Mona is bean-shaped in outline, with a slightly concave shoreline on the north. It is approximately 6 miles in length (west to east) and 5 miles in width at the widest point, and contains 14,042 cuerdas.[2] Monito contains an additional 100 cuerdas.

Topography

The island is relatively flat, the highest elevation being 272 feet above sea level. The surface is made up of two sharply defined levels, the

---

1/ The writers are indebted to Mr. Armando Morales of the Insular Department of Interior and to Mr. Angel Rivera of the Insular Forest Service for information as to the early history of the island. Information regarding fishing was supplied by Mr. Ventura Barnés of the Insular Division of Fisheries and Wildlife Conservation.

2/ One cuerda is equivalent to 0.9712 acres.

coastal plain and the limestone plateau. Sheer cliffs generally separate the two. About 900 cuerdas (six per cent) is coastal plain, nearly all of which is along the southwest shore where greatest protection from the surf is afforded. Narrow beaches are found along the south and southeast coasts, but the northeast and north coasts are cliffs from the plateau sheer to the sea. The coastal plain does not rise more than 25 feet above sea level.

The plateau, nowhere less than 100 feet above sea level, contains more than 13,000 cuerdas. There are no valleys, due largely to the porous character of the limestone rock, which permits subterranean drainage. There is, however, some variation in the level of the plateau, caused by erosion following rains of high intensity. After heavy rains runoff water and silt collect in shallow sinks or "bajuras" where subterranean drainage is apparently exceptionally good until the water drains away through the rocks.

A striking feature of the island is the extensive system of large caves. Water seepage for centuries through the soluble limestone has been responsible for their development. They may be seen in the cliffs in any part of the island, and a few open out on the surface of the plateau.

Climate

The climate of Mona is very similar to that of southwestern Puerto Rico, with the exception that rainfall is less seasonal. Daily temperatures are high and precipitation is low. Data on average monthly precipitation during the past 22 years, collected near the lighthouse on the east end of the island at an elevation of 173 feet above sea level, are as follows:

Month (Mes)	Precipitation (Precipitación)	Month (Mes)	Precipitation (Precipitación)
	Inches (Pulgadas)		Inches (Pulgadas)
January	1.40	August	3.53
February	2.00	September	4.78
March	2.38	October	5.08
April	2.85	November	4.48
May	4.49	December	2.43
June	3.63		
July	3.61	Total	40.66

Soil

The parent rock is tertiary limestone and gives rise to soils similar to the shallow phases Ensenada Clay and Aguilita stony clay, as described in the Soil Survey of Puerto Rico. These soils are red, brown, or dark grayish, granular and friable. The Gray soil is most common. On the plateau soil depth varies from 0 to about 2 feet. On the coastal plain it is deeper. Part of the coastal plain is sandy, varying from almost sterile low dunes to sandy loam similar to Jaucas sand, as described in the Soil Survey, "a mixture of nearly white coral fragments, sea shells, and a small proportion of igneous sand underlain at a slight depth by soft coral limestone."

Vegetation

Several vegetation types are present, differences being chiefly in structure rather than composition, and based primarily on the availability of soil moisture, as affected by soil depth and rate of evaporation. The extent of these various types, as determined by a timber survey in 1938 in which 122 cuerdas (588 plots) were tallied, is as follows:

	Cuerdas
Cactus brush	2,303
Brush	968
Upland forest	9,482
Central lowland forest	358
Coastal lowland forest	811
Other coastal lowlands	120
Total	14,042

The first four types, comprising all of the plateau, have never been greatly modified in composition by man, although the browsing of the several thousand wild goats has undoubtedly had some influence upon the character of this vegetation. A limited amount of land on the coastal plain has been cleared for farming, and the remaining forest, because of its accessibility, has been cut repeatedly.

The cactus brush, the most xeric type, is found on the plateau along the east, north, and southeast coasts where exposure to the wind is greatest, and includes all of the lighthouse reservation. On the north and southeast coasts it is confined to a narrow strip, but on the east it comprises a band about one mile in width. The vegetation is generally less than 6 feet tall, and is made up of succulents and xerophytic shrubs and small trees. It is of no apparent commercial value at present.

The brush, a transition between the cactus brush and the upland forest, is confined to a narrow strip between these two types, never wider than a quarter mile. It is intermediate in structure and composition between the other two, being taller and having less cactus than the cactus brush. It is generally scrubby, however, and is of no apparent commercial value at present.

The upland forest, the most extensive type, is a complex mixture of small to medium-sized trees, most of which are slow-growing and produce very hard woods. Although more mesophytic than the brush types this forest does not generally form a closed canopy. Most of the trees do not exceed 12 feet in height. The most common species are as follows:

<u>Tabebuia lucida</u>, Britton, Roble
<u>Metopium brownei</u> (Jacq.) Urban, Papayo
<u>Bourreria succulenta</u> Jacq., Vaca
<u>Anamomis fragrans</u> (Sw.) Griseb., Guayabacón
<u>Hypelate trifoliata</u> Sw., Cigua
<u>Eugenia</u> sp. Indio
<u>Canela winterana</u> (L) Gaertn., Barbasco
<u>Exostema caribaeum</u> (Jacq.) R & S, Alvarillo
<u>Amyris elemifera</u> L., Tea
<u>Dipholis salicifolia</u> (L.) A. DC., Sanguinaria
<u>Bursera simaruba</u> (L.) Sarg., Almácigo
<u>Guaiacum officinale</u> L., Guayacán
<u>Guaiacum sanctum</u> L., Guayacancillo
<u>Gymnanthes lucida</u> Sw., Tabaco
<u>Eugenia</u> spp. L., Hoja menuda
<u>Coccolobis laurifolia</u> Jacq., Uvillo
<u>Guazuma ulmifolia</u> (L.) Cockerell, Guácima
<u>Pisonia albida</u> (Heimerl) Britton, Corcho
<u>Plumiera obtusa</u> L., Alelí
<u>Clusia rosea</u> Jacq., Cupey
<u>Guettarda elliptica</u> Sw., Cucubano
<u>Capparis indica</u> (L.) Fawc. & Rendle, Burro
<u>Krugiodendron ferreum</u> (Vahl.) Urban, Hierro
<u>Coccolobis obtusifolia</u> Jacq., Hicaquillo

The central lowland forest is confined to six "bajuras" on the plateau. The surface runoff resulting from rains of high intensity and its attendant erosion have produced a better environment for vegetative growth in these sinks than elsewhere on the plateau. The forest is taller and denser, the dominant trees reaching about 20 feet in height. There is little difference between the composition of this forest and that found elsewhere on the plateau, but the denser canopy here has eliminated the less shade-tolerant species such as <u>Metopium brownei</u>, <u>Plumiera obtusa</u>, and <u>Bursera simaruba</u>.

The coastal lowland forest, confined to the southwestern coastal plain, apparently contained few species not found on the plateau. This forest originally covered the entire coastal strip, or 931 cuerdas, but only about 85 per cent remains forested. This was by far the best developed forest of the island. Large trees still to be found indicate that the deeper soil, higher water table, and wind protection afforded by this site once supported a forest of trees to 20 inches in diameter and 60 feet in height. Undoubtedly only the more shade-tolerant trees of the island were represented. Two species found typically here are <u>Bucida buceras</u> and <u>Laguncularia racemosa</u>.

The other coastal lowlands have been cleared and used for farming for many years. The natural return of forest to this area, if permitted, would be slow.

Past Use

Although Mona is mentioned by early explorers, and there are many interesting legends concerning its role as a hideout of buccaneers and their treasure, little information is available as to its occupation by permanent inhabitants or their modification of its vegetation and use of its resources. Although no attempt is made to trace the full history of Mona here, known historic details which have some bearing upon the character of present forests or their potentialities are presented.

Administration

Mona was under the administration of the Spanish Crown until the end of the Spanish-American war in 1898. It was then placed under the Insular Department of Interior, where it remained until December 22, 1919 when the Governor of Puerto Rico proclaimed the entire island (and Monito), less a 244-cuerda area on the eastern shore in use by the Lighthouse Service for Mona Light, an Insular Forest. Mona has remained in this status, being administered by the Forest Service under the Insular Department of Agriculture and Commerce, to the present date. In 1941 Monito was transferred temporarily to the Federal Government for military use.

Agriculture

Parts of Mona have been farmed more or less continously since the days of Spanish rule. It was noted in the Governor's proclamation in 1919 that 800 cuerdas (the coastal plain) were under an agricultural permit at the time. In April 1922 there were 6 families (46 persons) farming the coastal plain, with 32 acres under cultivation. Farming continued until 1942. At one time the rental fee for the use of the coastal plain reached $500 annually. Although much of the area was in use for pasture, cultivated crops, including corn, squash, watermelon, pigeon peas, beans, onions, sweet potatoes, peanuts, tobacco, cotton, and sugar cane were successfully produced. Coconut palms and papaya have also grown well. Guinea grass was introduced, and has grown satisfactorily on parts of the coastal plain and in the "bajuras" of the plateau. An old report mentions a good elephant-grass pasture.

Phosphates

The numerous caves contained large deposits of guano, a fertilizer. During Spanish rule a German company was authorized to extract guano, and a colony was formed. This resource evidently supported a fairly large industry, for a narrow gauge railroad was built, and heavy machinery was brought to the island. The work was discontinued shortly after the Spanish-American war although concessions remained in effect at least until 1919. The deposits of guano are not yet exhausted.

Recreation

During 1937, through efforts of the Governor, $10,000 was allotted to develop tourism at Mona. An airplane was purchased and cheap transportation was provided from Puerto Rico to a landing field on the beach at La Sardinera. Three wells were drilled and an acre water catchment area was made with zinc roofing. A fishing lodge and seven cottages were constructed, a fishing boat and gear were bought, and the reef was blasted open to permit the entrance of shallow-draft boats. The enterprise was never very successful, as the facilities of Mona interested only a very small sector of the population of Puerto Rico. With the coming of the war this activity ended.

Fishing

Interest in fishing off Mona increased with efforts to develop tourism. The greatest impetus, however, was given in 1943 when the Division of Fisheries and Wildlife Conservation in the Insular Department of Agriculture and Commerce made provision for a colony of fishermen to live during the fishing season (best from April to October) in the abandoned CCC camp, and ice and transportation of the fish to Puerto Rico was supplied by the government. Forty-eight fishermen caught about 45,000 pounds of fish during the first year. Nineteen fishermen returned to Mona during the 1944 season.

Forests

Almost nothing is known concerning early exploitation of Mona's forests. It is to be assumed that the guano colony cleared part of the coastal plain for agriculture and cut at least such trees as were needed for industrial and domestic use. Cutting between 1898 and 1919 may have been extensive, because the Governor's proclamation, in describing the public lands (including Mona) to be set aside as Insular Forests, stated "These. . . lands . . . have been continuously exploited in such a destructive manner that they have become completely deforested or else their forest growth has become greatly depleted". One report mentions that "several hundred tons" of guayacán were removed.

Since the proclamation of most of the island as an Insular Forest, its administration has been in accordance with the Forest Law of November 22, 1917. The protection of the forest was then made a responsibility of the forest guard in the Boqueron unit. Agricultural use continued, and a limited amount of forest cutting for charcoal was permitted through timber sales. Control of cutting was difficult, however, as the guard could seldom go to the island. Two stipulations in early permits were that certain species, which were listed in the permit, would not be cut, and that all products would be brought to Boqueron for tallying. It was frankly admitted in one of the earlier annual reports of the Forest Service that control was not very effective and that there had been illicit felling.

A charcoalwood permit was issued in 1929 which resulted in partial cutting of 2,500 acres on the southern part of the plateau. During the period 1930 to 1937 about 1,000 cords were removed for stakes and charcoal.

Organized forestry began on Mona with the establishment of a 200-man CCC camp at La Sardinera in 1937. A truck trail to the lighthouse was completed, and numerous foot trails were built. An intensive timber survey was made of the entire island, and 432 cuerdas on the coastal plain were planted with trees. The camp was closed in 1941 for lack of funds.

During the period 1938 to 1942 a total of 4,370 sacks of charcoal and approximately 8,000 seven-foot posts were removed, chiefly from the forest plantations.

Forestry Potentialities

It must be kept in mind in considering a project such as forest management on Mona that the capacity of the site to produce is not the only factor which governs success. Here, because of location, forestry, like agriculture, is at an economic disadvantage when compared with Puerto Rico. All work necessary in the establishment, maintenance, and harvesting of forest products will probably always be done by Puerto Ricans at wage rates at least as high as in Puerto Rico and very possibly higher. Also such products must bear the cost of handling and shipping to Puerto Rico, or elsewhere. As most forest products are bulky, this factor is an important one.

The potentialities of forestry on Mona depend basically upon the yields which may be obtained from one or both of the following management policies, (1) silvicultural manipulation of the native vegetation to provide optimum growing conditions for the best trees present, at the expense of inferior trees, or (2) introduction of new, superior tree species and provision for their optimum growth at the expense of inferior native vegetation.

The natural vegetation should receive first consideration for if it can be managed profitably there might never be need to plant. Improvement of the natural forest has one great advantage over planting, the trees are already established. Artificial reproduction, on the other hand, while costly, makes possible introduction of superior tree species into the forest, if such are available.

Natural Vegetation

Three of the vegetation types, the upland, central lowland, and coastal lowland forests, comprising 10,661 cuerdas, contain merchantable forest products. The 1938 timber survey showed them to contain 82,110 posts and stakes and the fuelwood equivalent of 38,450 sacks of charcoal, or 7.8 and 3.6, respectively, per cuerda.

For purposes of forest management the upland and central lowland types, making up the entire plateau forest, may be considered together, as in character and productive capacity they are nearly equal. In the timber survey the total stand on the 9,840 cuerdas of these two types was found to be as follows:

D.B.H. (D.A.P.)	Number of Stems (Número de Troncos): Stake and Post Species (Especies para Estacas y Espeques)	Charcoal Species (Especies de Carbón)	Others (Demás)	Total
4	55,437	170,792	186,730	412,959
6	9,512	26,919	93,365	129,796
8	1,800	3,343	47,796	52,939
10	171	600	15,589	16,360
12		171	5,739	5,910
14		86	1,542	1,628
16			600	600
18			171	171
Total	66,920	201,911	351,532	620,363

It was estimated from these data that the plateau forest contained sufficient material of 4 inches in diameter or larger to produce 80,881 posts and stakes and 38,314 sacks of charcoal. The "other" species are soft-wooded and not suitable for either purpose.

The forest of the plateau can produce only posts, round timbers, and fuelwood. Making what appears to be a logical assumption, the least accessible parts of the plateau forest are considered to be very nearly climax in development, and even in such places the trees are too short to ever produce sawtimber. The forest may previously have contained trees of larger diameter but tree height is evidently limited by a basic ecological reaction to the adverse precipitation-evaporation ratio. Many tree species which are short here grow taller on the better sites of the coastal plain. Trees on the plateau which grow above the general canopy level periodically die back during dry weather.

The plateau forest is very sparse. The survey showed only 8.2 stakes and posts and 3.9 sacks of charcoal available per cuerda, so small an amount as to be costly to harvest, despite the fact that past cuttings removed little in the aggregate, and this, many years ago. Stands on this site will never greatly exceed the density of the present one, which has ten square feet of basal area, or less than ten per cent of the density of mesophytic forests in Puerto Rico.

Tree growth on the plateau is very slow. Observation in areas recently cut over points to what might be expected - very slow recovery. The low rainfall and almost total absence of soil are responsible. Six growth plots established on the plateau in 1937 unfortunately cannot now be located for lack of adequate description.

Improvement of the plateau forest by silvicultural means is possible. Posts and round timbers are worth more per cubic foot than fuelwood, so yield might be increased by improvement cuttings which favor those species such as guayacán, roble, tabaco, alvarillo, and hierro, which produce the best posts, at the expense of inferior species. The trees removed on such cuttings would have little or no sale value. The fully-stocked, all-aged forest which would result, managed on a rotation of maximum cubic foot increment, might contain about the following stand per cuerda:

Diameter (Diámetro)	Number of Trees (Número de Arboles)
Inches (Pulgadas)	
1	303
2	76
3	34
4	19
5	12
6	8

Increases in yield as a result of improvement work would be small and very gradual. The trees to be favored are very slow-growing, particularly on the site in question. Full stocking with the better species would not be reached in less than 60 years and even then the annual yield from the entire plateau would be only about 40,000 posts and stakes, and 5,000 sacks of charcoal. At current Puerto Rican stumpage rates (reduced 20 per cent to compensate for transportation factor at Mona) this would net the government only $3,400 annually, or $0.35 per cuerda. This, of course, excludes unknown costs of the improvement cuttings.

On the coastal plain the forest was much better developed than on the plateau. Although few large trees are found, the present situation is the result of overcutting, and thus the survey data are not an accurate index of possible development. It is believed that the forest of the deeper soils here was similar in structure to the best dry limestone forests of southwestern Puerto Rico. Thus timbers and poles, as well as smaller products could be produced. Following periodic improvement cuttings over many years, favoring the best species available, it is believed that the 811 cuerdas of natural coastal forest would yield at least 5 times as much per cuerda as the plateau forest, $1.75 stumpage per cuerda per year, or about $1,400 for the entire coastal plain.

Artificial Reforestation

It is seen that yields from the native forests will be low regardless of the manner in which they are managed. The introduction of new, better species into the forest should then be considered. From 1937 to 1939 a total of 263,750 trees were planted, 159,706 of Dominican mahogany, Swietenia mahogani; 102,688 of Australian pine, Casuarina equisetifolia; and 1,356 of avelluelo, Colubrina arborescens. A review of this planting work and its results provides valuable information.

Forest planting on Mona is expensive and risky. The first plantings were made with nursery stock shipped from Rio Piedras. Even though there was radio communication, a delay between rains and time of planting was impossible to avoid. Later, a forest nursery was established on the island. This required the development of water, a costly undertaking. Also, to obtain high survival it was necessary to transplant with a ball of earth and then to water the trees after planting until they were established. The planting of 432 cuerdas in 1937 and 1938 cost more than $90.00 per cuerda, including 24 per cent replanting, but excluding cost of maintaining camp, nursery, and development of water. In addition some of the plantations, now seven years old, are still poorly stocked and many are in need of weeding.

Planting on the plateau has not yet proven successful. Three small plots of Swietenia mahagoni, planted in 1937, are the only forest plantings made to date on the plateau. Two of these, one above the camp, and the other above Uvero, were seen. The trees have grown slowly during their first seven years, having attained only 6 to 10 feet in height. They have been attacked repeatedly by shoot borers and so their form is only fair. No results of the broadcasting of seed of this species on the plateau by airplane could be found. The future of this species on the plateau is uncertain, and no further planting is recommended until it is seen whether or not the trees will continue their height growth. It will be necessary for them to grow to at least twice the height of the general canopy level if they are to produce sawtimber. If this proves impossible, planting of this species is not justified, as its growth is not rapid and in small sizes its products are worth no more than those of the native trees.

On the coastal plain planted Casuarina has grown very well. After seven years trees on the sandy parts of the plain are three to seven inches in diameter and average 60 feet in height. It is suited to some 200 cuerdas along the southwest coast. Swietenia is growing well on the heavier soils, having attained 15 feet in height and four inches in diameter in seven years. It is best suited to about 200 cuerdas on the plain. Where the soil is very shallow Swietenia has not had time to show whether it will grow to sawtimber sizes. Colubrina, planted on sands with brackish subsoil, has failed, apparently due to damage to its roots from the salt. The surviving trees are bushy in form having died back repeatedly.

Other tree species might be tried. To date attempts have been made to establish only 3 tree species. One is well adapted. It is therefore possible that other carefully selected species will also prove adapted to the sites and may be more productive than those already planted. On the plateau, for reasons already explained, no primarily sawtimber species should be planted. However, rapid growing post species, such as bayahonda, Prosopis juliflora, might deserve trial on an experimental scale. Such a species might spread rapidly when established. On the coastal plain only areas which cannot be put to a higher use should be devoted to forest production. On such areas maría, Calophyllum calaba, has possibilities. This species produces a good timber, is very well adapted to poor sites, and may be established by direct seeding, a very cheap method. Also, some species of eucalyptus may prove superior to Casuarina.

Forest production on the coastal plain could be much higher per cuerda than on the plateau. If the existing forest area of the coastal plain were continued in this use 200 cuerdas of Casuarina could produce a net stumpage value (subtracting planting costs) of about $20.00 per cuerda per year, chiefly from posts. The production of the balance of the plain, calculated on the basis of natural forest in the absence of proof of eventual productivity of planted trees, would, as previously stated, be $1.75 per cuerda per year, excluding unknown costs of improvement cuttings. The total yield for the coastal plain would thus be $5,070 per year, or $6.25 per cuerda of forested land.

The estimated potential production of the entire island, excluding the cactus brush and brush types is $8,470 annually or $0.80 per cuerda per year.

Forestry and Other Uses

By agricultural standards the per cuerda yield just estimated is so low that attention is immediately drawn to the possibility of other crops which might give a higher yield. The writers do not pretend to be agricultural economists, and therefore will not attempt to draw direct economic comparisons between the returns from forestry and other uses. However, mention of the most probable ones seems desirable here.

Farming

The discovery of relatively high forest yields on the coastal plain should be accompanied by recognition of the fact that some of this same land could produce coconuts, pasture, and some food crops. In fact, the best agricultural land of the plateau was not even considered in calculating forest production, as it is recognized that if the island is to be inhabited at all these best lands should produce food.

If cattle breeding should be considered for Mona it might be possible to develop suitable pasture on most of the coastal plain and in the bajuras as well, an area which might reach 1,000 cuerdas. Assuming 5 cuerdas per animal on the coastal plain and 15 cuerdas in the bajuras about 175 animals could be supported. Such an enterprise would probably require nearly complete elimination of the native goats.

A low-growing xerophytic agricultural crop such as sisal could probably be produced on the plateau. Although yields might be low, almost anything at all would exceed forest yields on this site, particularly in the cactus and brush types.

Phosphates

The future of guano extraction apparently depends upon the cost of extraction and transportation as compared with the cost of other fertilizers. A complete survey of the guano deposits could not be made during our visit, but residents of the island informed us that this resource is by no means exhausted. The extraction of guano need not conflict with any other use of the island.

Recreation

It is believed that recreation should be one of the principal uses of the island. This is another use which need not interfere with the production of the land itself. Although initial development costs will be high, Mona might offer the following to tourists: deep sea fishing, boating, riding, hiking, swimming, and the caves. It is believed that American tourists could be attracted for Mona has some advantages over winter resorts in the States, many of which are crowded, and none of which have as pleasant a winter climate as Mona. It is doubtful that a successful tourist business could be established if based solely on use by Puerto Ricans, as Mona offers little which is not to be found in their native land.

Fishing

It is generally agreed that every effort should be made to increase the fresh fish component in the Puerto Rican diet, and the waters near Mona are one of the best nearby sources of fish. If properly located, a fishing village might be established without interference with recreation or any other use of Mona.

Wildlife

The wild goats and the iguanas are objects of interest to the tourist, also to the hunter. The iguanas are not harmful and should be protected at least to an extent which would maintain their numbers. The policy with regard to the goats should depend upon the degree with which they interfere with forest, forage, or food production. Their numbers should in any case be reduced, as there are indications of overpopulation, a browse-line being visible in some places.

Botanical Use

There is something to be said for the reservation of at least a part of Mona as a natural area for botanical and ecological study. Located between Puerto Rico and Hispaniola the island has some of the flora of each, and contains environmental conditions for plant growth which are unique.

Conclusions

1. The natural forests of Mona, primarily because of adverse environmental conditions, are very low in productivity.

2. All of Monito island and 3,271 cuerdas in eastern Mona, including the lighthouse reservation, are incapable of supporting merchantable trees of any description.

3. The balance of the plateau, 9,840 cuerdas, can support only a short, sparse, slow-growing forest which will produce little wood, and no sawtimber.

4. This plateau forest may be improved in composition silviculturally, but this would not bring a commensurate increase in productivity. Planting would be expensive and results uncertain. Planting of sawtimber species would not produce sawtimber. Introduction of rapid-growing post and fuelwood species, although not yet tried, is a more promising method to increase present yields if planting is contemplated.

5. The coastal plain is largely suitable for and should be permanently dedicated to higher land uses, such as farming.

6. Silvicultural improvement of the remaining coastal forests is economically justifiable, as is planting, where necessary.

7. Mona may remain largely covered with woody growth but forest products will never be available in quantity, and their production will be a minor enterprise as compared to fishing, recreation, and agriculture if these are developed to the greatest extent possible.

(Traducción del artículo anterior)

LAS POTENCIALIDADES DASONOMICAS DE LA ISLA DE MONA

Desde el cese de las actividades de la CCC (Cuerpo Civil de Conservación) en julio de 1942, no se ha llevado a cabo ningún proyecto de trabajos dasonómicos en el Bosque Insular de la isla de Mona. Debido a los gastos incurridos al establecer las plantaciones y a la necesidad de planear los trabajos forestales a efectuarse en la post-guerra, los autores fueron enviados a la isla en septiembre del 1944 para determinar la condición actual de este bosque y estudiar a la vez las posibilidades dasonómicas de la isla. Este informe incluye los hallazgos y conclusiones a que se llegó.

El Medio Estacional

Los factores inherentes al medio estacional establecen limitaciones bien definidas a la adaptabilidad de la isla de Mona para los diferentes propósitos. Parece oportuno, por lo tanto, describir estos factores antes de entrar en consideraciones sobre los bosques y las posibilidades dasonómicas de la isla.

Situación

La isla de Mona está situada en la latitud 18°05' al norte y en la longitud 67°55' al oeste, a cerca de 45 millas al oeste de Mayaguez, Puerto

Rico y 40 millas al este-sudeste de Punta Espada, Santo Domingo. En un día despejado tanto Hispaniola como Puerto Rico pueden verse desde las partes culminantes de esta isla. Tres millas al norte-noroeste se encuentra la isla de Monito.

Area

El contorno general de la isla de Mona tiene forma arriñonada, con el litoral norte ligeramente cóncavo. Tiene aproximadamente 6 millas de largo (de este a oeste), 5 millas de ancho por el sitio más ancho (de norte a sur) y ocupa una superficie de 14,042 cuerdas.1/ La isla de Monito aporta 100 cuerdas adicionales.

Topografía

La isla es relativamente plana pues su punto culminante tiene solamente 272 pies sobre el nivel del mar. Su relieve comprende dos niveles marcadamente definidos: la llanura costanera y la meseta calcárea las que se ven generalmente separadas por escarpados riscos. La llanura costanera está constituída por cerca de 900 cuerdas (equivalente al 6% del total) la mayoría de las cuales se encuentra en el litoral sudoeste donde existe mayor protección contra la marejada. En las costas del sur y sudeste podemos observar estrechas playas pero en el norte y el nordeste el litoral está formado por riscos que se van sucediendo desde la meseta hasta el mar. La planicie costanera no excede de 25 pies sobre el nivel del mar.

La meseta consta de más de 13,000 cuerdas y en ningún sitio tiene menos de 100 pies sobre el nivel del mar. No hay valles debido en gran parte a la naturaleza porosa de la roca cálcarea la que facilita el drenaje subterráneo. Existe alguna variación en cuanto a los niveles de la meseta, originada por la erosión que provocan las lluvias intensas. Después de las lluvias fuertes el agua de deslave y los sedimentos se empozan en someras cavidades conocidas con el nombre de "bajuras", donde el drenaje subterráneo parece ser excepcionalmente bueno, prolongándose hasta que toda el agua se escurre a través de las rocas.

Una característica notable de la isla es el extenso sistema de grandes cuevas. Su formación se debe a que por siglos el agua se ha ido colando por la roca, arrastrando consigo las sales solubles. Muchas de ellas pueden verse en los riscos en cualquier parte de la isla y algunas abren a la superficie de la meseta.

Clima

El clima de la isla de Mona es muy similar al que prevalece en la parte sudoeste de Puerto Rico con excepción de que la lluvia observa menos

---

1/ Una cuerda equivale a 0.9712 acres. Hacemos notar a los lectores de la América Hispana que en las cifras la coma y el punto tienen una significación inversa a la de esos países debido al origen norteamericano del texto original.

los términos de las estaciones. La temperatura diaria es alta y la precipitación es baja. Los siguientes datos muestran la precipitación mensual promedio abarcando el período entre los últimos 22 años y obtenidos cerca del faro situado en el extremo este de la isla, a una elevación de 173 pies sobre el nivel del mar. (Véase la página 220)

Suelos

La roca madre consiste de piedra caliza terciaria la que origina suelos similares a las fases someras de la arcilla Ensenada y de la arcilla pedregosa Aguilita, que aparecen descritas en el Soil Survey of Puerto Rico. Estos suelos son de color rojo, pardo o grisáceo obscuro, granulares y friables. El más común es el suelo gris. En la meseta la profundidad del suelo varía entre 0 y 2 pies. En la planicie costanera es más profundo. Parte de la planicie costanera es arenosa y varía entre dunas bajas y casi estériles y suelos lómico-arenosos parecidos a la arena Jaucas descrita en el Soil Survey como sigue: "una mezcla de fragmentos de coral casi blanco, residuos marinos y una escasa proporción de arena ígnea con un subsuelo de piedra caliza blanda y coralina a poca profundidad".

Vegetación

Existen en la isla varios tipos de vegetación que difieren principalmente más en estructura que en composición debido primordialmente a la cantidad de agua en el suelo lo cual depende de la profundidad edáfica y del índice de evaporación. Según fué determinado en un reconocimiento forestal practicado en 1938, en 122 cuerdas (588 lotes), la extensión de estos tipos es como sigue:

	Cuerdas
Maleza de cactos	2,303
Maleza	968
Bosques de altura	9,482
Bosques de la bajura central	358
Bosques de la bajura costanera	811
Demás bajuras costaneras	120
Total	14,042

Los primeros cuatro tipos que comprenden toda la superficie de la meseta nunca han sido grandemente modificados en su composición por el hombre pero el ramoneo de los varios millares de cabras tiene indudablemente alguna influencia sobre la naturaleza de esta vegetación. Una porción limitada del bosque en la planicie costanera ha sido tumbado para roturar el resto del mismo, debido a su accesibilidad, ha sido cortado repetidas veces.

El tipo más xerofítico o sea la maleza de cactos se encuentra en la meseta, a lo largo del litoral este, norte y sudeste donde es mayor la exposición al viento e incluye por lo tanto toda la reserva alrededor del faro. La faja que forma la maleza de cactos en el litoral norte y sudeste es muy estrecha pero la que forma en el este tiene cerca de una milla de ancho. La altura de la vegetación es generalmente menor de 6 pies y consiste de plantas suculentas y arbustos y árboles xerofíticos de pequeño tamaño. Hoy día carece aparentemente de valor comercial.

La maleza, que constituye una transición entre la maleza de cactos y los bosques de la altura, está confinada a una estrecha faja localizada entre estos dos tipos y su tamaño no pasa nunca de un cuarto de milla. En estructura y composición muestra una etapa intermedia entre ambos tipos pues es más alta y tiene menos cactos que la maleza de cactos. Es por lo general achaparrada y en el presente no tiene ningún valor comercial aparente.

Los bosques de la altura forman el tipo más extendido y están constituídos por una mezcla compleja de árboles de pequeños a medianos, la mayoría de los cuales son de crecimiento lento y producen maderas muy duras. Aunque son más mesofíticos que los tipos de maleza este bosque no forma por lo general un dosel cerrado. La mayor parte de los árboles no excede de 12 pies de altura. Las especies más comunes son las siguientes: (Véase la página 222)

El bosque de la bajura central se encuentra solamente en seis "bajuras" en la meseta. El deslave superficial originado por las fuertes lluvias, acompañado por la erosión ha reunido en estos sitios bajos un ambiente mejor que en otros sitios de la meseta. El bosque es más alto y más denso. Los árboles dominantes alcanzan hasta cerca de 20 pies de altura. Existe poca diferencia entre la composición de este bosque y la del resto de la meseta pero como el dosel es más denso las especies como Metopium brownei, Plumiera obtusa y Bursera simaruba, por ser menos tolerantes de la sombra, han sido eliminadas.

El bosque de la bajura costanera está limitado a la planicie del sudoeste y tenía aparentemente pocas especies que no estuvieran presentes en la meseta. Este bosque cubría otrora toda la faja costanera o sea 931 cuerdas pero sólo el 85 por ciento de este área continúa embosquecida. Por mucha ventaja era éste el bosque mejor desarrollado de la isla. La presencia hoy día de árboles grandes indica que el suelo más profundo, el nivel freático más alto y la protección que ofrece este sitio contra el viento daban margen a un bosque con árboles hasta de 20 pulgadas de diámetro y 60 pies de altura. Sin lugar a dudas, solamente los árboles tolerantes de sombra están aquí representados. Dos especies típicas en este tipo de bosque son: Bucida buceras y Laguncularia racemosa.

Las demás llanuras costaneras de la bajura han sido limpiadas durante muchos años con propósitos de cultivos agrícolas. Si se recurre a la regeneración natural, ésta procedería muy lentamente.

Usos Anteriores

Aunque los exploradores antiguos mencionaban a la isla de Mona y aunque existen numerosas leyendas que hablan de la isla como escondite de piratas con sus tesoros, hay poca información que indique que ésta fuese ocupada por pobladores permanentes ni que hubiese la subsiguiente modificación de la vegetación ni uso de sus recursos. Aunque no es nuestro propósito trazar aquí una historia completa de la isla de Mona, presentamos sin embargo los hechos históricos conocidos que tienen algo que ver con el carácter actual de los bosques o con sus potencialidades.

Administración

Hasta el final de la Guerra Hispano-Americana en 1898, la isla de Mona estuvo bajo la administración de la Corona de España. Por ese entonces pasó a la custodia del Departamento del Interior del Gobierno Insular hasta el 22 de diciembre de 1919 cuando el Gobernador de Puerto Rico declaró Bosque Insular a toda la isla (junto con Monito), con excepción de un área de 244 cuerdas en la costa este donde radica el Servicio del Faro. Mona ha permanecido hasta la fecha en esas condiciones, siendo administrada por el Servicio Forestal del Departamento Insular de Agricultura y Comercio. En 1941 la isla de Monito se transfirió temporalmente a la tutela del Gobierno Federal para usos militares.

Agricultura

Desde los días del régimen español varias partes de la isla han estado más o menos contínuamente bajo cultivo agrícola. En la proclama expedida por el gobernador en 1919 consta que 800 cuerdas (la planicie costanera) estaban sujetas a un permiso agrícola durante ese tiempo.

En abril de 1922 había 6 familias (46 personas) que cultivaban 32 acres en la planicie costanera. El cultivo agrícola prevaleció hasta el 1942. En cierta época se obtuvo hasta $500 anuales por concepto de rentas por uso de la planicie costanera. Aunque gran parte del área se usaba para pastoreo, tales cosechas agrícolas como maíz, calabaza, melones, chícharos, habichuelas, cebollas, batatas, maní, tabaco, algodón y caña de azúcar se producían allí con éxito. También crecían bien las palmas de coco y las papayas. La yerba de guinea se introdujo allí y ha crecido satisfactoriamente en algunas partes de la planicie costanera y en las "bajuras" de la meseta. En un informe antiguo se menciona la existencia de pastos de yerba elefante.

Fosfatos

Las numerosas cavernas contenían enormes depósitos del fertilizante conocido con el nombre de guano. Durante el régimen español, una compañía alemana obtuvo autorización para extraer el guano, creándose allí una pequeña colonia. Este recurso evidentemente sostenía una industria bastante grande pues se construyó una ferrovía de entrevía estrecha y se trajo maquinaria pesada a la isla. Poco después de la guerra Hispano-Americana se paralizó el trabajo aunque las concesiones siguieron en pie por lo menos hasta el 1919. Aún no se han agotado los depósitos de guano.

Recreación

En el 1937, por iniciativa y esfuerzo del gobernador se otorgaron $10,000 para desarrollar el turismo en la isla de Mona. Se compró un avión que proveía transportación barata desde Puerto Rico hasta el campo de aterrisaje en la bahía de La Sardinera. Se excavaron 3 pozos y se construyó un área de captación de 1 acre con techo de zinc galvanizado. Se construyó una caseta de pesca y 7 cabañas, se compró un bote y utensilios de pesca y se dinamitó el escollo para que pudieran entrar los botes de poco calado. La empresa nunca tuvo mucho éxito ya que sólo una parte muy pequeña de la población de Puerto Rico estaba interesada en las facilidades desarrolladas en la isla de Mona. Con el advenimiento de la guerra cesó por completo esta actividad.

Pesca

El interés en la pesca aumentó en la isla con los esfuerzos para desarrollar el turismo. Sin embargo el mayor ímpetu se originó en 1943 cuando la División de Pesca y Conservación de la Vida Silvestre, adscrita al Departamento de Agricultura y Comercio del Gobierno Insular hizo lo pertinente para establecer una colonia de pescadores que habría de vivir en el campamento abandonado de la CCC durante la época de pesca (mejor dicho, de abril a octubre). El gobierno también suministró el hielo y la transportación del pescado a la isla. Durante el primer año 48 pescadores obtuvieron 45,000 libras de pescado. Durante la temporada de 1944, diecinueve pescadores volvieron a la isla de Mona.

Bosques

No se sabe casi nada sobre las primeras explotaciones de los bosques de la isla de Mona. Es lógico asumir que la colonia creada con motivo de los yacimientos de guano rozó parte de la planicie costanera para fines agrícolas y cortó los árboles que necesitaba para sus necesidades industriales y domésticas. Puede que las cortas efectuadas entre 1898 y 1919 hayan sido extensivas ya que el Gobernador al describir en su proclama las tierras públicas (incluyendo las de la isla de Mona) que debían reservarse como Bosques Insulares se expresó así: "Estas . . . tierras . . . han sufrido una explotación continua en forma tan destructora que o están completamente desprovistas de bosque o su vegetación arbórea ha sido en gran parte arrasada". En un informe se menciona que "algunos cientos de toneladas" de guayacán han sido removidas.

Desde que la mayor parte de la isla de Mona fué proclamada Bosque Insular, su administración se efectuó de acuerdo con la Ley Forestal del 22 de noviembre de 1917. La responsabilidad de la debida protección del bosque recayó sobre el guardabosque de la unidad de Boquerón. El aprovechamiento agrícola continuó y mediante ventas se permitió el corte de una cantidad limitada de leña para carbón. Sin embargo, el control sobre las ventas era difícil porque el guarda podía ir pocas veces a la isla. Los primeros permisos estipulaban que ciertas especies enumeradas en él no podían ser cortadas y que todos los productos debían ser medidos en Boquerón. En uno de los primeros informes anuales del Servicio Forestal se adujo francamente que el control de la corta no era muy efectivo y que habían tenido lugar cortas ilegales. Un permiso para cortar madera de hacer carbón, otorgado en 1929, dió como resultado la corta parcial de 2,500 acres en la parte sur de la meseta. Durante el período de 1930 a 1937 se removieron cerca de 1,000 cords para usar en forma de estacas y carbón.

En la isla la dasonomía organizada empezó sus esfuerzos en 1937 en La Sardinera con el establecimiento de un campamento CCC que contaba con 200 hombres. Se terminó de construir un camino de camión que llegaba hasta el faro y se hicieron varios senderos. También se llevó a cabo un reconocimiento intensivo de los recursos forestales de toda la isla y se sembraron árboles en 432 cuerdas de la planicie costanera. El campamento fué cerrado en 1941 por falta de fondos.

Durante el período de 1938 a 1942 se removió principalmente de las plantaciones un total de 4,370 sacos de carbón y aproximadamente 8,000 espeques de 7 pies de largo.

Potencialidades Dasonómicas

Al considerar un proyecto tal como la ordenación dasocrática de la isla, debe tenerse en cuenta que la capacidad productiva del medio estacional no es el único factor que determina el éxito. En este caso, debido a la localización, lo mismo la dasonomía que la agricultura están colocadas en un plano económico desventajoso si se compara con Puerto Rico. Probablemente los puertorriqueños harán siempre todos los trabajos de establecimiento, conservación y cosecha de los productos forestales, a razón de los jornales prevalecientes en Puerto Rico o posiblemente aún más altos. A esto es preciso añadir el costo de manipulación y transportación a Puerto Rico o demás sitios. Este último es un factor de importancia debido a que la mayor parte de los productos forestales son abultados.

Las potencialidades dasonómicas de la isla de Mona dependen básicamente del rendimiento que puede obtenerse siguiendo una o ambas de las siguientes normas dasocráticas: (1) ordenar silviculturalmente la vegetación nativa para proveer a los árboles mejores con condiciones óptimas de desarrollo, a expensas de los árboles inferiores o (2) introducir nuevas especies de árboles superiores y proveerles condiciones óptimas de desarrollo a expensas de las especies nativas inferiores.

A la vegetación natural debe otorgársele mayores consideraciones porque si se maneja con provecho nunca habrá necesidad de plantar. El mejoramiento de la vegetación forestal existente tiene una gran ventaja sobre la plantación y es que los árboles ya están arraigados. Por el contrario, la reproducción artificial aunque es costosa, hace posible la introducción de especies forestales superiores si es que las hay.

Vegetación Natural

Los tres tipos de vegetación que contienen madera cortable son: los bosques de altura, los bosques de la bajura central y los bosques de la bajura costanera, todos los cuales suman 10,651 cuerdas. El reconocimiento forestal de 1938 demostró que contienen 82,110 rollos y fustes y el equivalente en madera de 38,450 sacos de carbón o sean 7.8 y 3.6 por cuerda respectivamente.

Para los propósitos dasocráticos los tipos de bosques de altura y los de la bajura, que forman toda la parte forestal de la meseta, pueden considerarse en conjunto ya que son casi iguales en lo relativo a carácter y capacidad productiva. En el reconocimiento forestal practicado en 1938 el total del rodal en las 9,840 cuerdas de estos dos tipos de bosques estaba constituído como sigue: (Véase la página 226)

De estos datos pudo deducirse que el bosque de la meseta tenía suficientes fustes de 4 pulgadas o más de diámetro para producir 80,881 espeques y estacas y 38,314 sacos de carbón. Las "demás" especies son blandas y no sirven para ninguno de estos propósitos.

Los bosques de la meseta solamente pueden producir rollos, espeques y leña. Por deducción aparentemente lógica, las partes menos asequibles del bosque de la meseta se consideran muy próximas a la fase clímax y aún en esos sitios los árboles son muy cortos para poder llegar algún día a producir madera aserrable. Puede que antes el bosque tuviese árboles de mayor diámetro pero evidentemente la altura dendrológica está limitada por una reacción ecológica básica a la proporción adversa de la precipitación-evaporación. Muchas especies arbóreas que son aquí más bajas crecen más en los mejores sitios de la planicie costanera. Los árboles de la meseta que sobresalen del nivel general del dosel forestal sufren periódicamente durante la sequía por los efectos de la marchitez descendente.

El bosque de la meseta es muy ralo. El reconocimiento indicó que a pesar de que los cortes efectuados en el pasado lejano extrajeron una parte muy pequeña del total, la cantidad de espeques y estacas que podría obtenerse por cuerda sería solamente de 8.2 además de 3.9 sacos de carbón por cuerda. Los rodales de esta localidad nunca serán más densos de lo que son hoy día, es decir con un área basimétrica de 10 pies cuadrados por acre o sea menos del 10 por ciento de la densidad de los bosques mesofíticos de Puerto Rico.

El crecimiento de los árboles de la meseta es muy lento. Al observar las áreas que han sido cortadas totalmente se puede tener una idea de lo que es de esperarse - renovación muy lenta. Todo ello se debe a la escasez de lluvia y a la ausencia casi total de suelo. En 1937 se señalaron seis cuarteles para prueba de crecimiento pero desgraciadamente no han podido ser localizados debido a falta de una descripción adecuada.

El bosque de la meseta puede mejorarse silviculturalmente. Como los rollos y espeques valen más por pie cúbico que la leña, debe aumentarse el rendimiento de los primeros por medio de cortas de mejora en las cuales se beneficien tales especies que producen buenos espeques como guayacán, roble, tabaco, alvarillo y hierro a expensas de las especies inferiores. Los árboles que se removerán en esas cortas tendrán poco o ningún valor. El bosque de edades múltiples y bien provisto que se produciría después de estas cortas de mejora tendría la siguiente provisión de material por cuerda, ordenado a base de turnos con incrementos máximos en pies cúbicos: (Véase la página 227)

El aumento en rendimiento como resultado del trabajo de mejora sería poco y muy gradual. Los árboles que habría que favorecer son de crecimiento muy lento particularmente en un medio adverso como lo es éste. Por lo tanto no se obtendría un rodal de especies buenas completamente provisto sino al cabo de no menos de 60 años y aún así el rendimiento anual de toda la meseta sería sólo de 40,000 espeques y estacas y 5,000 sacos de carbón. Haciendo los cómputos a base del precio de madera en Puerto Rico (restándole el 20 por ciento para compensar el factor de transportación de la isla de Mona) el gobierno obtendría una ganancia líquida de sólo $3,400 al año o sea $0.35 por cuerda. Esta cifra, desde luego, no incluye los gastos de las cortas de mejora que no es posible evaluar.

El bosque de la zona costanera está mucho mejor desarrollado que el de la meseta. Aunque existen allí pocos árboles grandes, la situación actual se debe a la corta inmoderada y por lo tanto los datos del reconocimiento no ofrecen indicio seguro del desarrollo posible en el futuro. Se cree que los bosques en los suelos más profundos de la meseta eran similares en estructura a los mejores bosques de la zona caliza seca al sudoeste de Puerto Rico. Es posible por lo tanto que además del material de pequeñas dimensiones puedan producir también postes y madera aserrable. Después de las cortas de mejora que han de efectuarse periódicamente por muchos años, favoreciendo las mejores especies disponibles, se cree que las 811 cuerdas del bosque natural de la costa rendirán por lo menos cinco veces tanto como el bosque de la meseta; es decir, $1.75 en pie por cuerda cada año, equivalente a $1,400 anuales por año en toda la planicie costanera.

Reforestación Artificial

Es evidente que el rendimiento de los bosques nativos será bajo no importa la forma en que se ordenen dasocráticamente. Por lo tanto debe considerarse la introducción en el bosque de especies nuevas y mejores. Desde el 1937 al 1939 se sembraron 263,750 árboles entre los cuales 159,706 eran de caoba dominicana, *Swietenia mahagoni*; 102,688 eran de pino australiano, *Casuarina equisetifolia* y 1,356 eran de avelluelo, *Colubrina arborescens*. Una breve reseña de estos trabajos de plantación y los resultados obtenidos constituyen valiosa información.

La plantación forestal en la isla de Mona resulta un trabajo costoso y con el que se corren muchos riesgos. Las primeras plantaciones se efectuaron con arbolitos del vivero de Río Piedras. Aunque había comunicación radiofónica, fué imposible evitar el retraso entre las lluvias y el período de siembra. Luego se estableció un vivero en la isla. Esto requería suministro de agua, que constituye empresa costosa. Además, para obtener una supervivencia alta será preciso sembrar con cepellón y luego regar el arbolito hasta que hubiere arraigado. La siembra de 432 cuerdas en 1937 y 1938 costó más de $90 por cuerda incluyendo una reposición de fallas de 24 por ciento del total pero excluyendo el costo de funcionamiento del campamento, vivero y suministro de agua. Algunas de las plantaciones que hoy día cuentan siete años están todavía mal provistas y muchas de ellas necesitan desyerbo.

Aún no puede decirse si la plantación en la meseta ha sido un éxito o un fracaso. Tres lotes pequeños en los que se plantó Swietenia mahagoni en 1937 son las únicas plantaciones forestales que se efectuaron en la meseta. Pudimos ver dos de ellas, una más arriba del campamento y la otra más arriba de Uvero. Los árboles han crecido lentamente durante los primeros siete años pues sólo tienen de 6 á 10 pies de altura. Varias veces han sido atacados por taladradores de los vástagos o retoños y por lo tanto su forma es sólo regular. No se halló ningún indicio de las siembras al voleo efectuadas por medio de aeroplano. El futuro de esta especie en la meseta es incierto y no se recomienda ninguna plantación adicional hasta tanto no se sepa si los árboles continuarán creciendo. Para que puedan producir madera aserrable será preciso que crezcan por lo menos el doble que el nivel del dosel general. Si no sucede así, no tiene justificación ninguna la futura siembra de esta especie pues su crecimiento no es rápido y en pequeñas dimensiones sus productos no valen más que los de especies nativas.

En la planicie costanera los arbolitos de Casuarina han crecido muy bien. Al cabo de 7 años los árboles de las partes arenosas de la planicie tienen de 3 a 7 pulgadas de diámetro y un promedio de 60 pies de altura y se ve que se adapta bien a algunas 200 cuerdas a lo largo del litoral sudoeste. La caoba va creciendo bien en los suelos más pesados pues en 7 años ha adquirido una altura promedio de 15 pies y 4 pulgadas de diámetro. Se adapta mejor a cerca de 200 cuerdas de la planicie. Allí donde el sueló es somero, no puede decirse aún si la caoba podrá crecer hasta tamaños aserrables. La Colubrina que se sembró en terrenos arenosos con subsuelo salobre ha fracasado debido probablemente a que la sal dañifica la raíz y los árboles que persisten son achaparrados y sufren repetidamente de marchitez descendente.

Sería factible tratar con otras especies. Hasta la fecha sólo se han tratado 3 especies. Una de ellas se ha adaptado bien. Es posible pues que otras especies cuidadosamente seleccionadas puedan adaptarse también a esos sitios y mejor aún, ser más productivas. En la meseta, por las razones anteriormente expuestas, no debe sembrarse ninguna especie primordialmente aserrable. Sin embargo merecen someterse a prueba las especies como Prosopis juliflora de crecimiento rápido que sirvan para espeques. Una especie como ésta puede que se esparza rápidamente una vez arraigada. En la planicie costanera sólo deben dedicarse a bosques aquellos terrenos que no tengan una utilización mejor. En tales áreas la maría, Calophyllum calaba, tiene algunas posibilidades. Esta especie produce buena madera, se adapta bien a los sitios pobres y puede regenerarse por siembra directa, un método que resulta muy barato. Además, puede que algunas especies de eucalipto resulten más convenientes que la casuarina.

La producción forestal de la planicie por cuerda puede ser mucho más elevada que la de la meseta. Si el área forestal actual en la planicie costanera se continuase aprovechando en esa forma las 200 cuerdas de casuarina podrían producir un total neto en pie (restando el costo de las siembras) de cerca de $20 anuales por cuerda, principalmente de espeques. La producción del resto de la planicie, calculándola a base del bosque natural y en vista de la falta de prueba de la productividad de los árboles plantados sería, como dijimos antes, de $1.75 por cuerda por año, sin incluir los gastos no conocidos de las cortas de mejora. De manera que, el rendimiento total de planicie costanera sería de $5,070 al año o sea $6.25 por cuerda de tierra forestal.

La producción potencial que se calculó para toda la isla, excluyendo la maleza de cactos y otro tipo de maleza es de $8,470 anuales o sea $0.80 al año por cuerda.

Dasonomía y Demás Usos

A juzgar por los standards agrícolas el rendimiento por cuerda que indicamos poco más arriba es tan bajo que enseguida se piensa sobre las posibilidades de otròs productos de mayor rendimiento. Los autores distan mucho de presumir de economistas agrícolas y por lo tanto no tratarán de hacer comparaciones entre los rendimientos dasonónicos y los demás. Sin embargo, conviene mencionar los más probables.

Cultivos Agrícolas

Al hallazgo de los rendimientos forestales relativamente altos de la planicie costanera debe añadirse el hecho de que parte de estos terrenos pueden muy bien usarse para producir cocos, pastos y algunas cosechas agrícolas. De hecho, en los cálculos de aprovechamiento forestal que se hicieron ni siquiera se tomaron en consideración los terrenos agrícolas de la meseta ya que se considera que si la isla ha de habitarse alguna vez estas tierras mejores deben rendir sólo cosechas alimenticias.

Si se tuviere en mente establecer una industria pecuaria en la isla sería posible obtener pastos adecuados en casi toda la planicie costanera y en las bajuras alcanzando ambas regiones un total de 1,000 cuerdas. Asumiendo un promedio de 5 cuerdas por cabeza de ganado en la planicie costanera y 15 cuerdas por cabeza en las bajuras se podría alimentar un total de cerca de 175. Esta empresa requeriría probablemente una eliminación casi completa de las cabras nativas.

En la planicie quizas podría sembrarse una cosecha agrícola de porte bajo y de índole xerofítica tal como el sisal. Aunque puede que los rendimientos fuesen bajos, casi cualquier producto produciría más que el bosque en este sitio, particularmente en los tipos de malezas.

Fosfatos

El futuro de las extracciones de guano depende aparentemente del costo de extracción y transportación según compare con el costo de otros fertilizantes. No pudimos hacer un reconocimiento de los depósitos de guano durante nuestra visita a la isla pero los residentes nos informaron que este recurso no está agotado. La extracción del guano no interfiere con ningún otro aprovechamiento de la isla.

Recreación

Se cree que uno de los principales usos de la isla debe ser como centro de recreación. Este otro aprovechamiento tampoco interfiere con la producción de la tierra en sí. Aunque los gastos iniciales serían elevados, la isla posee las siguientes conveniencias turísticas: pesca en alta mar, paseos en bote, equitación, excursión, natación y la atracción turística de las cuevas. Se cree que los turistas americanos podrían interesarse ya que Mona ofrece más ventajas que cualquier otro sitio en los Estados Unidos pues la mayoría están abarrotados de gente en el invierno y ninguno tiene un clima tan agradable como la isla de Mona en la época fría. Es dudoso que se pueda establecer una industria turística que dependa sólo de los puertorriqueños porque la isla de Mona ofrece muy poco más de lo que ellos disfrutan en su lar nativo.

Pesca

Es de opinión general que no debe escatimarse esfuerzos en aumentar el consumo de pescado en el régimen alimenticio de los puertorriqueños y las aguas cerca de la Mona son uno de los mejores reductos pesqueros de la isla. Podría establecerse una aldea pesquera bien ubicada sin menoscabo de los centros recreativos ni demás usos de la isla.

Vida Silvestre

Las cabras salvajes y las iguanas atraen el interés tanto de los turistas como de los cazadores. Las iguanas son inofensivas y deben protegerse por lo menos de manera de conservar la cantidad actual. La norma a seguirse con las cabras depende de la magnitud de su intervención en la producción forestal, forrajera o agrícola. De todos modos deben reducirse en número ya que existen indicios de exceso de población y en algunos sitios puede verse el efecto de su ramoneo.

Uso Botánico

Hay algo que decir sobre la veda de por lo menos parte de la isla de Mona para conservarse como área natural con propósitos de estudios botánicos y ecológicos. Como está situada entre Santo Domingo y Puerto Rico, la flora de la isla coincide unas veces con una y otras con la otra y posee además condiciones ambientales únicas.

Conclusiones

1. Debido principalmente a las condiciones climatológicas adversas, los bosques naturales de la isla de Mona son de exigua productividad.

2. Toda la isla de Monito y 3,271 cuerdas del este de Mona incluyendo la reserva del faro no pueden producir ninguna clase de árboles maderables.

3. El resto de la planicie o sean 9,840 cuerdas pueden producir sólo un tipo de bosque bajo, ralo y de crecimiento lento capaz de producir muy poca madera que es además no aserrable.

4. La composición de ese bosque de la planicie puede mejorarse silvícolamente en composición pero esto no aportaría un aumento equiparable en productividad. Las operaciones de plantar resultarían costosas e inciertas. Las especies maderables no llegarían a producir árboles aserrables. Si se tiene en mente establecer plantaciones la introducción de nuevas especies de crecimiento rápido que surtan espeques y leña resultaría un método más prometedor para aumentar el rendimiento, aunque aún no se ha probado.

5. La planicie costanera sirve en su mayor parte y debía dedicarse permanentemente para otros usos óptimos tales como agricultura, etc.

6. La mejora silvicultural del resto de los bosques costaneros tiene justificación económica y debe efectuarse por medio de plantaciones en donde sea necesario.

7. Aunque la Mona está siempre cubierta de vegetación arbórea los productos forestales no se obtendrán en cantidades apreciables y su aprovechamiento resultaría una empresa menor comparada con la pesca, recreación y agricultura si éstas se desarrollaran tan extensamente como fuere posible.

Résumé

L'île de Mona, située entre Puerto Rico et Saint-Domingue possède une superficie de 14.042 cuerdas.1/ Le relief se compose de deux niveaux superficiels générales: la plaine côtière et le plateau; le dernier étant à 100 pieds au-dessus du niveau de la mer et comprennant plus de 90 pour cent de la superficie totale de l'île. Le sol est très superficiel particulièrement sur le plateau. Le sous-sol est calcaire. La précipitation atmosphérique annuelle est de 40,66 pouces. L'île est presque inhabitée.

La végétation du plateau, éparse et rabougrie est répresentée par de nombreuses essences xérophytiques qui apparaissent énumerées à la page 222.

Pendant ce siecle, l'île de Mona a été dediée à l'agriculture, à l'extraction des dépôts de phosphates, récréation, pêche et sylviculture. Il y est très difficile de surmonter les difficultés crées à cause du fait

1/ 1 cuerda = 0,9712 acres.

d'être eloignée de Puerto Rico et aussi l'absence d'une communauté établie. Aux mêmes titres la perspective de l'aménagement forestier n'envisage pas des possibilités satisfaisantes. Dans ces endroits oú les forêts croissent mieux, sur les meilleures parties de la plaine côtière, le terrain peut produire des cultures agricoles plus importantes du point de vue économique que la culture forestière. Comme on le voit, l'île paraît s'adapter mieux à d'autres utilisations comme récréation et pêche.

Les conclusions auxquelles on est parvenu après une étude récénte peuvent se résumer comme suit:

1. Les forêts naturelles de l'île de Mona, à cause principalement des adverses conditions du milieu possèdent une productivité très insignificante.

2. L'île de Monito et 3.271 "cuerdas" dans l'est de Mona y compris la réserve du phare ne peuvent produire d'arbres exploitables d'aucune sorte.

3. Le reste du plateau, c'est-à-dire 9.840 "cuerdas" pourra posseder seulement une forêt éparse, à accroissement lent produisant bois de petites dimensions mais aucun bois scié.

4. Cette forêt du plateau peut être améliorée en composition par des méthodes sylvicoles mais cela ne vaut pas la peine car la productivité n'augmentera pas. Les opérations de plantation sont coûteuses et les résultats incertains. La plantation d'essences à bois scié ne produira que bois de petites dimensions. Jusqu'à present on n'a pas essayé l'introduction d'essences à accroissement rapide produisant bois de chauffage et poteuax mais il semble que par cette méthode le rendement augmente si l'on a en vue la plantation.

5. La plaine côtière sert et doit être dediée aux utilisations plus hautes comme la culture agricole, etc.

6. L'amélioration sylvicole, ou la plantation le cas échéant du reste des forêts côtières est justifiée economiquement.

7. Bien que l'île de Mona puisse être couverte toujours de végétation arbustive le rendement en produits forestiers n'atteindra jamais les quantités desirables. La production forestière réprésentera toujours une entreprise secondaire en comparation avec l'industrie de la pêche, récréation et agriculture au cas que celles-ci furent dévéloppées au mesure du possible.

HOW TO MAKE WOOD UNPALATABLE TO THE WEST INDIAN DRY-WOOD TERMITE, CRYPTOTERMES BREVIS WALKER, III

George N. Wolcott, Entomologist
Agricultural Experiment Station
Rio Piedras, Puerto Rico

Of the numerous constituents and derivatives of coal-tar creosote, one coming to be extensively used for wood preservation is pentachlorphenol. Because of the commercial importance of pentachlorphenol, its particular value in protecting wood against the attack of the West Indian Dry-wood termite, Cryptotermes brevis Walker, has been tested in comparison with other coal-tar creosote constituents and derivatives, and more especially with other phenolic compounds. As the bromides of some repellent metals had proved to be considerably more repellent to termites than the chlorides of the same metals, the bromophenols have been compared with the chlorphenols.

With most discouraging unanimity, all the tested organic compounds show the same unfortunate tendency to volatilize from the wood sample into the air. Or if this is not the correct term, at least this would appear to be indicated by a decreasing effectiveness in repelling termite attack with the passage of time. Indeed, we have no criterion of the volatility of the chemical other than that, after the lapse of time, the sample hitherto immune to termite attack is eaten by them. This may not be very satisfactory proof to the chemist, but is the most obvious kind of pragmatic proof to the entomologist if the termites which before could not eat the treated sample are now able to do so with impunity. It should be emphasized, moreover, that these tests with the wood sample exposed in the air are not necessarily comparable in their results with those of the so-called "grave-yard" tests, in which the wood samples are buried in the ground for determining resistance to subterranean and wet-wood termites, or other tests where the wood remains submerged in fresh or salt water. For chemicals which are not at all soluble in water, or in dilute soil acids or alkalies, mere exposure to air, into which they can volatilize, or by which they are oxidized, is a more severe drain.

The results of these tests can possibly best be shown by tabular presentation, Table 1, in which the number of days exposure in air after treatment by submergence 10 minutes at a certain dilution of the chemical has resulted in sufficient volatilization so that the termites ate the sample. In explanation of the roughness of some of the curves, it should be noted that these data as presented represent merely the preliminary tests. Since the end result of most tests concludes with the sample being eaten: a most obvious indication of lack of value at that concentration, it offers no incentive to repetition to iron out these unevennesses. For the substances which have little value in repelling termites at moderate dilutions, the curves are too short to indicate much of what might be expected at greater strengths. For those substances which are temporarily effective at great dilutions, however, the normal curve appears to tend towards a much longer period of effectiveness at the greater concentrations. This is most obvious in the case of DDT, which has a reasonably smooth curve up to 1 per cent, which was eaten after 37 days, but the 2 per cent has not been eaten in a much longer period, and has in fact not been eaten to date, over a year later.

Table 1.—Days After Submersion Ten Minutes of Wood Samples Before Attack by the West Indian Dry-Wood Termite, *Cryptotermes brevis* Walker

Chemical	Dilutions - Per cent									
	0.02	0.05	0.1	0.2	0.5	1	2	5	10	Undiluted
Cu pentachlorphenate	42	108	111	★						
Sodium pentachlorphenate	14	22	25		★					
Hexachlorphenol				5	7	133	★			
Pentachlorphenol			10	13	273	337	★			
Pentabromophenol				5	14		★			
Tetrachlorphenol			5	7	37	46	116	★		
DDT		25	27	29	35	37	★			
Cyclopentane proprionic acid salts:										
Nuodex D-22 (Cd)			7	8	9	11	★			
Nuodex D-23 (Cu)			7	9	10	11	★			
Nuodex D-26 (Hg)			9	10	11	14	★			
2,4-dichlorophenoxyacetic acid			5	11	15	21	★			
Sodium 2,6-dibromobenzenoneindo-3-bromophenol		10	12	21	28	31	33	+		
Tribromophenol						3	12	14	+	
2-chlor-orthophenylphenol (liquid)						18	42	44	45	★
2,4-dibromophenol						7	16	18	+	
2,6-dibromo-4-aminophenol						4	7	10	+	
2,6-dibromophenol						4	5	12	+	
Thiophenol						8	10	13	+	
p-bromophenol						7	10	12	+	
Orthochlorophenol (liquid)							4	7	9	13
P H E N O L (liquid)							2	3	4	32
Pyridine (Liquid)										3
2,6-lutidine (liquid)										4
alpha-picoline (liquid)										5

Table 1.— Continued

Chemical	Dilutions - Per Cent									
	0.02	0.05	0.1	0.2	0.5	1	2	5	10	Undiluted
Alpha-fluornaphthalene					3	4	5	+		
Alpha-beta-methylnaphthalene (liquid)						6	9	12		52
Naphthalene tetrachloride					7	14	15	+		
Dibromonaphthalene					8	17	18	+		
m,p-cresol (liquid)						3	7	8		220
Anthracene						2	3	4	+	
Chrysene						4	5	?		
Carbazole						5	7	5	+	
2-chloro-2-nitrotoluene							7	+		
Quinoline (liquid)						7	7	8		232
Acenaphthene						3	5	62	+	
3,5-xylenol						4	54	+		
Fluorene					5	7	73	+		
Phenanthrene				4	7	8	87	+		
Fluoranthene		9	10	24	25	31	360	+		
Pyrene		2	4	19	25	182	195	+		

★ Stands for uneaten to date
+ Stands for untested

The reaction of the termites to the DDT-impregnated wood is paralleled by that to wood treated with the cadmium, copper and mercuric salts of a substituted cyclopentane proprionic acid, so recently synthesized by the Nuodex Products Co. of Elizabeth, New Jersey as to have not yet been placed on the market. Tests have not been continued for as long a time as with DDT, but to date the 2% impregnations of all four stand on an apparent parity, so far as the reactions of the termites are concerned, even though there is no parallelism in chemical composition. Under test for an even shorter time is the DuPont product 2,4-dichloro-phenoxyacetic acid, a creamy white powder, insoluble in ether petroleum, but promptly dissolving in acetone. Only tests extending over a longer period of time will prove the comparative value of these new chemicals.

As nearly a year elapses after treatment with 1 per cent pentachlorphenol, however, before the termites can attack the treated wood, it would appear probable that the recommended application of 5 per cent should give much more than five years protection. Pentachlorphenol is manufactured by the Dow Chemical Co. of Midland, Michigan and by the Monsanto Chemical Co. of St. Louis, Missouri, and sold as the commercially pure chemical as well as in solution and diluted ready for application, under a variety of trade names. For treatment of furniture already infested with polilla, it is most effective in promptly killing the termites, both its solvent and the chemical itself being initially toxic to them, while the pentachlorphenol is repellent long after its toxicity has disappeared. The organic solvents penetrate more readily and more deeply into infested wood than does the water in which sodium arsenate has been dissolved, and, killing the termites by suffocation, its action is much quicker and more certain than depending on their eating the arsenic-poisoned wood.

The commercial availability and proved merit of pentachlorphenol should not be allowed to prevent the use of the even more effective copper pentachlorphenate, which is at least experimentally available for test. (Unfortunately, the similar compounds with other repellent metals, which should be almost if not equally desirable, were received from Dow Chemical Co. too late for more than the most preliminary results to be available at the time this paper is being written.) Copper pentachlorphenate, as supplied by the Monsanto Chemical Co. is a fine purplish-brown powder, looking much like, and seemingly as light as the spores of a dry puff-ball. Although not readily soluble in many organic solvents, it is so very effective in repelling termites that a strong solution should not be needed for practical wood-impregnation. The manufacturers furnish the accompanying table of solubilities:

Acetone	3.2%
Butyl acetate	4.0%
Butyl alcohol	4.8%
Butyl Carbitol	23.2%
Butyl Cellosolve	23.4%
Diacetone alcohol	3.8%
Ethyl alcohol	2.2%
Ethyl Cellosolve	10.5%
Ethylene glycol	3.1%
Methyl alcohol	2.2%
Methyl Cellosolve	25.6%
Methyl ethyl ketone	6.4%

They did not note, however, that the strong solutions in butyl "Carbitol" and butyl "Cellosolve" may be greatly diluted with benzol, or with alcohol, and after dilution with alcohol, may be further diluted with water to a surprising amount before the purplish-brown powder again precipitates out of the clear light brown solution.

Sodium pentachlorphenate, made commercially available by the Wood Treating Chemicals Co. of St. Louis, is mainly interesting because it is soluble in water. Very definitely, sodium is not in itself repellent to termites, and that its combination with this phenol should prove almost as repellent as that with copper seems most surprising.

When the final and last possible substitution of chlorine is made with pentachlorphenol, the resulting hexachlorphenol proves less resistant to termite attack than the pentachlorphenol itself. By comparison, the record of tetrachlorphenol, in which four substitutions with chlorine have been made, is surprisingly good, and suggests that if two substitutions with copper, mercury, zinc or cadmium are made, the resulting compound, containing twice as much of these metals as the pentachlorphenates, should be correspondingly more repellent to termites. The poor record of the phenols with only one, two, or three substitutions of chlorine or bromine, makes doubtful the utility of using these as a basis for combining with even larger amounts of the repellent metals. Preliminary tests, however, with the only one commercially available, phenylmercuric chloride (C_6H_5HgCl), show surprising repellent properties, at least for the short time it has been tested. Excellent as some of these phenolic compounds are, it might seem desirable in the production of the most powerful termite repellent to start with some of the other coal-tar creosote constituents, such as fluorene, phenanthrene, fluoranthene and pyrene to combine with the repellent metals, rather than with phenol, which initially seems one of the least promising on which to build for permanence.

The advantage of complete insolubility in water of many of the organic termite repellents is not an exclusive characteristic. Red mercuric iodide is insoluble in water, and indeed in most other solvents, but at much more than the dilution at which it is repellent to termites, it dissolves;completely in acetone, forming a clear, sparkling colorless solution. From a saturated solution poured on a sheet of paper or a sample of light-colored wood, the acetone evaporates almost immediately, leaving the paper or wood with a decided yellowish or reddish stain. A week or more later and the stain is gone, presumably because some or all of the mercuric iodide has volatilized. If the treated wood sample is placed in a test with termites on the day after treatment, it is so toxic to them that most of them resting on it die before they can crawl off. The mortality is so serious that the experimenter hoping to keep his termites alive to register the repellent properties of other chemicals find mercuric iodide much too expensive of living material. Even the termites which later remain alive are too inert to be interested in eating, but they have a singular interest in resting on the treated sample after the initial volatilization. The sample treated two weeks before with 0.02 per cent Hg as mercuric iodide is promptly eaten by fresh termites; that impregnated a month previously with 0.05 per cent Hg as mercuric iodide is promptly eaten, and after two months the samples with 0.1 per cent Hg and 0.2 per cent Hg as mercuric iodide are readily eaten. Eventually, any strength at which mercuric iodide can be dissolved in acetone is no longer effective in preventing termite attack. Thus mercuric iodide seems an almost exact parallel to the organic chemicals, displaying high initial toxicity to the termites, followed for a short time by high repellent characteristics, which eventually completely disappears from the wood sample as the chemical volatilizes into the air.

Re-testing a year or more later the wood samples impregnated with other mercuric and mercurous inorganic compounds which are more or less soluble in water, and which had proved very repellent to termite attack for the first few days or weeks after treatment, indicates a similar tendency to volatilization into the air only of mercuric bromide. When first tested, mercuric bromide appeared to be ten times as repellent as mercuric chloride, but a year later all the samples of mercuric bromide up to 0.2 per cent Hg were eaten, while that of 0.2 per cent Hg as mercuric chloride was as immune from attack as it had been a year ago. So also were all the other samples of the tested compounds of mercury: their resistance to termite attack was apparently the same as it had been a year previous. If it were commercially practical, therefore, to use compounds of mercury for wood impregnation, one might expect permanence of all except mercuric iodide, and doubtfully of mercuric bromide. Indeed, mercuric iodide would appear to have no practical application in this connection, except where it was desirable to kill termites immediately, yet eventually have no trace of either solvent or repellent remain on the formerly infested wood.

In re-testing other inorganic chemicals, it was found that the historic wood sample that was impregnated with 0.15 per cent Cu as copper sulfate (the sample with 0.1 per cent Cu as copper sulfate having been slightly attacked by termites) nearly two years ago appears to be quite as resistant to termite attack as it was when originally presented to the termites, and they do not even rest upon the sample treated two years ago with 0.2 per cent Cu as copper sulfate. Of course one can not be sure in the course of many years, wood impregnated with some of the inorganic salts of some of these repellent metals may not become infested with polilla, but present tests give no indications of such an eventuality due to volatilization of the protecting chemical into the air.

In finishing mahogany furniture, cabinet-makers often use potassium dichromate as a stain to make sapwood look like heartwood, and so that the salmon pink of the freshly-cut wood will at once have the appearance and external patina of old age: of having "come out of the Cathedral at Santo Domingo", to use the popular expression after the Czechoslovak architect, Antón Nechodomo, had actually used these century-old timbers in making furniture for his own house on Monte Flores Hill, and it was the thing to do in Puerto Rico. It would seem pointless, however, for potassium dichromate to be used as a preparation to make wood termite-resistant, for it has little value as such, especially as compared with cheaper and more effective compounds. The real reason is that, in an acid medium the dichromate combines with the copper sulfate, or the zinc of zinc chloride, to form copper chromate or zinc chromate. Both of these are insoluble in water, thus, when the acid and the water of the preparation evaporate, copper chromate or zinc chromate is precipitated on and in the wood in a form that will not readily leach out when and if exposed to the action of water. Tests show zinc in zinc chromate to be no more repellent to termites than the zinc in zinc chloride, and the copper in copper chromate to be no more repellent to termites than the copper in copper sulfate. For wood that is not to be exposed to weathering, or is to be covered by paint or varnish, one might just as well use the cheaper compounds of these metals, and expend the saving in more thorough application.

The acid used for providing an acid medium in these preparations is usually commercial acetic acid, or pyrolignic acid, which is an even cheaper grade of acetic. Twenty-four hours after a wood sample has been submerged in undiluted acetic acid, termites will swarm over it and devour it as tho it had never been treated with anything. In the same way, they will eat wood that twenty-four hours before was submerged in undiluted formic acid: the acid that makes the sting of ants formidable. The amount of hydrochloric acid necessary to make mercurous nitrate dissolve in water also evaporates so completely within twenty-four hours that the termites give no indication of being aware of its former presence. Nor do they give any indication, twenty-four hours after treatment of the sample, of being aware of as much nitric acid as is necessary to dissolve zinc chromate in water. In all of these cases, only the acid was tested, without the chemical which it causes to dissolve, to make sure that the effect of the chemical plus the acid when treating the woods was due entirely to the dissolved metal, and not to the acid.

The above does not apply to all acids. Mercurous sulfate is insoluble in water, but by adding sulfuric acid, enough dissolves so that dilutions containing less than 0.1 per cent Hg can be prepared. At all dilutions, however, the termites are acutely aware of both chemicals, and even at 0.02 per cent Hg they get as far away as possible from the treated sample. This is in part due to the presence of the sulfuric acid, which does not at once evaporate as did the other acids, and continues to be apparent to the experimenter as well as to the termites for days and weeks after submersion. Mercurous sulfate can also be dissolved in diluted sulfurous acid, which has a much less obvious odor originally, and also evaporates readily. When sulfurous acid diluted with water is used as solvent, the termites attack the wood treated with 0.02 per cent Hg as mercurous sulfate, but not that with 0.05 per cent Hg as mercurous sulfate, although they swarm over it and do not avoid the sample as they did when sulfuric acid had been used. A year later, their reaction was the same, the sample was preferred to rest upon, but it was not eaten anywhere, even to the slightest amount.

In making the original tests, ammonia was thought as unlikely to be of permanent value as a termite-repellent. As ammonium di-H and mono-H orthophosphate are commonly used for fire-proofing wood (or rather, for making wood fire-resistant), it seemed desirable to test at least these ammonia compounds for their value in preventing polilla attack. In a test comparing samples treated with 2 per cent NH_4 as ammonium di-H and mono-H orthophosphate, all the termites immediately congregated on the latter, making deep gouges into it. When this was removed, they eagerly ate the other sample. Obviously, neither has appreciable value in protecting wood from termite attack, regardless of that in making wood fire-resistant.

Because of the poor showing of the ammonium phosphates, and because so many phosphates are insoluble in water, no attempt was made to test the phosphates of the repellent metals. Thanks to samples of copper orthophosphate and copper pyrophosphate submitted by the Monsanto Chemical Co., however, eventually some tests were made. Both of these phosphates are insoluble in water, but a small amount of phosphoric acid makes them readily soluble. The presence of phosphoric acid (85 per cent solution) had no effect on the results obtained, as termites readily ate samples submerged 10 minutes in 1 per cent and 2 per cent dilutions of the acid, and, after a little hesitation, even the 5 per cent dilution. The impregnations with both the copper phosphates proved to be most unexpectedly effective, for altho the termites were able to eat the samples treated with 0.01 per cent Cu as either phosphate, they did not eat those with 0.02 per cent Cu, the pyrophosphate having a slight edge over the orthophosphate in repelling attack. At this dilution, the phosphates do not darken or change the appearance of the wood, in contrast to more or less darkening often resulting when it is impregnated with most other copper compounds at dilutions preventing termite attack.

The only other phosphate available for test was the powdered ferric phosphate, which dissolves in water only after a rather considerable amount of phosphoric acid has been added, and even then the solution is not entirely clear. At 0.2 per cent Fe as ferric phosphate, the maximum strength which could be dissolved, the termites ate the treated sample.

Phosphorus tribromide, a heavy, clear liquid, soluble in carbon bisulfide, fumes on exposure to the air, and turns wood submerged in 5 per cent and greater dilutions a very pronounced green. As they dry, the wood samples become dirty brown, but when completely dry, they are somewhat pinkish. Termites prefer the treated samples to rest upon, and to eat, and apparently nothing happens to those eating the samples impregnated with the greater dilutions. The termites eat less, however, of the samples impregnated with 0.5 per cent and 1 per cent of phosphorus tribromide, and the subsequent mortality is heavy. This would appear to indicate that, like sodium arsenate and thallium acetate, phosphorus tribromide is attractive and toxic. One would hesitate to recommend it, however, for any use in which something else might serve.

The ineffectiveness of ferrous iron sulfate (copperas) in not being able to repel termites has already been noted in the first paper of this series, as compared with the very marked value of ferric iron sulfate, ferric nitrate and especially ferric chloride. Further tests show that ferrous chloride, ferrous bromide, ferrous carbonate and ferrous oxalate at 2 per cent Fe have no more repellent effect on termites than does an equivalent amount of ferrous sulfate. This applies only to the ferric vs. ferrous iron compounds, for stannous tin chloride makes wood more resistant to termite attack than does stannic tin chloride. The cuprous copper compounds seem hardly more repellent than those of cupric copper, despite the difficulties in getting more than suspensions of the former in water, in which to submerge the sample to be tested. All of the above merely indicates that each metal and each compound is a separate case, and that by reasoning one can not anticipate what actual tests with the termites will show.

Theoretically, the conclusion of all tests should result in the treated sample remaining uneaten for several days, and the termites in desperation finally attacking the mahogany. Unfortunately, the results in all cases may not be as clear-cut as one might wish, especially when the test includes a chemical which is more or less toxic. One can be sure of the results when the chemical is violently toxic, but doubt creeps in when it is only slightly so, and the termites do not promptly die, but merely become more and more inert, less and less interested in eating. So far as known, this has resulted in only one definite error in results previously reported. Of barium chloride, later tests with fresh termites and no other samples than mahogany indicated that the previous tests had been at fault in apparently indicating barium to be of value as a repellent. The number of these tests was not insufficient, but when reviewed, it appeared that invariably some other very susceptible sample had been present, or the termites used had been somewhat poisoned with thallium or arsenic, and were no longer sufficiently keen about eating for their avoidance of the barium-treated sample to be conclusive. Indeed, fresh termites did not hesitate to eat samples treated with 2 per cent Ba as chloride, and even 4 per cent Ba as hydroxide in later tests, from which one must conclude that barium has little or no value as a repellent for termites.

Barium fluoride is a fine white powder, apparently not soluble in anything, but with the addition of Bentonite, it holds up in a suspension that can be used for submerging samples for ten minutes. Tests with the suspensions containing 1 per cent F and 2 per cent F indicate that although no termites appreciably eat the treated samples, most of them eventually die within the next few days or weeks. Not all of them die, however, and the treatment can be considered entirely effective only as a repellent. It can hardly be recommended, however, as the suspension of barium fluoride does not penetrate the wood at all, and is merely deposited as a whitish film on the outside, where the least abrasion will remove it.

Previous tests had indicated that 2 per cent F as potassium fluoride is doubtfully repellent. Tests made with the equally soluble sodium fluoride at 2 per cent F indicate it as being repellent and possibly toxic. At 1 per cent F, the sample treated with sodium fluoride was slightly eaten, and most of the termites died, but not all. Both potassium and sodium fluoride are completely soluble in water at these concentrations, but lithium fluoride only forms a suspension like that of barium fluoride. A sample submerged in water containing 1 per cent F as lithium fluoride, repeatedly stirred during submersion, on being tested with termites was slightly eaten, and resulted in the death of many of them. A tentative conclusion from these tests was that fluorine at greater than 2 per cent concentrations is repellent, but at less than 1 per cent F, the sample will be eaten and prove toxic to most of the termites. Admittedly, the results are not as clear-out as might be desired, but when one is testing for value as a repellent, to have hundreds of the experimental termites die, but not all of them, is an unmitigated calamity, for not even those surviving can be used for further tests.

Since fluorine unquestionably has repellent value, theoretically its compounds with the repellent metals should be doubtly repellent. The only supply of aluminum fluoride available was one containing water of crystallyzation, and proved to be insoluble in water, but forming a fairly stable suspension. On the dried samples, no indication of the dried chemical was obvious. Of the 0.5 per cent Al samples, termites ate many irregular and very shallow gouges, making no attempt to penetrate to the untreated wood below the superficial outer layer. But, whether from eating the aluminum fluoride treated wood, or from some other cause, many of the termites died.

The available sample of ferric fluoride, a light yellowish powder, also did not completely dissolve, even in hot water, the result being a rusty reddish-yellow opaque liquid that was repeatedly stirred while wood samples were submerged in it. The termites ate the treated samples up to and including the 0.2 per cent Fe as ferric fluoride, without apparent mortality. Thus one may conclude that ferric fluoride has no advantage over ferric chloride, and in fact is valueless at the concentration at which wood is protected from termite attack by the chloride. Chromium is another of the border chemicals: 2 per cent Cr as chromium chloride preventing termites from eating a treated sample, but not 2 per cent Cr as chromium sulfate. Chromium fluoride is a dull greyish green powder, only slightly soluble in water, but at the greater dilutions it makes a clear green solution that dries on the treated wood samples with no apparent stain. Termites ate the sample treated with 0.5 per cent Cr as chromium fluoride (the maximum concentration soluble in water) without apparent mortality.

By contrast with the unsatisfactory results obtained with the fluorides of aluminum, ferric iron and chromium, those with the more repellent metals indicate that these fluorine compounds give the maximum efficiency in repelling termites. Of these, cadmium fluoride is possibly most satisfactory, for, after a little hesitation, this fine white powder completely dissolves in cold water to make a clear colorless solution. The greater dilutions, however, are eaten by termites, but with terrific mortality. At the concentration of 0.05 per cent Cd as cadmium fluoride, the sample is uneaten, altho stained by the spots of liquid excrement of sick termites.

Zinc fluoride is another fine white powder, which, according to the book, should be completely soluble in hot water. The sample tested was not, but even at the greatest dilutions is only a suspension that must be continually stirred. Yet the wood sample submerged in 0.01 per cent Zn as zinc fluoride was not touched by termites, and they did not even rest upon it.

Cupric fluoride is a light bluish-green powder, looking somewhat like dried Bordeaux mixture, which is only slightly soluble in water. Even at the greatest dilutions, the solution of cupric fluoride is not clear, but a slightly milky bluish. However, it is better than a suspension, and the wood samples submerged in it, on drying are without appreciable stain or color. Termites attacked the sample submerged in the solution containing 0.005 per cent Cu as cupric fluoride, but did not eat that treated with 0.01 per cent Cu as cupric fluoride. This is an efficiency for copper in combination with fluorine twenty times that of copper as copper sulfate, and twice that of copper as cupric bromide, and makes cupric fluoride and zinc fluoride approximately equally resistant to termite attack.

Table 2 gives the relative efficiency in repelling termites of all the valuable metallic salts tested to date. In practically all cases, except possibly for the fluorides, the more efficient compounds also happen to be the more expensive ones. Some fluorides are still listed by some dealers, but actually, for the duration of the war, are unobtainable in large quantities. Zinc fluoride is listed to cost five or six times as much as zinc chloride, but it is approximately twenty times as effective in stopping termites. Considering the prices of other cadmium compounds, it seems hardly likely that cadmium fluoride will ever be cheap enough to use in practice, even if it becomes readily available. There seems to be no intrinsic reason, however, why cupric fluoride should be so expensive, and when and if it becomes more readily available, it may well displace copper sulfate for wood impregnation on the basis of its superior efficiency in repelling termites.

Table 2.— The Relative Value of the Various Elements as Repellents to the Attack of the West Indian Dry-wood Termite *Cryptotermes brevis* Walker.

West Indian mahogany eaten in preference to almácigo submerged ten minutes in:	Mahogany LINE	Almácigo submerged ten minutes as below, eaten in preference to West Indian mahogany.
0.01% Cu as cupric fluoride		0.005% Cu as cupric fluoride
0.02% Cu as cupric bromide		0.01 % Cu as cupric bromide
0.02% Cu as copper Pyro- and Orthophosphate		0.01 % Cu as Pyro- and Orthophosphate
0.15% Cu as cupric sulfate		0.1 % Cu as cupric sulfate
0.2 % Cu as cupric nitrate		0.1 % Cu as cupric nitrate
0.2 % Cu as cupric chloride		0.1 % Cu as cupric chloride
0.1 % Cu as cuprous bromide		0.05 % Cu as cuprous bromide
0.2 % Cu as cuprous chloride		0.1 % Cu as cuprous chloride
0.2 % Cu as cuprous iodide		0.1 % Cu as cuprous iodide
0.05% Hg as mercuric acetate		0.02% Hg as mercuric acetate
0.1 % Hg as mercuric nitrate		0.05% Hg as mercuric nitrate
0.15% Hg as mercuric chloride		0.1 % Hg as mercuric chloride
0.2 % Hg as mercuric bromide		0.1 % Hg as mercuric bromide
0.5 % Hg as mercuric iodide?		0.2 % Hg as mercuric iodide
0.05% Hg as mercurous sulfate		0.02% Hg as mercurous sulfate
0.08% Hg as mercurous nitrate		0.05% Hg as mercurous nitrate
0.05% Cd as cadmium fluoride		0.02% Cd as cadmium fluoride
0.1 % Cd as cadmium acetate		0.05% Cd as cadmium acetate
0.1 % Cd as cadmium bromide		0.05% Cd as cadmium bromide
0.2 % Cd as cadmium iodide		0.1 % Cd as cadmium iodide
0.2 % Cd as cadmium sulfate		0.1 % Cd as cadmium sulfate
0.5 % Cd as cadmium nitrate		0.2 % Cd as cadmium nitrate
1 % Cd as cadmium chloride		0.5 % Cd as cadmium chloride
0.01% Zn as zinc fluoride		
0.2 % Zn as zinc chloride		0.1 % Zn as zinc chloride
0.2 % Zn as zinc chromate		0.1 % Zn as zinc chromate
0.2 % Zn as zinc nitrate		0.1 % Zn as zinc nitrate
0.2 % Zn as zinc sulfate		0.1 % Zn as zinc sulfate
		0.2 % Zn as zinc acetate
0.2 % Fe as ferric chloride		0.1 % Fe as ferric chloride
0.4 % Fe as ferric nitrate		0.2 % Fe as ferric nitrate

0.4 % Fe as ferric sulfate	0.2 % Fe as ferric sulfate
	0.2 % Fe as ferric fluoride
2 % Cr as chromium chloride	1 % Cr as chromium chloride
	2 % Cr as chromium sulfate
0.5 % Al as aluminum sulfate	0.4 % Al as aluminum sulfate
0.8 % Al as aluminum chloride	0.4 % Al as aluminum chloride
1 % Al as aluminum nitrate	0.5 % Al as aluminum nitrate
2 % Al as aluminum bromide	1 % Al as aluminum bromide
1 % Sb as antimony chloride	0.5 % Sb as antimony chloride
2 % Pb as lead nitrate	1 % Pb as lead nitrate
2 % B as sodium perborate	1 % B as sodium perborate

(Traducción del artículo anterior)

COMO LOGRAR QUE LA MADERA NO SEA APETECIBLE AL TERMES DE LA MADERA SECA, CRYPTOTERMES BREVIS (Walker) III

Entre los numerosos componentes y derivados de la creosota de hulla figura el pentaclorofenol como uno de los que va ganando más adeptos como agente de preservación de la madera. Debido a la importancia comercial del pentaclorofenol, se ha estudiado su peculiar valor como preservativo de la madera contra el ataque del termes de la madera seca *Cryptotermis brevis* (Walker) en comparación con otros componentes y derivados de la creosota del alquitrán de hulla y en especial con otros compuestos fenólicos. Como los bromuros de algunos metales que actúan como agentes repelentes demostraron repeler a los termes considerablemente más que los cloruros de los mismos metales se procedió a comparar los efectos de los bromofenoles con los efectos de los clorofenoles.

Por unanimidad desalentadora, todos los compuestos orgánicos probados demostraron la misma tendencia desafortunada de volatilizarse de la muestra bajo prueba, perdiéndose en el aire. O, si en realidad no es este el término exacto por lo menos es lo que parece indicar la pérdida gradual de la efectividad en repeler al termes según va pasando el tiempo. Desde luego, en lo único que nos basamos para esa deducción con respecto a la volatilidad del reactivo químico es el hecho de que después de un lapso de tiempo los termes se comen las muestras de prueba que hasta entonces habían conservado la immunidad al ataque del insecto. Puede que ésta no sea una prueba satisfactoria para el químico pero para el entomólogo constituye el tipo más obvio de prueba pragmática ya que los termes que antes no podían comer la muestra tratada luego podían comerla impunemente. Además, debemos hacer hincapié en el hecho de que los resultados de las pruebas que se efectuaron con las muestras expuestas al aire no son necesariamente comparables ni a los que se efectuaron en "cementerios" donde las muestras de madera fueron enterradas para determinar la resistencia a los termes subterráneos y de madera húmeda ni con aquellas pruebas en que las muestras se mantuvieron sumergidas en agua dulce o salada. Para los reactivos que son completamente insolubles en agua o en los ácidos o álcalis edáficos diluídos, la mera exposición al aire, en el que se puede volatilizar u oxidar constituye una fuente de pérdida más seria.

Los resultados de las experiencias posiblemente pueden demostrarse mejor por medio de presentación tabular (Tabla núm. 1) en la que se expresa el número de días que pasaron sin que el termes se comiera la muestra de prueba, expuesta al aire después de haber sido sumergida durante 10 minutos en una disolución del reactivo a determinada concentración o sea que el número de días equivale al tiempo necesario en que se efectúa la siguiente volatilización del reactivo dejando la muestra impune al ataque del insecto. La irregularidad de algunas de las curvas que trazan el comportamiento del reactivo puede explicarse anotando que los datos enumerados representan sólo las experiencias preliminares. Como el resultado final de las distintas pruebas termina cuando los insectos devoran la muestra: indicación obvia de que la concentración no es efectiva, no ofrece pues incentivo alguno para repetir la prueba con vías a eliminar dichas irregularidades. Para aquellas substancias que tienen poco valor en lo que se refiere a repeler el ataque de los termes a disoluciones moderadas, las curvas son muy cortas para indicar lo que era de esperarse a concentraciones mayores. Sin embargo, para aquellas substancias que son temporalmente efectivas a menor concentración, la curva normal tiende hacia un período más prolongado de efectividad a mayor concentración. Esta aseveración es obvia en el caso de DDT que ofrece una curva razonablemente regular hasta el 1 por ciento, que tomó 37 días para ser devorado, pero el 2 por ciento no ha sido devorado en un período mucho más largo, y de hecho, no ha sido devorado aún hoy día después de haber pasado más de un año.

La reacción de los termes a la madera impregnada con DDT cabe compararse a la de la madera tratada con las sales de cadmio, cobre o mercurio mercúrico del ácido ciclopentano-propiónico que tan recientemente han sido sintetizadas por la Nuodex Products Co. de Elizabeth, New Jersey que aún no están a la venta. Estas sales no llevan todavía bajo prueba el tiempo que lleva el DDT pero hasta la fecha las pruebas de impregnación de los cuatro reactivos al 2 por ciento muestran aparente semejanza en lo que concierne a la reacción de los termes, aún a pesar de que no tienen parecido en lo que respecta a composición química. Hace aún menos tiempo que ha estado bajo prueba el producto Dupont, ácido 2,4-dicloro-fenoxiacético, polvo color blanco crema, insoluble en éter de petróleo pero prontamente soluble en acetona. Sólo al prolongarse por más tiempo es que las pruebas indicarán el valor comparativo de estos nuevos reactivos. Debido al hecho de que ha de pasar casi un año después del tratamiento con la disolución al 1 por ciento de pentaclorofenol para que los termes puedan atacar la madera tratada con dicho reactivo parece probable que la aplicación recomendada de la disolución al 5 por ciento daría una protección efectiva de mucho más de 5 años. La Dow Chemical Co. de Midland, Michigan y la Monsanto Chemical Co. de St. Louis, Missouri elaboran y venden el pentaclorofenol en forma de reactivo comercialmente puro y en solución lista para usarse y a la que dan una variedad de nombres de fábrica. Para tratar los muebles ya infestados con polilla la disolución es muy efectiva para matar rápidamente a los termes debido a que tanto el disolvente como el reactivo son agentes tóxicos para estos insectos con la conveniencia de que además el pentaclorofenol los repele por mucho tiempo después que su toxicidad ha desaparecido. Los disolventes orgánicos penetran más ligero y más profundamente dentro de la madera infestada que el agua en que se ha disuelto arsenato de sodio y al matar los termes por sofocación su acción es mucho más rápida y más segura que la de éste último que depende de que el insecto ingiera la madera infestada con arsénico.

Debe dejarse que la disponibilidad comercial y mérito probado del pentaclorofenol interfiera con el uso de pentaclorofenato de cobre que es más efectivo pero sólo puede obtenerse para propósitos de experimentos. (Desgraciadamente los compuestos similares derivados de otros metales, que deben ser tan o casi igualmente deseables, se recibieron muy tarde oriundos de la Dow Chemical Co. y cuando se escribió este artículo los resultados disponibles eran demasiado preliminares.) El pentaclorofenato de cobre suministrado por la Monsanto Chemical Co. es un polvo fino, color pardo anaranjado parecido a y tan liviano como las esporas secas del bejín. Aunque no se disuelve con facilidad en muchos de los disolventes orgánicos, repele los termes con tal eficacia que no es necesario una disolución muy fuerte para que sea eficaz en repeler los termes en impregnaciones prácticas de la madera. Los fabricantes suministran la siguiente tabla de solubilidades: (Véase la página 248) Ellos no anotaron, sin embargo, que las disoluciones fuertes de pentaclorofenato de cobre en "carbitol" butílico y "cellosolve" butílico pueden ser grandemente disueltas con benzol o con alcohol y que después de diluirlas con alcohol pueden ser considerablemente diluídas en agua en cantidades sorprendentes sin que el polvo color pardo anaranjado se precipite de la disolución pardo clara.

El pentaclorofenato de sodio, que puede obtenerse en cantidades comerciales de la Wood Treating Chemicals Co. de St. Louis es sobre todo interesante por su solubilidad en agua. No cabe lugar a dudas que el sodio de por sí no repele a los termes y es sorprendente que su combinación con este fenol lo haga repeler a los termes casi tanto como el cobre.

Cuando se efectúa la última substitución posible en el anillo de pentaclorofenol usando cloro, el hexaclorofenol obtenido es menos resistente que el pentaclorofenol al ataque de los termes. Por comparación el tetraclorofenol en que sólo se han hecho cuatro substituciones con cloro en el anillo fenólico, es sorprendentemente bueno y nos sugiere que si se hacen dos substituciones con cualquiera de los metales cobre, mercurio, zinc o cadmio, el compuesto que resulta teniendo cantidad doble de metal que los pentaclorofenoles tendrían por consiguiente que repeler más a los termes. La pobre actuación de los fenoles con sólo una, dos o tres substituciones con cloro o bromo hace dudosa la utilidad de este hecho como base para más substituciones de los anillos con cualquiera de los metales en cuestión. Sin embargo las pruebas preliminares con el único compuesto disponible comercialmente o sea cloruro fenilmercúrico (C_6H_5HgCl) muestran que ésto tiene propiedades repelentes por lo menos durante el corto tiempo en que se ha probado. Aunque algunos de estos derivados fenólicos son excelentes, para producir los compuestos que más puedan repeler el ataque de los termes sería deseable empezar combinando en vez de fenol alguno de los otros componentes de la creosota del alquitrán de hulla tales como fluoreno, fenantreno, fluoranteno y pireno con los metales repelentes ya que éste inicialmente es uno de los menos prometedores en lo relativo a permanencia.

La ventaja de completa insolubilidad en agua de muchos de los repelentes orgánicos de los termes no es una característica exclusiva. El yoduro mercúrico rojo es insoluble en agua y en la mayoría de los demás disolventes pero disuelve en acetona formando una disolución clara o incolora mucho más concentrada de lo que se necesita para repeler los termes. Si se echa sobre un papel o un pedazo de madera de color claro un poco de disolución saturada, se evapora la acetona casi inmediatamente dejando en el papel o en la madera una mancha amarillenta o rojiza. Al cabo de una semana o más desaparece la mancha debido a que alguno o todo el yoduro mercúrico se ha volatilizado. Si una muestra de prueba se trata con este compuesto y se somete a la acción de los termes un día después del tratamiento se ve que les es tan tóxico que al ponerlos sobre la muestra mueren antes de poder salir de ella. La mortalidad es tan seria que el investigador esperando tener termes vivos para estudiar las propiedades repelentes de otros reactivos encuentra que el yoduro de mercurio le consume mucho material vivo. Aún los termes que quedan vivos permanecen muy inertes, sin interés en comer, pero les queda cierto interés en quedarse sobre la muestra tratada, después de la volatilización inicial. Después de 2 semanas de haber tratado la muestra con yoduro mercúrico al 0.02 por ciento, los termes frescos se la comieron de inmediato lo cual pasa también con la que se impregna con una disolución al 0.05 por ciento de Hg en forma de yoduro mercúrico un mes antes de someterse a la prueba con estos insectos. Los termes se comieron con facilidad las muestras que habían sido tratadas con Hg en forma de yoduro mercúrico al 0.1 por ciento o al 0.2 por ciento dos meses antes de someterlas a la prueba con los insectos. Con el tiempo el yoduro mercúrico con que se ha impregnado la madera pierde su efectividad para contrarrestar el ataque de los termes aún si se usa la concentración máxima a que puede éste disolverse en acetona. Por lo tanto, el yoduro mercúrico se comporta exactamente como los compuestos orgánicos: muestran toxicidad inicial alta, seguida por un corto tiempo de elevadas características repelentes que eventualmente desaparecen por completo de la muestra según se va volatilizando el reactivo. Al volver a efectuar la prueba al año o aún más tarde con las muestras de madera cada una de las cuales había sido impregnada con alguno de los compuestos inorgánicos mercúricos o mercuriosos, que son más o menos solubles en agua y que ya se había probado que repelen el ataque de los termes durante los primeros días o semanas después del tratamiento, se encontró que sólo el bromuro mercúrico tiene la tendencia similar de volatilizarse. Cuando se probó con el bromuro mercúrico por primera vez, parecía ser diez veces más repelente que el cloruro mercúrico pero al volver a someterlo a prueba un año después de la impregnación los termes devoraron las muestras con bromuro mercúrico hasta de una concentración de 0.2 por ciento de Hg en forma de bromuro mercúrico mientras que las de 0.2 por ciento de Hg en forma de cloruro mercúrico eran aún tan inmunes al ataque como lo habían sido el año anterior. Esto último sucedió también con las otras muestras con que se probaron los demás compuestos de mercurio: su resistencia al ataque del termes era aparentemente igual que el año anterior. Podemos concluir que si fuese práctico desde el punto de vista comercial el usar compuestos de mercurio en la impregnación de la madera, es de esperarse que todos excepto el yoduro mercúrico y dudosamente el bromuro mercúrico tengan facultad tóxica de permanencia. Sin lugar a dudas el yoduro mercúrico no tendría aplicación práctica a este respecto excepto en aquellos casos en que se quiera matar al termes inmediatamente, ya que eventualmente no quedará indicio alguno del disolvente ni del repelente en la madera que estaba infestada.

Al volver a probar otros compuestos inorgánicos al cabo de casi dos años después de la impregnación se encontró que la muestra de madera que se impregnó con una disolución al 0.5 por ciento de Cu en forma de sulfato de cobre (la muestra de 0.1 por ciento de Cu en forma de sulfato de cobre fué ligeramente atacada por los termes) era entonces tan resistente al ataque de los termes como lo había sido anteriormente y en el caso de la muestra que se impregnó 2 años atrás con 0.2 por ciento de Cu en forma de sulfato de cobre los termes ni siquiera permanecieron sobre la muestra al hacerse la prueba. Desde luego, uno no puede estar seguro de si al cabo de muchos años la madera impregnada con alguna de las sales inorgánicas de los metales repelentes no habrán de infestarse con polilla pero en los resultados de las pruebas actuales no hay indicación alguna de que ésto suceda como resultado de la volatilización del reactivo protector.

En el acabado de los muebles de caoba los ebanistas usan a menudo el bicromato de potasio como tinte para enmascarar la albura de manera que parezca duramen y en forma de que el color rosa salmón de la madera recientemente cortada adquiera la apariencia y pátina externa que da el tiempo o sea, usando el dicho popular, "como salida de la catedral de Santo Domingo", frase que se originó cuando el arquitecto checo Antón Nechodomo usó esa madera de siglos para construir los muebles de su propia casa en Monte Flores. Un tratamiento semejante debería hacerse en Puerto Rico. Sería insubstancial usar el bicromato de potasio para hacer resistente a la madera contra el ataque de los termes pues como tal es de poco valor, especialmente si se compara con otros compuestos más baratos y más efectivos. La verdadera razón estriba en que en medio ácido el bicromato se combina con el cobre del sulfato de cobre o con el zinc de cloruro de zinc para formar el cromato de cobre o el cromato de zinc. Ambos son insolubles en agua y por lo tanto el ácido y el agua se evaporan dejando el precipitado dentro y sobre la madera en tal forma que el agua sola no puede eliminarlo. Las pruebas han indicado que el Zn del cromato de zinc no es más repelente a los termes que el Zn del cloruro de zinc y el Cu del cromato de cobre no es más repelente a los termes que el Cu del sulfato de cobre. Es lógico por lo tanto que para la madera que no ha de utilizarse a la intemperie o la que lleve barniz o pintura pueden usarse los compuestos más baratos de estos metales y la economía que esto implica puede utilizarse en aplicarlo más concienzudamente.

El ácido que se usa para crear el medio ácido en estas preparaciones es casi siempre ácido acético comercial o ácido piroligńico que es una forma más barata del ácido acético. Al pasar veinticuatro horas después de haber sumergido una muestra de madera en ácido acético sin diluir los termes andan por encima de ella y la devoran como si nunca hubiese sido tratada. De la misma manera estos insectos se comen la madera después de pasar 24 horas de haber sido sumergida en ácido fórmico, el mismo ácido que hace penosa la picada de las hormigas. La cantidad de ácido clorhídrico que se necesita para que el nitrato mercurioso se disuelva en agua también se evapora tan completamente dentro de las siguientes 24 horas que los termes ni siquiera notan su previa presencia. Tampoco notan nada cuando se usa la cantidad de ácido nítrico capaz de disolver el cromato de zinc en el agua. En todos estos casos solamente se usó el ácido en la prueba para poder estar seguros de que el efecto de la disolución se debe solamente al metal disuelto y no al ácido.

Lo que hemos dicho más arriba no se aplica a todos los ácidos. El sulfato mercurioso es insoluble en agua pero añadiéndole ácido sulfúrico se disuelve lo suficiente para obtenerse disoluciones que contengan menos del 0.1 por ciento de Hg. A todas las diluciones los termes se dan bastante cuenta de la presencia de ambos reactivos y aún usando 0.02 por ciento Hg se alejan lo más posible de la muestra tratada. Esto se debe en parte a la presencia del ácido sulfúrico el cual no se evapora tan ligero como los otros ácidos y tanto los termes como el investigador lo notan días y semanas después del tratamiento con ese ácido. El sulfato mercurioso también puede disolverse en ácido sulfuroso cuyo olor es menos obvio y también se evapora con facilidad. Cuando se usa el ácido sulfuroso diluído en agua como disolvente del sulfato mercurioso al 0.02 por ciento en Hg, los termes atacan la madera pero no la atacan cuando se usa el mismo compuesto con una concentración de 0.05 por ciento de Hg a pesar de que pasean sobre ella y no la rehuyen como en el caso de ácido sulfúrico. Un año después de tratada la muestra, la reacción es la misma, podían descansar sobre la muestra pero no la comían en lo más mínimo por ningún sitio.

En los experimentos originales, se creyó que el amoníaco no tendría valor como repelente permanente de los termes. Como se usa el bi-H y mono-H ortofosfato amónico para poner la madera a prueba de fuego (o mejor dicho, hacerla resistente al fuego), pareció que valía la pena tratar por lo menos estos compuestos de amonio para ver si servían como repelentes de la polilla. En la prueba para comparar las muestras tratadas con 2 por ciento NH_4 en forma de bi-H y mono-H ortofosfato amónico respectivamente todos los termes se congregaron inmediatamente sobre la muestra que había sido sumergida en el último de estos compuestos, perforando profundos canales en ella. Cuando esta muestra se removió, los termes devoraron la otra muestra. Es obvio por lo tanto que aunque tornan la madera resistente al fuego, ninguno de los dos compuestos sirve para proteger la madera contra el ataque de los termes.

No se llevó a cabo ninguna prueba con los fosfatos de los metales repelentes después de observar la pobre actuación de los fosfatos de amonio y también debido a que muchos fosfatos son insolubles en agua. Sin embargo, en vista de que la Monsanto Chemical Co. gentilmente nos envió muestras de ortofosfatos de cobre y pirofosfato de cobre, eventualmente se efectuaron algunos ensayos con estos compuestos. Ambos son insolubles en agua pero una pequeña cantidad de ácido fosfórico los hace solubles. La presencia de ácido fosfórico (disoluciones al 85 por ciento) no tuvo que ver nada con los resultados pues se probó que los termes devoraban las muestras que habían sido sumergidas durante 10 minutos en disoluciones al 1 por ciento o al 2 por ciento de ácido y después de alguna vacilación, hasta la de 5 por ciento. La impregnación con cualquiera de estos fosfatos de cobre demostró ser sorprendentemente efectiva pues aunque los termes se comieron las muestras tratadas con Cu al 0.01 por ciento en forma de cualquiera de estos fosfatos, no atacaron sin embargo las muestras al 0.02 por ciento, aunque el pirofosfato fué un poco más efectivo que el ortofosfato para repeler el ataque. A esa última concentración los fosfatos no obscurecen ni alteran la apariencia de la madera, contrario a lo que ocurre cuando se impregnan con otros compuestos de cobre a concentración suficiente para evitar el ataque de los termes.

El otro fosfato disponible para la prueba, fosfato férrico en polvo, sólo se disuelve en agua después de añadir una cantidad considerable de ácido fosfórico y aún en ese caso la disolución no queda completamente clara. Los termes devoraron la muestra tratada con una disolución de fosfato férrico al 0.2 por ciento, concentración máxima que es posible obtener con este compuesto.

El tribromuro de fósforo, líquido pesado, claro y soluble en bisulfuro de carbono, se desprende en humos al contacto con el aire y le da a la madera sumergida previamente en disoluciones al 5 por ciento o más, un color verde pronunciado que según se va secando se torna pardo sucio y finalmente al secarse por completo queda de un color rosa. Los termes prefieren posar sobre las muestras y comerlas y aparentemente nada les pasa a los que las comen a concentraciones menores. Sin embargo al llegar a una disolución de 0.5 por ciento y 1 por ciento en tribromuro de fósforo los termes las apetecen menos y la mortalidad subsiguiente es alta. Esto parece indicar que al igual que con arsenato de sodio y acetato de talio el tribromuro de fósforo es apetecible y venenoso. Sin embargo, vacilamos en recomendarlo para todo uso en que pueda utilizarse cualquier otro compuesto.

La inefectividad de sulfato ferroso (caparrosa) como repelente de los termes, en comparación con el muy marcado valor de sulfato férrico, nitrato férrico y especialmente cloruro férrico ha sido ya mencionado en el primer artículo de esta serie. Pruebas posteriores han demostrado que ninguno de los siguientes: cloruro ferroso, bromuro ferroso, carbonato ferroso ni oxalato ferroso a concentración del 2 por ciento en Fe ferroso tienen mayor poder de repeler los termes que una concentración igual de sulfato ferroso. Esto se aplica sólo en el caso de iones ferrosos contra los férricos pues el cloruro estanoso es más efectivo que el cloruro estánico en cuanto a resistencia al ataque del termes. Los compuestos cuprosos son un poco más repelentes que los cúpricos a pesar de lo difícil que es obtener algo más que suspensiones del primero en agua para impregnar la muestra. Todo lo anterior indica meramente que cada metal actúa a su manera, cada compuesto constituye un caso aislado y que no podemos anticipar los resultados de los experimentos por medio de deducciones.

Teóricamente, sólo se llega a un resultado definido cuando los termes no devoran la muestra y finalmente desesperados atacan la muestra (testigo) de caoba. Los resultados en todos los casos no son, desgraciadamente, tan concluyentes como se desea, especialmente cuando la prueba incluye reactivos que son más o menos tóxicos. Uno puede estar seguro de los resultados cuando el reactivo es violentamente tóxico pero surge la duda cuando es ligeramente tóxico y los termes no mueren al instante sino que van poco a poco poniéndose más inertes y con menos interés en comer. Hasta donde se tiene conocimiento, sólo se conoce un caso de error definitivo en los resultados que se han informado previamente. Se trata de cloruro de bario que en pruebas posteriores con termes frescos y acompañados sólo con una muestra de caoba indicaron que se había llegado a una conclusión errónea al indicar que este servía como repelente. Las pruebas que se hicieron fueron suficientes pero al repetirlas pudo demostrarse que invariablemente en los experimentos previos se había colocado cerca de ella otra muestra muy susceptible, o puede que los termes usados estaban algo envenenados con talio o arsénico, por esa razón no estaban lo suficientemente alerta para comer y por lo tanto su alejamiento de la muestra tratada con bario no era una prueba concluyente. En los experimentos que se efectuaron más tarde los termes frescos no vacilaron en comerse las muestras tratadas con Ba al 2 por ciento en forma de cloruro de bario y lo mismo pasó con las muestras tratadas con Ba al 4 por ciento en forma de hidróxido; de lo que se infiere que bario tiene poco valor como repelente de los termes.

El fluoruro de bario es un polvo blanco, fino y aparentemente no es soluble en nada pero añadiéndole bentonita se mantiene en una suspensión en la que se pueden sumergir las muestras por diez minutos. Las pruebas indicaron que aunque los termes no se comían una cantidad apreciable de las muestras tratadas con suspensiones que contenían 1 por ciento o 2 por ciento de F, la mayor parte de ellos morían en los próximos días o semanas. Sin embargo, no todos morían y el tratamiento debe considerarse completamente efectivo sólo como repelente. Sin embargo, no es recomendable ya que la suspensión de fluoruro de bario no penetra en la madera y meramente se deposita sobre ella a manera de película blancuzca que puede ser removida con el más leve roce.

Las pruebas anteriores habían indicado que el F al 2 por ciento en forma de fluoruro de potasio era un repelente dudoso. Pruebas posteriores, en las que se usó fluoruro de sodio al 2 por ciento indicaron que éste compuesto es repelente y posiblemente tóxico. Los termes sólo se comieron ligeramente las muestras tratadas con una disolución de fluoruro de sodio al 1 por ciento y murió la mayoría, pero no todos. Tanto el fluoruro de potasio como el de sodio son completamente solubles en agua a esas concentraciones pero el fluoruro de litio sólo forma una suspensión parecida al fluoruro de bario. Al someter a la prueba de los termes una muestra que había sido sumergida en una solución al 1 por ciento de fluoruro de litio agitándola repetidamente, se verificó que los termes la comieron muy poco y muchos de ellos murieron. Una conclusión tentativa que se deriva de estos experimentos es que el flúor es repelente a concentraciones mayores del 2 por ciento pero a concentraciones menores del 1 por ciento, los termes se comen la muestra y la mayoría se envenena. Es bueno admitir que los resultados no son tan decisivos como se hubiera deseado pero cuando uno está probando el valor de determinados compuestos como repelentes el que se le mueran cientos de termes pero no todos es una calamidad que no se mitiga pues aún aquellos que sobreviven no pueden usarse para futuras pruebas.

Como sin lugar a dudas el flúor tiene propiedades repelentes, los compuestos que forma con los metales repelentes deben ser teóricamente dos veces más repelentes. El fluoruro de aluminio que teníamos a mano contenía el agua de cristalización y era insoluble en agua pero formaba una suspensión bastante estable. En las muestras secas no se veía indicio alguno del reactivo seco. Los termes formaron excavaciones irregulares y muy someras en la muestra que se trató con 0.5 por ciento de Al sin tratar siquiera de penetrar en la madera debajo de la superficie exterior donde no habían llegado los efectos del tratamiento. Muchos de los termes se murieron ya sea por haber comido la madera tratada con fluoruro de aluminio o por alguna otra causa. La muestra de fluoruro férrico a mano era un polvo amarillo, liviano que tampoco se disolvía por completo ni en agua caliente sino que resultaba un líquido opaco color ladrillo amarillento que había que agitar repetidamente mientras las muestras de madera estaban sumergidas en él. Los termes se comieron las muestras tratadas con disoluciones hasta de 0.2 por ciento de Fe en forma de fluoruro férrico sin mortalidad aparente. Puede llegarse a la conclusión de que el fluoruro férrico no tiene ningunas ventajas sobre el cloruro férrico y de hecho carece de valor a la concentración en que el cloruro sirve para proteger la madera contra el ataque del termes. El cromio es otro de los elementos que actúan de manera similar; en forma de cloruro de cromio al 2 por ciento protege la madera contra los ataques del termes pero no así en forma de sulfato de cromio al 2 por ciento. El fluoruro de cromio es un polvo color obscuro, verde grisáceo poco soluble en agua pero a menor concentración forma una solución verde clara que al secarse en las muestras de madera no deja ninguna mancha. Los termes se comieron la muestra que se trató con una disolución al 0.5 por ciento de Cr (su solubilidad máxima en agua) en forma de fluoruro de cromio sin mortalidad aparente.

En contraste con los resultados poco satisfactorios que dieron los fluoruros de alumino, hierro férrico y cromio podemos decir que los metales más repelentes forman fluoruros con eficiencia máxima en repeler a los termes. Entre éstos el fluoruro de cadmio es posiblemente el más satisfactorio pues, al cabo de algún rato este fino polvo blanco se disuelve por completo en agua fría formando una disolución clara e incolora. Los termes se comen las muestras impregnadas con fluoruro de cadmio de menores concentraciones pero con una mortalidad terrible. A una concentración de 0.05 por ciento de Cd en forma de cloruro de cadmio, los termes no se comen las muestras pero el excremento líquido de los termes enfermos la manchan.

El fluoruro de zinc es otro polvo blanco, fino, que según los textos es soluble en agua caliente. La muestra a mano no lo era ya que aún a concentraciones pequeñas formaba una suspensión que había que estar moviendo continuamente. Los termes no tocaron y ni siquiera descansaron sobre la muestra que se había sumergido en fluoruro de zinc al 0.01 por ciento.

El fluoruro cúprico es un polvo liviano, color verde azuloso, parecido al caldo Bordelés seco y sólo un poco soluble en agua. Aún a menores concentraciones la disolución de fluoruro cúprico no es clara sino algo lechosa azulosa. Sin embargo, esto es mejor que una suspensión y las muestras de madera que se han sumergido en ella no muestran ningún color o mancha al secarse. Los termes atacaron la muestra que se sumergió en la solución de 0.005 por ciento Cu en forma de fluoruro cúprico pero no se comieron la que fué tratada con 0.01 por ciento de Cu en forma de fluoruro cúprico. Esto señala que el cobre en combinación con flúor es 20 véces más eficiente que en combinación con el ión sulfato y dos veces más eficiente que en combinación con ión bromuro. También indica que el fluoruro cúprico es aproximadamente igual de resistente a los termes que el fluoruro de zinc.

La Tabla núm. 2 (Véase la página 255) muestra la eficiencia relativa de todas las sales de metales que se han probado hasta ahora y que merecen alguna atención en lo que se refiere a repeler los termes.

En casi todos los casos, excepto posiblemente los fluoruros, los compuestos más eficientes son los más costosos. Algunos de los fluoruros pueden obtenerse con algunos comerciantes pero durante este período de guerra no pueden obtenerse en cantidades grandes. El fluoruro de zinc cuesta 5 o 6 veces más que el cloruro de zinc pero es aproximadamente 20 veces más efectivo en repeler los termes. En vista del precio de los demás compuestos de cadmio, parece dudoso que el fluoruro de cadmio sea algún día lo suficientemente barato para poder usarse en la práctica aún si fuese más asequible que hoy día. No existe razón intrínseca alguna, sin embargo, por la cual el fluoruro cúprico sea tan costoso y si alguna vez fuere más asequible, podría muy bien desplazar al sulfato de cobre en la impregnación de la madera ya que es más eficiente para repeler los termes.

Résumé

Cet article constitue une autre suite de l'étude relative à l'efficacité de diverses composés chimiques pour éviter l'attaque au bois par les termites du bois sec.

Le tableau 1 à la page 246 montre les données sur le nombre de jours passés avant que les composés chimiques y énumerés se volatilisent de sorte que le traitement devient ineffectif. Le pentachlorphénol est un des composés plus satisfaisants et au même temps commercialement disponible. Beaucoup d'autres composés phénoliques éssayés étaient moins effectifs.

Un parallèle intéressant avec les procédés des composés organiques fut celui du iodure mercurique, insoluble dans l'eau mais soluble dans l'acétone. Cette substance se volatilise et reste effective seulement un ou deux mois selon la concentration. Le bromure mercurique possède une tendance similaire. Les échantillons traités avec sulfate cuprique retiennent sa resistance à l'attaque des insectes pendant presque deux années.

On répéta quelques essais faits autrefois avec sels inorganiques et aussi on fit des nouveaux essais. Dans le tableau 2 apparaît le résumé de

tous ces essais. Le bois imprégné avec les concentrations à gauche (dans le tableau) acquiert plus de résistance aux termes que l'acajou, Swietenia mahagoni. Mais ce dernier est un peu plus résistant que le bois imprégné avec les concentrations à droite.

---oOo---

TIMBER SALES IN CARIBBEAN NATIONAL FOREST CONTINUE TO INCREASE

Continued efforts of the U. S. Forest Service to make available for local consumption a maximum of forest products during the present shortage have resulted in record sales during the first nine months of Fiscal Year 1945.

In 1943 the shortage of charcoal was becoming acute as a result of the clearing of coffee lands to raise crops with a higher economic return. A cutting technique was devised which would remove overmature, mature, and deformed trees, and those of inferior species, and which would be applicable to all classes of stands found in the forest. As cuttings of this type can be justified almost solely upon the basis of forest improvement, minimum stumpage rates were set sufficiently low to encourage a high volume of business. Three additional field men were employed to administer sales and to mark the trees to be cut.

During the period, July 1, 1944 to March 31, 1945 a total of 1,750 individual sales were made, or nearly 6 times the number during the comparable period in the previous year. Volume sold was 2,831,200 board feet, or nearly 7 times that of the previous year. Receipts were $19,213.27, or about 5 times the previous year. The products sold include 358,800 board feet of sawtimber, more than 43,000 crossties, and 7,070 cords of fuelwood, most of which went into the production of 121,500 30-to 40-pound sacks of charcoal. In all, 134 cutters and charcoal makers were kept employed in the woods.

The cutting done as a result of these sales, in removing only mature or inferior trees, improved more than 3,000 acres of forest. In addition the receipts exceed the cost of protection and management of the forest. Further increase in sales volume is expected until the cutting rate reaches the maximum permissible without jeopardizing future yields.

FURTHER NOTES ON THE REGENERATION AND GROWTH OF *TABEBUIA PALLIDA* MIERS

Frank H. Wadsworth, Forester
Tropical Forest Experiment Station
Puerto Rico

In a previous article[1] the potentialities of roble, *Tabebuia pallida* Miers, as a tree for use in establishing a forest cover on difficult planting sites were described. Recent observation and study have brought forth additional information of interest regarding this tree.

Regeneration

Further experience in planting this species corroborates the belief that wherever possible wilding stock should be used. Although nursery stock is not difficult to produce there is an abundance of wilding stock on the island and now ready to plant. Moreover, experiments to date show a tendency toward higher survival with wildings than with nursery stock. This is believed to be due to the fact that wildings, being older, have mature woody stems and roots and resist drying for a long period, while nursery stock is more succulent and loses moisture rapidly.

During 1945 about 125,000 wildings of roble were planted in the Caribbean National Forest to fill openings in secondary stands and young plantations. Planting was done during the normal dry season, a practice which proved permissible when wildings planted during January 1944 survived well despite the abnormally long drought that followed. Most of the planting was done on moderately well-drained acid clays where the annual precipitation varies between 100 and 120 inches.

This wilding stock was pulled in roble stands within and near the National Forest. In some locations it was possible for the same crew to pull and plant, the pulling being done during part of the morning, and the planting during the rest of the day. Where the distance was greater separate crews were used and trees were pulled one day and planted the next. Between 400 and 500 trees can be located and pulled per manday, varying, of course, with their abundance.

Success of this year's plantings seems assured. Despite a short period of unfavorable weather at the start survival is higher than 90 per cent now that the rains have started.

1/ Wadsworth, Frank H. Roble, a valuable forest tree in Puerto Rico. Caribbean Forester 4:59-76. 1943.

Growth

The Thurmond plots at El Verde described in detail in the previous article were remeasured during the spring of 1945, seven years after establishment. The findings bear out previous statements regarding the intolerance of the species and the temporary character, ecologically speaking, of pure roble forests. Average ten-year diameter growth, based on the seven years of record are shown in Table 1.

Table 1.— Ten-year Diameter Growth of Roble by Crown Classes Based on Seven-year Data. Pure Stand, El Verde. (Incremento en Diámetro del Roble por un Período de 10 años según las Clases de Copa - Basado en Datos de 7 años. Rodal Puro, El Verde)

Crown Class (Clases de Copa)	Number of Trees (Número de Arboles)		10-year Diameter Growth (Incremento en 10 años) Inches (Pulgadas)
Dominant	54		2.2
Codominant	66		1.7
Intermediate	29		1.2
Suppressed	6		1.1
Total	155	Average	1.8

The data in Table 1 are not very different from those collected in 1942. However, it was noted that there is a tendency for growth of some of the dominant trees to fall off as they increase in size beyond 5 inches in diameter. In some the crowns have become thin and general appearance is unhealthy. This does not, of course, necessarily mean that the trees will not grow to a much larger size. Trees more than 20 inches in diameter have been seen. On the other hand it does indicate that roble may make its best development during a short period, after which growth and ability to compete are reduced. Such a finding would not greatly affect the value of roble, as the tree is most useful for posts, ties, and ox-yokes, all of which are made from trees of relatively small diameter.

The temporary character of the pure roble stand in the plots is more in evidence than before. Invasion by numerous species of Lauraceae and pomarrosa, Eugenia jambos L, is clearly in progress. In fact parts of the stand are sufficiently open to permit the development of shade-intolerant yagrumo macho, Didymopanax morototoni (Aubl.) Dcne. & Pl. The fate of saplings of roble under the same stand is indicated by data collected from 145 tagged saplings from 2 to 10 feet tall. The average height growth of these trees during the entire seven years of record was only 1.5 feet, and less than five per cent of them appear destined to enter the canopy layer unless released. A stand such as this may be suitable for underplanting with better species such as Guarea trichilioides L, or Cordia alliodora

(R & P) Cham. If the site has not been sufficiently improved by the roble for these species, the stand should be thinned immediately to harvest the larger trees and liberate the sapling stand.

Conclusions

Recent experimental work and observations have borne out the following previous beliefs regarding roble.

1. Roble can be easily established artificially with wildings.
2. Roble competes very successfully with herbaceous vegetation during its first two years after planting.
3. Roble growth is not as rapid as that of some other species.
4. For best growth roble stands should be kept sufficiently open by frequent thinnings to create a large number of dominant and codominant trees, with few intermediates.
5. Roble stands provide a favorable environment for the establishment of more shade-tolerant trees and will be invaded naturally by these.
6. Roble remains as one of the best species for establishing a forest cover on open, grassy degraded sites.

(Traducción del artículo anterior)

NOTAS ADICIONALES SOBRE LA REGENERACION Y CRECIMIENTO DE TABEBUIA PALLIDA MIERS

En un artículo que apareció anteriormente en esta revista[1/] se discutió lo relativo a las potencialidades del roble, Tabebuia pallida, Miers como árbol que podía usarse para establecer una cubierta forestal en sitios cuya repoblación dasonómica ofrece determinadas dificultades. Las observaciones y estudios recientes han suministrado información adicional de interés en lo que respecta a este árbol.

Regeneración

Las experiencias posteriores en cuanto a la siembra de esta especie corrobora la creencia de que deben usarse brinzales de monte siempre que sea

---

1/ Wadsworth, Frank H. Roble, a valuable forest tree in Puerto Rico. Caribbean Forester, 4:59-76. 1943.

posible. Aunque los semillones de roble (o sea arbolitos provenientes de semilla) no son difíciles de producir en el vivero, existe una provisión abundante de material silvestre en la isla, listo para resembrar al sitio deseado. Además, los ensayos actuales muestran una tendencia hacia mayor supervivencia cuando se siembran semillones silvestres que cuando se usan arbolitos de los viveros. Se infiere que ello se debe a que los brinzales silvestres, por ser más viejos, tienen ya tallos y raíces fuertes que pueden resistir los efectos de la sequía por períodos prolongados mientras que los semillones de viveros son más suculentos y pierden la humedad con rapidez.

En el 1945 se plantaron cerca de 125,000 brinzales silvestres de roble en el Bosque Nacional del Caribe, en los claros de los rodales secundarios y plantaciones jóvenes. La siembra se efectuó durante la época normal de sequía, práctica cuyo éxito ya había sido probado pues los brinzales que se sembraron en enero de 1944 sobrevivieron a pesar del período anormal de sequía con que tropezaron. La mayor parte de las plantaciones se hicieron en los suelos moderadamente arcillosos, de buen drenaje y donde la precipitación anual varía entre 100 y 120 pulgadas.

Los semillones silvestres se arrancaron de los rodales de roble en o cerca del Bosque Nacional. En algunos sitios la misma cuadrilla de hombres pudo hacer ambas operaciones de arranque y siembra, efectuando la primera durante parte de la mañana y la segunda durante el resto del día. Donde la distancia entre el sitio de arranque y el de siembra era mayor fué preciso usar distintas cuadrillas, arrancando los brinzales un día y sembrándolos el siguiente. Cada hombre puede localizar y arrancar entre 400 y 500 arbolitos al día, cifra que varía según la abundancia de éstos.

Parece seguro el éxito de las siembras que se hicieron este año. A pesar del período corto inicial de condiciones climatológicas desfavorables la supervivencia era más alta que el 90 por ciento de ahora, cuando ya han comenzado las lluvias.

Crecimiento

Los árboles en los lotes Thurmond en El Verde, que fueron descritos en detalle en el artículo anterior se volvieron a medir durante la primavera del 1945, siete años después de establecidos. Los hallazgos confirman las aseveraciones hechas previamente con respecto a la intolerancia de las especies y el carácter temporero desde el punto de vista ecólogico de los rodales puros de roble. El crecimiento promedio en diámetro calculado para un período de 10 años a base de las medidas registradas al cabo de sólo siete años aparece en la Tabla núm. 1, página 268.

Los datos de dicha tabla no son muy diferentes a los del 1942. Sin embargo, cabe notar que existe una tendencia en el índice de crecimiento diamétrico de algunos de los arboles dominantes de ir disminuyendo al pasar de 5 pulgadas de diámetro. En algunos de ellos la copa se ha vuelto más estrecha y la apariencia general es poco vigorosa. Pero ésto no quiere decir, desde luego, que los árboles no han de llegar a un tamaño mayor. Por el contrario, indica que el roble logra su mejor desarrollo durante un período corto después del cual disminuye su crecimiento y habilidad para competir. Dicho hallazgo no implica que el valor del roble haya sido afectado ya que el árbol se usa mayormente para espeques, traviesas y yugos, productos todos que se elaboran de árboles de diámetros relativamente pequeños.

El carácter temporero de los rodales puros de roble se ha puesto ahora más en evidencia que antes. La invasión de numerosas especies de las lauráceas y la pomarrosa, Eugenia jambos L. continúa en progreso. De hecho, en algunas partes el rodal está lo suficientemente abierto para permitir el desarrollo del yagrumo macho, Didymopanax morototoni, (Aubl.) Dcne. & Pl., especie que no tolera la sombra. La suerte de varios latizales de roble en el mismo rodal se registró midiendo 145 que habían sido marcados con etiquetas de metal y que tenían de 2 a 10 pies de altura. El crecimiento promedio en altura de estos arbolitos al cabo de siete años fué de 1.5 pies solamente y a menos que no sean liberados, sólo menos del 5 por ciento parecen destinados a entrar en el estrato de copa. Un rodal como éste puede que se adapte a la plantación de mejores especies tales como Guarea trichilioides L. o Cordia alliodora (R & P) Cham., bajo la sombra de los demás. Si aún el roble no ha mejorado el medio estacional lo suficiente para que prosperen estas especies, debe entresacarse el rodal inmediatamente en forma de cosechar los árboles más grandes y liberar los latizales.

Conclusiones

El trabajo experimental y las observaciones recientes han confirmado las siguientes creencias con respecto al roble.

1. El roble puede establecerse artificialmente con facilidad trasplantando brinzales silvestres a los sitios deseados.

2. El roble compite con mucho éxito con la vegetación herbácea durante los primeros dos años después de la siembra.

3. El crecimiento del roble no es tan rápido como el de otras especies.

4. Para lograr el mejor crecimiento del roble, los rodales deben conservarse por medio de entresacas, lo suficientemente claros para que surjan muchos árboles dominantes y codominantes con pocos intermedios.

5. Los rodales de roble proveen un ambiente favorable para el subsiguiente establecimiento de árboles más tolerantes de sombra que poco a poco irán invadiendo naturalmente el área en cuestión.

6. El roble es una de las mejores especies que sirve para crear una cubierta forestal en pastizales ralos y degradados.

Résumé

Cette note sert pour remplir des lacunes dans l'article mentionné au bas de la page 267 et qui contient la description de Tabebuia pallida, Miers et son importance à Puerto Rico.

Les études ultérieures sur sa régénération et croissance indiquent que:

1. Le roble peut s'établir artificiellement avec beaucoup de succès en employant des sauvageons.

2. Pendant les deux premières années après sa plantation, le roble peut rivaliser effectivement avec la végétation herbacée.

3. L'accroissement du roble n'est aussi rapide que celui de quelques autres essences.

4. Pour obtenir des meilleurs résultats les peuplements de roble doivent être conservés avec suffisantes clairières, faisant des éclaircies fréquentes, en vue de produire plus d'arbres dominants et co-dominants avec peu d'intermediares.

5. Les peuplements de roble fournissent un milieu favorable pour l'établissement d'autres essences qui tolèrent l'ombrage et qui envahissent le terrain graduellement.

6. Le roble est une des meilleures essences pour créer une couverture forestière dans les terrains degradés et herbacés.

---oOo---

BECA OTORGADA A JOSE MARRERO

El "Institute of International Education" le otorgó al Sr. José Marrero, uno de los miembros del personal técnico de la Estación de Experimentación Forestal Tropical una beca para proseguir sus estudios en el campo de la dasonomía. El Sr. Marrero fué uno de los 4 puertorriqueños elegidos entre más o menos 200 solicitantes de dichas becas. El piensa obtener el grado de Bachiller en Ciencias Dasonómicas y posiblemente el grado de "Master" en Dasonomía en la Universidad de Michigan. El Sr. Marrero posee el grado de Bachiller en Agronomía del Colegio de Agricultura de Puerto Rico. Este funcionario forestal se ausentó en junio para comenzar sus estudios y no regresará por lo menos en un año.

THE CARIBBEAN FORESTER

El "Caribbean Forester", que se comenzó a publicar en julio de 1938 por el Servicio Forestal del Departamento de Agricultura de los Estados Unidos, es una revista trimestral gratuita dedicada a encauzar el mejor aprovechamiento de los recursos forestales de la región del Caribe. Su propósito es estrechar las relaciones que existen entre los científicos interesados en la Dasonomía y ciencias afines exponiéndoles los problemas confrontados, las políticas forestales vigentes, y el trabajo realizado hacia la culminación de ese objetivo técnico.

Se solicitan contribuciones de no más de 20 páginas escritas en maquinilla. Deben ser sometidas en el lenguaje vernáculo del autor, con el título o posición que éste ocupa. Es imprescindible también incluir un resumen corto del estudio efectuado. Los artículos deben dirigirse al "Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, P. R."

The Caribbean Forester, published since July 1938 by the Forest Service, U. S. Department of Agriculture, is a free quarterly journal devoted to the encouragement of improved management of the forest resources of the Caribbean region by keeping students of forestry and allied sciences in touch with the specific problems faced, the policies in effect, and the work being done toward this end throughout the region.

Contributions of not more than 20 typewritten pages in length are solicited. They should be submitted in the author's native tongue, and should include the author's title or position and a short summary. Papers should be sent to the Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, Puerto Rico.

Le "Caribbean Forester", qui a été publié depuis Juillet 1938 par le Service Forestier du Département de l'Agriculture des Etats-Unis, est un journal trimestrel de distribution gratuite dedié à l'encouragement du ménagement rationnel des forêts de la région caraïbe. Son but est entretenir des relations scientifiques de ceux qui s'intéressent aux Sciences Forestières, ses problèmes et systèmes mis à jour, avec les travaux faits pour réaliser cet objectif d'amélioration technique.

On sollicite des collaborations de pas plus de 20 pages écrites à machine. Elles doivent être écrites dans la langue maternelle de l'auteur en comprennant son titre ou position professionnel et un résumé de l'étude. Les articles doivent être adressés au "Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, Puerto Rico".


UNITED STATES
ATLANTIC
OCEAN
GULF OF
MEXICO
MEXICO
BAHAMA
ISLANDS
CUBA
JAMAICA
HAITI
DOMINICAN
REPUBLIC
PUERTO
RICO
GUADELOUPE
DOMINICA
MARTINIQUE
STA. LUCIA
TRINIDAD
BRITISH
HONDURAS
CARIBBEAN SEA
HONDURAS
GUATEMALA
SALVADOR
NICARAGUA
COSTA
RICA
PANAMA
PACIFIC
OCEAN
VENEZUELA
BR.
GUIANA
COLOMBIA

The Caribbean Forester

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TROPICAL FOREST EXPERIMENT STATION
RIO PIEDRAS, PUERTO RICO

VOL. 6, SUPPLEMENT OCTOBER 1945

CONTENTS

VOLUME VI, SUPPLEMENT, AN EXPLANATION

This supplement number of The Caribbean Forester is an exception in that it contains one long article in contrast to the numerous short papers generally presented. This does not represent a change in policy. The Forester will continue in the future, as in the past, publishing numerous short articles.

At the time that the manuscript of the article herein was received war conditions made it impossible for the author to publish it in France. As this article concerns a subject well within the field of the Caribbean Forester and as it was obviously the result of years of careful study it was decided to make this exception and to publish it as a supplementary issue. This issue contains the first half of the manuscript. It is hoped that the second half can be published in another supplementary issue within a year.

Monsieur Stehlé is a very active student of ecology and his paper is considered a real contribution to this field. However, more work must be done before ecologists come to full agreement regarding the classification, origin, and succession of secondary and climax vegetation in the West Indies. For instance, it will be found that the classification used in this article is in some respects at variance with that presented in a recent paper by Dr. John Beard (Ecology, Vol. 25, No. 2, April 1944. pp. 127-158).

Recognizing the need for further ecological study and the value of publication of new findings and interpretations The Caribbean Forester invites not only comments on this article but would welcome further papers on this same subject.

FOREST TYPES OF THE CARIBBEAN ISLANDS 1/

Henri Stehlé
Ingénieur Agricole et d'Agronomie Coloniale
Martinique

Part I

INTRODUCTION

This study of the forest types of the Caribbean Archipelago is presented in accordance with the following outline:

I. Introduction

- A. Bibliographic reference to all authors mentioned in the text in alphabetical order, together with all references to publications. The numbers correspond to those inserted throughout the study.
- B. Definitions and concepts of the forest types of the Caribbean Isles.
- C. Effect of natural factors on forest vegetation.
- D. Edapho-climatic basis for and physiognomic aspect of forest types.
- E. Forest types, sub-types and facies of the Caribbean, with a proposal for their general classification.

II. Forest Types

- A. Mangrove
- B. Xerophytic Forests
- C. Mesophytic Forests
- D. Hygrophytic Forests
- E. Altitudinal Forests

For each of these types the following aspects are considered:

- a. Definition, sub-types, and facies
- b. Locality and range
- c. Soil conditions
- d. Climatic conditions
- e. Structure and composition
- f. Forest Physiognomy and Leaf Morphology
- g. Floristic composition and stratification
- h. Reproduction
- i. Evolution and succession
- j. Stages Preliminary to Agriculture and Forestation
- k. Biotic factors

1/ Translated from the French

Bibliographic Reference

1. Barbour, W. R. - Juil. 1942. Forest types of tropical America, in The Caribbean Forester, Rio Piedras, Puerto Rico, Vol. 3, No. 4, p. 137-150.
2. Beard, J. S. - Janvier 1942. Montane Vegetation in the Antilles, in The Caribbean Forester, Rio Piedras, Puerto Rico, Vol. 3, No. 2, p. 61-74.
3. Boergesen, F. - 1898. Notes on the shore vegetation of the Danish West Indian Islands, in Bot. Tidsskr. XXIX, p. 201-259.
4. Boergesen, F. et Paulsen, O. - 1900. La végétation des Antilles danoises, in Rev. Gén. Bot. XII.
5. Box, H. E. et Alston, A. H. G. - 1937. Pteridophyta of St. Kitts, in Journ. of Botany, Vol. 75, p. 241-258.
6. Brooks, R. L. - Juillet 1941. The regeneration of mixed rain forest in Trinidad, in The Caribbean Forester, Vol. 2, No. 4, p. 164-173.
7. Cajander, A. K. - 1926. The theory of forest types, Helsinki, Finlande.
8. Chevalier, A. - 1938. La végétation de la Guadeloupe d'aprés H. Stehlé, in Annales de Géographie, Vol. 47, p. 297-306, Paris.
9. Chevalier, A. - Mars 1943. Explorations botaniques à la recherche de nouvelles plantes à caoutchouc... et description d'une plante laticifère africaine ..., in Boissiera, fasc. VII, p. 248-257, Genéve.
10. Ciferri, R. - 1936. Studio geobotanico dell'Isola Hispaniola (Antille), R. Universita di Pavia.
11. Clements, F. E. - Décembre 1942. Cycles and Climaxes, in Chronica Botanica, Vol. VII, No. 6, p. 241-243, Waltham, Mass.
12. Committee (Report of). - Janvier 1917. Forest Terminology, Journal of Forestry, Vol. XV, No. 1, Washington, DC.
13. Domin, K. - 1929. Vegetation of Dominica, in Totius Orbis Flora Photographica Arte Depicta, Vol. I, p. 37-42.
14. Ducamp, R. - Juin 1909. Choses forestières Coloniales françaises, in Bull. Soc. Forest. Franche-Comté, No. 2.
15. Feldmann, J. et Lami, R. - 3 novembre 1936. Sur la végétation de la mangrove à la Guadeloupe, in Comptes-Rendus de l'Acad. des Sci. tome 203 No. 17, p. 883-884.
16. Flaugère, Marcelin et Kuhnholtz-Lordat. - L'enseignement de la forêt de Valbonne, in Ann. Ecole Nat. Agric., Montpellier, France, 181 p.
17. Giraud, J. - 1918. Esquisse géologique de la Martinique, Hanoi.
18. Gleason, H. A. and Cook, M. T. - 1927. Plant Ecology of Puerto Rico, in Scientific Survey of Puerto Rico and the Virgin Islands, Vol. VII, part. I, p. I-96 et part. II, p. 97-173.
19. Grebert, R. - Mai 1934 et seq. Les forêts de la Guadeloupe, in Bulletin de l'Agence générale des Colonies, Paris.
20. Hardy, F. - 1934. Some aspects of the flora of Barbados, Advocate C. Barbados.
21. Hemsley, W. B. - 1886-1888. Biologia Centrali-Americana, Botany IV, p. 223-235.
22. Hodge, W. H. - Juillet 1943. The Vegetation of Dominica, in the Geographical Review, Vol. XXXIII, No. 3, p. 349-375, New York.
23. Holdridge, L. R. - Juillet 1940. Some notes on the mangrove swamps in Puerto Rico, in The Caribbean Forester, Vol. I, No. 4, p. 19.

24. Kuhnholtz-Lordat, G. - Septembre 1936. Reconstitution de l'ambiance perdue de la sylve méditerranéenne, in Ann. Ecole Nat. Agric. Montpellier, France, fasc. II, p. 103-112.
25. Lacroix, A. - 1904. La Montagne Pelée et ses éruptions. Paris.
26. Lacroix, A. - 1909. La Montagne Pelée aprés ses éruptions. Paris.
27. Marshall. - 1934. Physiography and Vegetation of Trinidad and Tobago.
28. Murphy, L. S. - 1916. Forests of Puerto Rico, past, present and future, and their physical and economic environment. U.S.D.A. Forest Serv. Bull. 354, p. 1-99.
29. Polakowsky, H. - 1930. Petermann's Mitteil. XXIII, p. 220, 294, 346; Gotha.
30. Pittier, H. - 1926. Manual de las Plantas Usuales de Venezuela, Caracas Venezuela.
31. Revert, E. - Juin 1932. Essai sur le régime et la répartition des pluies a la Martinique, leur irrégularité et les conséquences ..., in Bull. Agri. Martinique, Vol. I, No. 6, p. 124-149.
32. Richards, P. W., Tansley, and Watt.- 1939. The recording of structure, life-form and flora of tropical forest communities as a basis for their classification, in Imperial Forestry Institute Paper No. 19, University of Oxford, England.
33. Romer, M. - p. 1-95, 1932, p. 1-103, 1933; p. 1-71, 1934-35-36; p. 1-93, 1937. Bulletin Annuel du Service Météorologique et de l'Observatoire géophysique, Paris.
34. Sands, W. N. - 1910. An account of return of vegetation and the revival of agriculture, in the area devastated by the soufrière of Saint-Vincent, in West Indian Bulletin.
35. Schimper, A. F. W. - 1908. Pflanzengeographie auf physiologischer grundlage, 2e. ed. Jena.
36. Stehlé, H. - 25 Avril 1936. Essai d'Ecologie et de géographie botanique. 1935. Flore de la Guadeloupe et Dépendances, Tome I, p. I-XIV et 1-284; Basse-Terre.
37. Stehlé, H. - 1936. Apercu sur la végétation de la Guadeloupe, in Revue de Bot. Appl. et d'Agric. trop., No. 184, p. 969-973. Paris.
38. Stehlé, H. - Février 1937, Mars 1937. Les associations végétales de la Guadeloupe et leur intéret dans la valorisation rationnelle, in Revue de Bot. Appl. et d'Agric. trop., No. 186, p. 98-109 et No. 187, p. 188-195, Paris.
39. Stehlé, H. - Décembre 1937. Esquisse des associations végétales de la Martinique, in Bulletin Agricole de la Martinique, Vol. VI, No. 3-4, p. 194-264, Fort-de-France.
40. Stehlé, H. - Février, 1940. Guadeloupe-Emerald of the Antilles, in Journal of the New York Botanical Garden, Vol. 41, No. 482, p. 36-44, New-York.
41. Stehlé, H. - Mars 1940. La végétation des Antilles Francaises, in Bull. Agri. Mart., Vol. IX, No. 1, p. 19-28. Fort-de-France.
42. Stehlé, H. - Juillet 1941. Conditions éco-sociologiques et évolution des forêts des Antilles françaises, in The Caribbean Forester, Vol. II, No. 4, p. 154-159, Rio Piedras.
43. Stehlé, H. - Octobre 1941. The Flora of Martinique, in Journal of the New York Botanical Garden, Vol. 42, No. 502, p. 235-244, New York.

44. Stehlé, H. - Juillet 1943, Octobre 1943. La végétation muscinale des Antilles françaises et son intérêt dans la valorisation sylvicole, in The Caribbean Forester, Vol. IV, No. 4, p. 164-182, et Vol. V, No. 1, p. 20-43.
45. Stevenson, N. S. - Juillet 1942. Forest Associations of British Honduras, in The Caribbean Forester, Vol. III, No. 4, p. 164-172.
46. Wald, E. Y. - Octobre 1939. Forestry in St. Lucia, in The Caribbean Forester, Vol. I, No. 1, p. 12-13.

Definition and Interpretation of the Forest Types of the Caribbean Islands

It was brought out in a report in 1935 on Guadeloupe (36) that in mangrove and the vegetation of the leeward coast, of calcareous plateau and basaltic streams, of formations comprising primary forest, of degraded primary and secondary forest, and finally of altitudinal and volcanic vegetation, the primitive forest types appear always to reflect local edaphic and climatic conditions. In an ecological monograph, before describing the selective elements of a vegetative association, its evolution and succession, it is desirable to present a clear description of its topographic position, site, and environmental conditions.

In a study made in 1942, defining the forest type as a result of the site and of phytogeographic factors, William R. Barbour, expresses with justification his preference for the European conception of the forest, intimately related to its ecological factors, as established in 1926 by the Finnish scientist Cajander (7), to that adopted by American foresters (12), consisting of the separation of types in a descriptive fashion, according to their composition. This latter interpretation is also found in the excellent ecological paper by Gleason and Cook (18) on Puerto Rico.

The Finnish interpretation, as defined for temperate and cold regions, was adapted to the forest types of the American tropics in a study in 1937 (39) of the forest climaxes of Martinique based on their ecological characters, and the composition of the seres that are derived from them through regression.

As a result of this study the following four primary forest types, like those of Barbour (1), are distinguished, based only on the climatic characters of their associations: xerophytic, mesophytic, hygrophytic, and altitudinal forests. The corresponding descriptive terms used by Barbour are dry forest, deciduous forest, rain forest, and cloud forest. These generally apply very well to Caribbean forest formations. He designates as "forêts sèches" what we called "forêts xerophiles", "forêts à feuilles decidues" (more properly "feuilles caduques") what we called "forêts mésophytiques", "forêts pluvieuses" what we called "forêts hygrophytiques", and by "forêts nuageuses" (little used in French) what we called "sylves montagnards" or "forets d'altitude". A similarity is clearly observed between these terms. With slight modification one may apply this classification to the forest types of the Lesser Antilles and invariably to those of the Greater Antilles.

In Guadeloupe and Martinique, where the writer has conducted investigations for over 10 years, and where ecological conditions and evolution of the forest cover were comprehensively described in 1941 in the Caribbean Forester (42), the dryness of xerophytic forests is not so extreme as to permit the use of terms such as arid or semi-desert. Similarly, other terms are not directly applicable and must be adapted to the Caribbean Islands. The well-known ecologist and cytologist, William Seifriz, wrote to the writer in 1942, immediately after the publication of Barbour's "Forest Types of Tropical America", to settle the matter of deciduous forests, with leaves "totally or partially" deciduous during the dry season, which he had not seen nor had ever been described for the Lesser Antilles. One must admit that the term "deciduous" does not differentiate well the xerophytic forests of our islands from mesophytic forests where species are partially deciduous. The mere fact that part or all of the leaves fall is not an accurate basis for differentiation of a forest type in Martinique because certain species, such as Swietenia, Cedrela, Ingas, and Spondias lose their leaves when growing in the southern part of Martinique or in the leeward littoral, Guadeloupe, but show persistent leaves in the interior regions of those islands where rainfall is higher. As deciduousness is an adaptation to local climatic conditions, the term "deciduous forest" should be replaced by "mesophytic" forest since it is properly an intermediate type between the dryness of the xerophytic forests and the high humidity of rain forests. Even so the limits between a xerophytic forest and a deciduous forest are difficult to set in the field.

It has been possible to identify in Martinique the mesophytic forests described by Gleason and Cook for Puerto Rico (18) by means of rainfall data, by observing predominant physiognomic factors, and by the similar fertile and deep soil and its heavy use for cultivation. He described it as follows: "The relative fertility of the soil and its accessibility have permitted man to settle there rapidly, and cultivate it..., its main difference from xerophytic forests being its greener aspect, greater height, evergreen and deciduous trees, and the presence of various strata..." The term mesophytic was chosen also by W. H. Hodge in a recent study on the Vegetation of Dominica (22). The term "hygrophytic forests", chosen in 1935 (36), instead of rain forest, to designate the tropical Caribbean forest, dense, humid, many-storied, and evergreen because of the prevailing high atmospheric humidity reaching almost complete saturation, is now adopted by French ecologists for the forests of the African continent. Professor Aug. Chevalier (8) used it in 1938 (8) in an analysis of Antillean studies, and used it in 1943 to characterize the location of a new African plant (9): "Vilbouchevitchia atro-purpurea is one of the most remarkable lianes of the hygrophytic forests".

Finally, cloud forests were thus named since clouds are formed at the level of these forests. Gleason and Cook (18) named them, quite reasonably, "mossy forests" owing to the abundance of epiphytic mosses, but they are here called "altitudinal" or "volcanic" forests; the former term referring to elevation and the latter to the topographic and edaphic conditions which gave rise to their formation in the French Antilles. They correspond also to the subalpine or temperate rain forest, names given by Dr. H. Pittier (3) in 1926 to their continental equivalents in Venezuela.

Ecological studies should be directed toward the evolution of the organism, either as individuals or as communities. As was indicated by E. Clements (11) in "Cycles and Climaxes", descriptive studies have only local or fragmentary value because of their static character, so they are frequently misinterpreted. In order to be comparable, such data, together with descriptions of floristic composition, should be always preceded by a thorough explanation of the edaphic and climatic conditions of the group being studied, followed by descriptions of the structure of the formation, its virgin character, the present stage of succession, and the direction in which succession is progressing. Ecology in all of its aspects is a science of cause and effect, and particularly so in the recognition of forest types.

It is the object of this paper to show the relations existing between the different factors of soil and climate and the forest types of the French Antilles, pointing out the environment created by natural elements and the floristic composition and physiognomy of the associations and formations observed. A synthesis of this classification with that of the forest types of the other islands of the Caribbean Archipelago and other regions of the continent, for the purpose of recognizing common characters, is the goal to be ultimately attained by future forest and ecological investigations. (Fig. 1.)

Effect of Natural Factors and Forest Vegetation

The action of numerous superimposed natural and human factors in creating, modifying and destroying the forest types of the Caribbean Islands is unquestionably very complex and difficult to completely describe. Setting aside the human factor, which creates artificial disclimaxes, the sum of the influences of the different edaphic and climatic factors on vegetation provides for its arrangement in communities as portions of primary types.

Analytic study of environmental factors must precede the determination of the relative importance of each in its effect upon vegetation. Factors which must be understood include origin of the soil, topography, slope, nearness to deep water, and of other islands, micro-fauna and micro-flora, climate, including rainfall distribution and intensity, wind direction, humidity, temperature, exposure, atmospheric pressure, cloudiness, and evaporation. Pedological studies based on geology, general topography, physico-chemical structure and decomposition of the primitive rocks, are desirable, but these factors are of lesser importance than those listed above. Climatic factors are more important in forest type formation, not only because of their action upon the soil itself but because of their action on the entire habitat and directly upon the plants themselves.

Martinique has no doubt the best climatic data of all the Lesser Antilles, better so than any French, British, Dutch, or Venezuelan island due to the presence of the principal Metereologic Station at Fort-de-France in the xerophytic forest region, and the well-equipped Morne-des-Cadets Station at Fond St. Denis, in the hygrophytic forest region both containing automatically recording instruments which eliminate all personal error. The most recent five-year summaries, covering the period of ecological observations have been used, and comparisons have been made during this period for the different forest types.

This paper reports on ten years investigations of the relations of soil and climate to the vegetation of Guadeloupe and Martinique, and an intensive study of the English islands of Barbados, St. Lucia and Dominica made in 1937.

The following table gives average rainfall data for the five islands, calculated in meters. It was obtained from the Puerto Rico Caribbean Service for the 10-year period 1921-1930.

Table 1.—Average Annual Rainfall for Five Caribbean Islands

Island	Annual Average Precipitation (1921-30)	
	Meters	Inches
Dominica	2.290	85
Martinique	2.269	84
St. Lucia	2.138	79
Guadeloupe	1.732	67
Barbados	1.536	57

The average precipitation for these islands, less than two meters annually, gives an idea of the average annual rainfall in the Caribbean Archipelago. The highest rainfall was that of Dominica, which results from its high relief. Martinique and St. Lucia are next, before Guadeloupe, but it is believed that this is not a true picture of averages in these two islands because most of the pluviometric stations are located at Grande Terre, a flat dry region as compared to the rest of Guadeloupe, which is mountainous and much wetter. Most of these rainfall reports have been taken in the majority of cases from sugar cane regions in the xerophytic or mesophytic forest regions. Guadeloupe, including Basse-Terre and Grande-Terre but not its Dependencies which are distant and atypical, is believed to be more humid than either Martinique or St. Lucia and probably as wet as Dominica.

Barbados, the southernmost island is the flattest and no doubt the driest. Its climax type is xerophytic forest with rare vestiges of mesophytic forest.

Edapho-climatic Bases for, and Physiognomic Aspect of Forest Types

Following identification of species it is possible to place them in communities and associations, or floristic units, and in formations, or physiognomic units reflecting the edaphic and climatic conditions of any particular region.

The physiognomic aspect of vegetation is directly related to natural factors - and it is only on precise, well-defined climatic or edaphic bases that the forest types of the Caribbean may be properly classified.

In a study on the Vegetation of the Mountains of the Antilles made in 1942, J. S. Beard arrived at the conclusion that there is a need for a physiognomic classification. He reasonably believes that such a classification will not be possible unless we determine exactly the similarities; including structure and form of leaves and profiles of the vegetation.

As was brought out in 1939 by Richards, Tansley and Watt(32), the texture of the leaves, phyllotaxy, and foliar and floral morphology are characters which may serve as a basis for the classification of tropical forest communities, but the writer believes that such a classification will be incomplete if it does not include a preliminary study of the action of soil and climate on the vegetation; action which has given rise to forest formations. French ecologists and foresters as R. Ducamp (14) in France and Indo-China; Flaugere, Marcelin (16), and Kunholtz-Lordat (24) for the Mediterranean Flora, think of natural factors forming the forest environment as a very important influence. When man alters or destroys this environment it is very difficult to bring it back to its original conditions. The opinion of these men is in accord with Cajander's theory (7) which asserts that in a primary forest type, even when the site has been deprived of all vegetation, it is possible to classify the region without the assistance of vegetation, for the nature of the forest depends biologically entirely on the combined action of edaphic and climatic factors.

It is, therefore, indispensable to describe the habitat first. It has been due to the absence of complete accurate descriptions of the environment of different primary forest formations that no well-defined forest types have been established before and to that lack is also due the present confusion in the nomenclature of Antillean forest types. Also, a careful comparison of the floristic and physiognomic descriptions made by different authors points out many a divergence in interpretation. For example, the xerophytic forest described by Gleason and Cook for Puerto Rico (18), by the writer for Guadeloupe (36 and 38), and Martinique (39); and by Hodge for Dominica is not homologous with "the dry or xerophytic forests" described by Barbour (1), but resembles more his "deciduous forest". Barbour's "deciduous forest" on the other hand, is most similar in aspect and composition to the "mesophytic forest" of Puerto Rico as described by Gleason and Cook (18) and by Murphy (28), and by the writer for Martinique (39 p. 212-215) and the French Antilles (42, p. 156) and to what Hodge calls "transitional belt" in Dominica. The author has used the term "transition forest" for the neighboring island of Guadeloupe, following the ecological, floristic and physiognomic study of its forests, when referring to the Clusietum of the upper zone. This same Clusietum is described by Hodge for Dominica as climax of the higher volcanic summits while Hodge's higher transition zone is a Podocarpus forest. The mesophytic vegetation of the mountainous interior described by Hodge is homologous with the hygrophytic forest of Martinique and of central Guadeloupe, so defined only because of its altitudinal location. This is the equivalent of Barbour's "moist tropical forest" and "rain forest" of Puerto Rico or of tropical America and of Beard's "lower montane evergreen rain forest" and "montane rain forest". Finally, Barbour's "cloud forest" represents Schimper's "elfin-woodland" or "mossy forest" or "clusietum".

Thus it appears that not only the most diverse nomenclature is applied to the same forest types, judging by the environmental conditions, deciduous character, etc., but also that the same names as employed by different foresters or botanists do not refer to the same forest formations. The problem is furthermore complicated by different interpretations of the different zones and the transition between zones, with obscure limits and by the relative abundance of different forest types in the small area of the Antilles.

However, ecological studies point to the marked similarities and analogies between the various islands, and it is possible to see homologous associations in similar forest types. But this physiognomic similarity does not imply identity, for this would require not only the same floristic composition, which depends upon site, but a thoroughly similar habitat, and above all a geographical distribution and dominance of selective species everywhere the same, conditions which are never present. As a whole the archipelago certainly possesses vegetation and forest types, sub-types and facies that are very well-defined by climatic and edaphic conditions. One may even find homologous associations, but each island is an ecological entity representing a floristic individuality because of its endemic species, an edaphic individuality because of its origin and stratigraphy, and a climatic individuality because of its outline, orientation, and position in the Caribbean Archipelago. Thus, careful study of meteorologic averages, soils, and man's influence in disturbing the equilibrium of climaxes, will be fundamental in the distinction of forest types, sub-types, facies, associations, and succession.

In order to illustrate clearly the fundamental influence, first of climate and second of soil on the forest aspect of the Caribbean Islands one has only to examine comparatively soil, climate and forest formation maps for one island.

On the maps of Martinique are shown the rainfall zones prepared by E. Revert, the different types of soil prepared by J. Giraud, and the regions of different primary forest types set up by the writer, pointing out man's influence in the important substitution of certain types by sugar-cane agriculture. The relations between ecological factors, especially climatic factors, and forest types appear to be unquestionable. (See Figs. 2, 3, and 4.)

Forest Types, Sub-types, and Facies of the Caribbean Archipelago

The magnificent confusion that nature seems to have wanted in the distribution of genera and species as well as vegetation groups make botanists' and foresters' classifications difficult and artificial, for scientists must establish an arrangement based on theories and known systems, for their own convenience and comprehension. Our forest types, sub-types, and facies, and plant associations are the consequences of our efforts to classify this vegetation in an orderly fashion. They are subject to inevitable differences in point of view by students in the Lesser Antilles as in other regions. Furthermore, the dissimilarities are always more evident than the analogies or identities, and constructive synthesis is always more difficult than analysis, which is necessarily a preliminary.

The fundamental principle of the predominating influence of the factors which constitute the microclimate over those that produce the natural soil condition is made clear in the differentiation of native groups in forest types. However, in the complicated action of heat, water, light, and wind it is the action of water and heat that ought to be considered first because the utilization of water by the vegetation could be exercised only if temperature fluctuates within certain limits.

The observations made in temperate and cold climates by taking the sum of daily mean temperatures to explain the vegetative cycle of selective species in a plant formation are of little value in tropical regions. Another method of investigation that brings out the effect of heat on plant growth is the analysis of mean maxima and minima. Although these records are useful for cultivated lands or vegetation covering large areas, they constitute only a limited aid in the interpretation of the relations between climate and tropical forest vegetation.

In the puzzle created by this relation of cause and effect, it seems preferable to resort to "hythergraphs" because of the importance of the factors from which they locate variations by monthly means. Rainfall and temperature combined, recorded monthly by means of plotted comparative diagrams over periods of at least five years, denote the differences for the various forest types to be read directly in the polygons of the hythergraphs. They were first used in Egypt to check the habitability of certain regions for men, livestock, and insects, and finally, in phytogeography to distinguish types of vegetation widely different, such as boreal forest, temperate forest, semi-desert, low or high prairie in North America, steppes of Russia and the pampas of the Argentine. Arthur D. Smith recently presented a brief summary of the value of hythergraphs in the study of primitive vegetation types. They certainly assist in the classification of vegetation and the determination of climaxes in degraded areas occupied by disclimaxes.

After making the diagrams corresponding to the six-year period from 1932-37 at two points in the Leeward Littoral, Martinique, located at different altitudes, one having a xerophytic forest climax (Fort-de-France, alt. 82 m.), and the other having a hygrophytic forest climax (Morne-des-Cadets alt. 510 m.), the hythergraphs (Fig. 5) plainly confirm the observations made in the remnants of primitive vegetation remaining in these regions.

At once it is seen that they are very unlike, they are different in form, their limits are not comparable, and their minima and maxima occur in different seasons.

Whereas in Hythergraph I, corresponding to the xerophytic forests, February and March appear to be the driest months and October the hottest; in Hythergraph II, corresponding to the hygrophytic forest, April is the driest month, July the most humid, and September the hottest. Furthermore, the month of January has the lowest temperature in the xerophytic region while in the hygrophytic it is about as high as August and September, the months having the highest temperatures. Finally, rainfall during the most humid month in the higrophytic region is almost double that in the xerophytic region.

These hythergraphs show the importance of using microclimatic factors as a basis for classification of forest types.

In order to trace the primitive symmetry of primary forest types of the Caribbean Islands, the areas not yet degraded should be searched for, the edaphic and climatic factors in those sectors should be carefully studied, and then simultaneous individual and complex effects on vegetation should be analyzed to explain the forest physiognomy and the forest types observed.

The criteria to which one must refer first are those related to the climate, the components of which exercise so outstanding an influence that one is able to classify the forests into four general Antillean forest types (mangrove forests being of an edaphic formation, are not included). These are: xerophytic, mesophytic, hygrophytic and altitudinal forests.

Then, the physiognomic aspect should not be completely excluded as was decided by Cajander, and a distinction based on the form and falling of the leaves according to Richards, Tansley and Watt may be used to recognize the following subtypes: spiny, deciduous, and evergreen. Nevertheless, the primary types based on these characters do not seem acceptable due to their relative occurrence not only in one type (particularly in the mesophytic type where both deciduous and evergreen trees are found) but on the same species (cedar and mahogany are facultatively deciduous).

Finally, the structure, origin, and evolution of the soil, furnish an outstanding contribution to the reasonable distinction of the elementary divisions of these sub-types into lower classes known as facies.

It is common belief among French foresters that the effect of the soil on forest types is less important than climate. In the Lesser Antilles it is undeniable that the similar or common origin of the islands, whether igneous, sedimentary or alluvial, shows a relatively homogeneous structure and numerous edaphic analogies. Such findings have led J. Giraud (17), A. LaCroix's collaborator (25 and 26) to state that in Martinique the geological constitution is governed by volcanic rocks resulting from ancient eruptions and in which he recognizes a homogeneous series due to their "familiar resemblance". The geological map that he has set up for that Island appears as Fig. 4.

Gleason and Cook mention the existence in the different complexes of the plant habitat in Puerto Rico the relative value of the physical or chemical nature of the soil in producing humus, but believe that temperature and rainfall are more important. In the dense and humid forests of Guadeloupe it is believed that the role of the parent soil is limited to permitting the establishment of forest vegetation due to an abundance of P_2O_5 and K_2O but has little to do with composition and aspect of the forest.

Beard (2), recognizing the four primary plant formations in the mountains of Trinidad, regards them to be primarily influenced by elevation, temperature, precipitation, wind and especially on the physiological drought of the highest summits, without any even secondary indication of edaphic conditions. In a brief paper entitled: "Climatic Basis of Plant Classification", W. H. Hodge (22) wrote, "The soil types of Dominica are limited by their common origin from disintegrating volcanic rock. For this reason, the many plant associations are here classified on the broad basis of climate."

The same observation applies to the islands of St. Lucia and Barbados, and it is my opinion that it could be applied to all of the Antilles. Nevertheless, the pH value of the soil, which varies from calcareous to volcanic soils, and varied disintegrations coexisting in most of the Caribbean Islands contribute to the formation of different facies within well-defined types and sub-types. In "Esquisse des Associations Végetales de la Martinique" (39) the distinctions between sandy, rocky, and swampy series in the associations and between sandy, calcareous, and volcanic facies in the xerophytic forest were clarified. The basaltic bluffs, calcareous plateaus and sandy shores of Guadeloupe constitute a distinction that may be compared to those described in 1937 by R. Ciferri (10) for Haiti and Santo Domingo in a remarkable geobotanical study written in Italian. Calcareous, sandy, and volcanic facies in the xerophytic and mesophytic forests, marshy and humid facies in the hygrophytic forests and even an alluvial facies in the altitudinal forest can be recognized in most of the Caribbean Islands by edaphic site characteristics and the physiognomy of the natural vegetation.

In consequence, the following classification is suggested:

General Classification of Caribbean Forest Types

I Type: Mangrove
- (a) Facies: Marine
- (b) Facies: Riparian

II Type: Xerophytic forests
- A. Subtype: Spiny
- B. Subtype: Deciduous
  - (a) Facies: Sandy
  - (b) Facies: Calcareous
  - (c) Facies: Volcanic

III Type: Mesophytic forests
(a) Facies: Calcareous
(b) Facies: Volcanic

IV Type: Hygrophytic forests
(a) Facies: Marshy
(b) Facies: Humid

V Type: Altitudinal forests
(a) Facies: Alluvial
(b) Facies: Volcanic
(c) Facies: Culminating (highest)

In every edaphic facies of the physiognomic subtypes of the Caribbean forests, one or more floristic associations can be attributed to well-defined climatic types. It is by means of these associations that the vegetation of every island in the Archipelago can be characterized, since floristic composition is, above all, of local importance.

The complexity of edaphic and climatic factors and interactions of these factors in Caribbean forests gives rise to an environment favorable to forest types, subtypes and facies common to all islands, thus forming an eco-physiognomic unity for the Archipelago, but plant associations that are directly related to insular floristic endemism, to "dynamic properties" particular to certain species, and to diverse topographic location may vary from one island to the other, constituting the prerogatives of the island concerned. In these natural communities the presence of dominant plants is evident and amongst them some can be distinguished by an analogous behavior and a pronounced selectivity in most of the islands, showing the definite relationship of such groups in homologous associations.

The detailed study of the various forest types described in the following pages was made according to the plan adopted in 1935 in "Ecology", (36) and according to the plan followed in 1942 by N. S. Stevenson (45) on the "Forest Associations of British Honduras".

THE MANGROVE TYPE

In the mangrove, a special type, two distinct primary facies are present: one saline, maritime, and pantropical, found in mangrove swamps, the other riparian, in a weakly brackish or fresh water habitat, and Antillean, although homologous with certain groups in tropical America. The former is an inundated forest settling on semiliquid mud or slime and producing aerial roots, while the latter shows the normal aspect of a tropical forest on unsubmerged soil, the trees having plank buttresses and superficial, normal roots and even with lianes and epiphytes.

Definitions and Facies

Mangrove, known in the French Antilles as "paletuvier" or "manglier" forests; in the British islands as "mangrove swamps" and "button-trees" and in Spanish-speaking islands as "mangles" and "manglares" constitutes a special type occurring on low or sheltered shores, coastal marshes and river estuaries. It belongs to the maritime associations of the halophytic series, and its two facies are the Rhizophora mangle-Avicennia nitida association or Rhizophoretum and to the Pterocarpus officinalis association. the golden fern community known as Acrostichum is excepted, since it is neither arborescent nor climax, but a regressive intermediate stage.

Location and Range

The maritime facies, occurring on saline or brackish mud, and properly known as mangrove, is pantropical. It is similar and may even be identical to the mangrove forests of American tropical and subtropical coasts, from Florida to Brazil, from Mexico to Paraguay and to the submerged shores of West Africa. The four genera characteristic of this facies of mangrove, which forms pure stands in practically all of the Lesser Antilles and Puerto Rico, are found in association on the tropical shores of the Old World, are grouped there in a similar manner and are also accompanied by the ferm, Acrostichum. The only difference lies in the companion species of typically less saline environment. In the Lesser Antilles saline mangrove is found from Trinidad to St. Bartholomew. The writer has studied it in Barbados, near Bridgetown. In Martinique it covers 2,500 hectares, or 2.5 per cent of the total land surface, and in Guadeloupe it occupies 5,500 hectares in the main island alone, or 3.6 per cent. A total of 4,320 hectares are in Grande Terre (8 per cent) and 1,180 hectares are in Guadeloupe proper (2 per cent). It is found also in the Dependencies of Marie-Galante, between St. Louis and Grand Anse, on 260 hectares or 1.8 per cent of the total surface, and in Saintes Islet, at Terre-de-Haut. The only exception among the islands studied is Dominica, where this facies does not occur along the rare estuaries and coastal swamps. It is found, nevertheless, in the smaller islands and islets, such as St. Martin, St. Bartholomew, St. Kitts, Antigua, St. Vincent, Bequia, Mustique, Cannouah, Grenada, Tobago, and Trinidad.

The other facies is riparian, found in fresh or brackish water or of black and deep muds but never saline, constituting a normal appearing forest of Pterocarpus officinalis L. This facies is confined to the Antilles and tropical America. In the Greater Antilles it is found only in Puerto Rico, and it is found in almost all of the Lesser Antilles, including Dominica (Indian River) and the small island of Marie-Galante (St. Louis), and only a small patch has been observed in Martinique. It is found also in St. Lucia, St. Vincent, and Trinidad, but the writer has not seen it in Barbados. (See Figs. 1 and 3).

Soil Conditions

Unlike other primary forest types, the existence of mangrove forests is principally due to edaphic conditions. These conditions are identical in the greater part of the islands. The similarity of the forest throughout its natural range is fully explained by the similar edaphic origin. Del Corral mentions them for Cuba, Gleason and Cook for Puerto Rico and the writer has described them for Guadeloupe (36, 37) and Martinique (39). These conditions can be summarized in the two facies as follows. An ecological unit as well as a taxonomic group, the Rhizophora-Avicennia mangrove is the only type of vegetation which develops on low sheltered seashores, where the accumulation of black, thick or semiliquid mud and slime is always immersed, soft or relatively firm, its salinity being increased by constant sea water infiltrations but alleviated by dilutions of fresh water from rivers and rain. Its variations originate from differences in water depth, salinity, pH, and age of coastal swamps. The soil is formed from recent alluvial sedimentation and suspension of decomposing organic matter, underlain by a varied subsoil, consisting of limestone, lateritic debris, sand or igneous rocks with layers of peat, sometimes to great depths. Barrabe reports that in the Rhizophora zone of Salee River in Guadeloupe the peat layer reaches a depth of as much as 8 meters. The Pterocarpus facies is also found on black mud but where fresh water infiltrations from rivers are abundant. The Pterocarpus belt is also seen along sluggish streams and rivers, at the inner margin of the more halophilous Rhizophora-Avicennia mangrove. The best example of this forest is found at Grande-Rivière-à-Goyave near Ste. Rose, extending from there to the seashore.

Climatic Conditions

In the French islands, halophilous mangroves are found on the windward as well as the leeward coast, either north or south, without any marked preference. The dilution by the intense rains of the winter season, of the salinity of the brackish mud which constitues its preferred site is an important factor, so the precipitation distribution throughout the year affects the distribution of this forest even though it is primarily an edaphic type. The two facies may be contiguous, but the Pterocarpus forest follows the river and stream margins up to a certain distance from the sea where it receives more abundant rains as a consequence of a more rugged topography.

Mangrove forests of the Caribbean Isles receive a mean precipitation of between 1,200 and 1,800 mm. annually, depending on the locality, and distributed among 90 and 180 days a year, with a maximum intensity generally in November, sometimes in October or December and exceptionally in August.

The saline mangroves at Petit Canal, Guadeloupe (Duval Station), according to reported five-year means, receive a mean precipitation of 1,270 mm. of rain in 100 days per year. Those recorded nearer the seashore, at Beauport, Port-Louis receive 1,220 mm. in 90 days; they contain all the elements in the Rhizophoretum. The same association of maritime mangroves, very well developed at Poterie, Trois-Ilets, Martinique, receives a mean precipitation of 1,605 mm. in an average of 178 days. The precipitation and monthly distribution of the rain in this sector, where mangrove forests attain their optimum development appear in Table 2. The highest mean rainfall is in November, with 223 mm., and the lowest rainfall is in April, 39 mm. No marked dryness is seen in those means.

Table 2.— Precipitation Distribution in Mangrove Forests at Poterie, Trois-Ilets. Six-year Averages, 1932-1937

Month	Precipitation	Rainy Days	Month	Precipitation	Rainy Days
	Millimeters			Millimeters	
January	103.7	17.7	July	179.1	18.3
February	59.1	11.8	August	205.8	19.8
March	46.2	8.3	September	188.8	15.3
April	39.4	10.2	October	179.7	13.2
May	110.7	13	November	223.3	17.8
June	147.6	16.2	December	121.7	15.5
			Annual	1605.1	177.1
			Monthly	133.7	14.7

In the Lezarde valley and at Bonne Mère, Ste. Rose, Guadeloupe, where the Pterocarpus association attains its optimum development, characterized by huge stems, the precipitation is much higher, 1,687 mm. distributed in 142 rainy days at Lezarde, and at Bonne Mère, near Grande-Rivière-à-Goyave, 1,808 mm. in 210 days.

Among the other climatic factors which influence the composition and development of mangrove forests, is the wind. The filling of mangrove swamp vegetation and the burying of the forest is sometimes due to the action of the prevailing winds, blowing unfixed sand from the shore from dunes farther inland into the forest. This has been observed at Francois and Robert in Martinique; at the Bouillante marshes in Guadeloupe; at the margins of the Folle-Anse forests in Marie Galante; and at Marigot in Saintes Island. The most halophilous and hygrophilous mangroves are the first to disappear after this filling of aeolian origin takes place. It also disappears when muddy deposits raise the surface above sea-level, so the soil is periodically inundanted by rains.

The climatic conditions under which mangroves grow are generally of little importance as compared with the great influence of salinity and depth of mud or slime deposits supporting the vegetation. Nevertheless, rainfall, wind and insolation exert certain influence, favoring or limiting the extension of mangroves, and above all, deciding on the relative predominance of the Rhizophora or Pterocarpus facies.

Observations in the French Antilles corroborate those of Gleason and Cook (18) for Puerto Rico: "Conditions on the landward side of the mangroves in the southern shore are in most cases essentially different from those of the north shore. There, under a rainy climate and with an abundant supply of ground water .... the succession of vegetation is from the mangroves to the Pterocarpus forest."

The writer believes, nevertheless, that the *Pterocarpus* forest is not due to a "succession" but to edaphic and climatic conditions different from those prevailing where saline mangroves are found. It is an "association" always found within definite environmental limits and constitutes a climax, as does the *Rhizophora* mangrove, though it is more limited in area and geographical range.

Climatic conditions typical also of the nearly xerophytic forest, exert certain influence on mangrove vegetation and partially accounts for the microphyll leaf type of mangroves and the environmental dryness and insolation. Also the salinity of the water or mud from which mangrove vegetation obtains its nutrients, is a serious obstacle against intensive evaporation. Plant tissues are impregnated with a certain quantity of salt, resulting in a remarkable reduction in the degree of evaporation, which for sea water is, 0.6 per cent of that of fresh water.

Structure and Composition

The structure, floristic composition, stratigraphy, morphology of the leaves, and reproduction of mangrove forest are as peculiar as the environmental conditions under which it thrives.

Structure

The characteristic structural adaptations of the *Rhizophora-Avicennia* association, are essentially similar throughout the Archipelago. They are reproduction by vivipary, the presence of breathing organs known as pneumatophores or aerial roots of unusual and curious form and function, a high tannin content in its leaves, its great value as a pioneer species along the seashore and its important role as a land and humus builder.

The structure of this forest is diffuse and nearly impenetrable, and offers no clear, definite stratification. The largest trees of the four most characteristic species which are always more or less associated in all of the islands explored by the writer (the first four species in Table 3) measure approximately 20 meters in height and 1 meter in diameter, never over these dimensions. *Rhizophora*, with its arched roots forming a natural layering; the abundant twigs; the long, cylindric-conic fruits hanging from and germinating on the parent tree before falling in the mud like a ship anchor; and *Avicennia*, with its pneumatophores rising and falling like props above the mud to play their part as oxygen conveyors; the intermingled, curved and abundant branches with low ramifications which serve as supports; the microphyll leaves (all species presenting a marked analogy in this respect and their elliptic shape even though taxonomically they are very different); and the particular aggregation and mixture serve to give mangrove vegetation its peculiar aspect. The *Pterocarpus* facies, on the other hand is very similar to the hygrophytic forests.

Forest Physiognomy and Leaf Morphology

The uniform environmental conditions, both hygrophilous and halophilous, over the large areas of coastal swamps have allowed the Rhizophora-Avicennia mangrove to settle there on a large scale throughout the Lesser Antilles, from Trinidad to Puerto Rico (Dominica excepted) showing a remarkably uniform physiognomy and a very homogeneous composition.

The leaves of this facies are simple, except for Drepanocarpus which has pinnate leaves and is more characteristic of the Pterocarpus forests, as is Pavonia, preferring sites less inundated by saline water. The largest leaf of the four characteristic arborescent species is that of Rhizophora which is near the limit between microphyll and mesophyll; the form is elliptic or nearly so, lanceolate, ovate or oval; 2-7 cm. long and 1-3 cm. wide; stiff, chartaceous, and coriaceous; smooth and glossy; dark bluish green. In Table 3 are shown the leaf types and size classes (after Raunkiaer).

Table 3.—Leaf Types and Sizes (Raunkiaer) of Species in the Rhizophora-Avicennia Facies of Caribbean Mangrove

Species	Leaf Type	Number of Leaflets	Form and Dimensions of Leaves	Form and Dimensions of Leaflets
Rhizophora mangle L.	Simple	-	Mesophyll (elliptic)	-
Avicennia nitida Jacq.	Simple	-	Microphyll (lanceolate)	-
Laguncularia racemosa (L.) Gaertn.	Simple		Microphyll (elliptic)	-
Conocarpus erecta L.	Simple			-
Drepanocarpus lunatus (L.f.) G. F. W. Meyer	Pinnate	5-11	Microphyll (elliptic)	Microphyll (oblong)
Pavonia scabra (B.Vogel) Stehlé	Simple	-	Mesophyll (ovate)	-

The physiognomy of the forest as well as the morphology of the leaves of the Pterocarpus facies is entirely different. It shows no reproduction by vivipary, respiration by pneumatophores nor annual falling of leaves in the mud to form organic matter; instead, it has the aspect of a beautiful, humid, evergreen, dense and many-storied forest. Its stratification is clearly noticeable, and it has epiphytes and plank buttresses. Yet it differs from the Rhizophora-Avicennia facies in being homogeneous in physiognomy and composition, containing only one dominant species, Pterocarpus officinalis, which constitutes from 75 to 95 per cent of the total vegetation, no lower field layer, and no cortical nor epiphilous epiphytic mosses. It is pauci-specific while the great central forests of the islands are sharply distinct, due to such characteristics as their heterogeneity, the marked diversity of their strata and of their species, and an extremely abundant and varied phanerogamic as well as cryptogamic epiphytism.

In Guadeloupe, along the Grande-Rivière-à-Goyave, near Bonne-Mere, the writer has reached by boat a magnificent Pterocarpus forest. Wood-cutters had not been able to enter by any firm trail so that there were areas which had never been exploited. Study proved it to be virgin and showed its relation in structure and physiognomy to certain aspects of the hygrophytic forests. Higher atmospheric humidity, pronounced shade, and mitigation of the effect of the sun's rays create a special microclimate and environment quite different from that of the Rhizophora-Avicennia facies. The tree crowns are wide, large and high. There are giants reaching up to 35 to 40 meters in height and 1.20 to 1.30 meters in diameter with straight boles and black, fissured bark. At the base they have angular buttresses and numerous ramifying roots running here and there and thus forming powerful supports. The branches are numerous and thick where they join the trunk, the lower ones always being prostrate.

Gleason and Cook describe a similar forest in Humacao Playa, Puerto Rico, but its primitive aspect has disappeared through periodic annual cutting for fuel, and coppice growth of 3 to 6 shoots per tree has resulted, each shoot reaching 20 meters in height and 50 centimeters in diameter. The buttress roots reach as much as 1.5 meters in height and are four times as long as high. That enormous system of buttress roots gives this forest a very rare, primitive appearance.

The mesophyll or macrophyll imparipinnate Pterocarpus leaves, are wider, simpler, and thicker, than those of Rhizophora. These leaf characteristics, plus the fact that the leaves of Pterocarpus are evergreen and very green in color, are outstanding differences between the two facies of mangroves. The leaves are, nevertheless, smooth, glossy and stiff, like those of Rhizophora, and the leaf size class of certain species such as Drepanocarpus and Pavonia is the same as Rhizophora. The thick, ovate leaves of Clusia rosea Jacq., a species which belongs to this association and the adventitious, long and hanging roots developed by this species, contribute in giving this association a certain analogy with the vegetation of the edaphically similar alluvial facies of certain associations of Guttiferae in the Antilles, such as Tovomita in Martinique; Moronobea at Guadeloupe, and both of these species in association at Dominique; all of them occasionally found in hygrophytic forests; and also comparable to Clusia and related species found at high elevations. The leaf types and size classes of this forest appear in Table 4.

Table 4.—Leaf Types and Size Classes (Raunkiaer) of the *Pterocarpus* Mangroves of the Caribbean

Species	Leaf Type	Number of Leaflets	Form and Dimension of Leaves	Form and Dimension of Leaflets
Pterocarpus officinalis Jacq.	Pinnate	5-9	Macrophyll (ovate-oblong)	Mesophyll (ovate)
Clusia rosea Jacq.	Simple	-	Mesophyll (ovate)	-
- - - -				
Drepanocarpus lunatus (L.f.) G.F.W. Meyer	Pinnate	5-11	Mesophyll (elliptic)	Microphyll (oblong)
Pavonia scabra (B.Vogel) Stehlé	Simple	-	Mesophyll (ovate)	

Floristic Composition and Stratigraphy

The two mangrove facies are homogeneous from the standpoint of floristic composition and they constitute a poor, but specialized flora, adapted to the particular conditions prevailing in swamps of greater or lesser degree of salinity.

Association

In all of the Lesser Antilles and in Puerto Rico, this mangrove is composed of four species, whose abundance and relative tolerance of saline water is as follows, in order of landward zonation from the sea: *Rhizophora mangle* L., *Avicennia nitida* Jacq., *Laguncularia racemosa* (L.) Gaertn. and *Conocarpus erecta* Jacq. The first species is a pioneer on the seashore. The second colonizes on sand and coral. (See Figure 6.)

Lianes are rare, among them the swamp lianes: *Cydista equinoctialis* (L.) Miers, *Rhabdadenia biflora* (Jacq.) Muell-Arg. and *Brachypteris ovata* (Cav.) Small. Where fresh water infiltration is great, other lianes become established, principally: *Montrichardia arborescens* (L.) Schott and *M. aculeata* Crueg. At the margins of coastal rivers or streams which traverse open areas, stands of *Hibiscus tiliaceus* L. and the first herbaceous, hygrophilous and somewhat halophilous herbs appear *Sesban sericea* (Willd.) DC., *Cyperus ligularis* L., *C. surinamensis* Rottb. and *Heleocharis caribaea* (Rottb.) Blake.

Among the rare epiphytes found are *Tillandsia polystachya* L. and *Ionopsis utricularioides* Lindl., and the only parasite, *Phoradendron trinervium* (Lam.) Griseb, all three of them seen only occasionally.

In the regions where the climate is dry and the soil slightly alkaline, such as the leeward side of Guadeloupe and in southern Martinique, Parkinsonia aculeata L. is also found. Drepanocarpus lunatus (L. f.) G.F.W. Meyer and Pavonia scabra (B. Vogel) Stehlé are more halophilous than these associates and are common to both facies.

The fern Acrostichium aureum, L. characterized by the numerous microscopic golden spores, is abundant in all degraded mangroves of either facies. It is a regressive sere, the presence of which has been explained in a previous paper (39), and cannot be considered in any way as an association or stabilized group.

Virgin mangrove in the Caribbean is therefore specifically limited to the 4 species of Table 3 and to the three swamp lianas found on their branches and branchlets without any marked stratification.

A study of mangrove would not be complete if it did not include cryptogams and lichens, which form definite layers, marine algae; and in the fauna, the mollusks fixed to the roots. These lichens present a true vertical zonation. Three zones may be clearly differentiated: upper littoral, littoral and submarine. On the branches and trunks of Rhizophora, under a diffuse layer of gray lichens, a very complete layer of the beautiful golden yellow lichen, Pyrenula cerina Eschm. appears, associated with Opegrapha gris. The prop roots of Rhizophora and the erect pneumatophores of Avicennia are covered by a dense felt of algae forming spots of vivid violet or black, clearly on the limit of the littoral level. The Rhodophyceae are represented by Caloglossa Leprieurii Mont. and the Cyanophyceae by Microcoleus tenerrimus Gom., Lyngbya majuscula Harv., and Sirocoleum guyanense Kutz. Whereas various associated species of Bostrychia are found, Catenella repens (Lightf.) Batters, said to be an associate, has never been found in Guadeloupe or Martinique.

This lichen and algal flora is a characteristic of this Caribbean mangrove very similar to that of the Guianas.

The shells of the specialized oysters found in mangrove swamps serve as supports for algae. The oysters attach themselves on the roots and lower branches of mangrove trees in abundant clusters. Among them we find Ostrea rhizophora Guilding and Perna alata Gmelin, representatives of the animal kingdom which complete the physiognomic picture of this strange forest. Besides the birds (stilt birds and palmipeds), the Antillean mangrove fauna now includes racooon, Procyon lator L., introduced from South America.

2. Pterocarpus officinalis Association.—This forest is more similar to the hygrophytic forest than to the Rhizophora mangrove. This similarity is principally due to the humid and shady environment, the stratification, and the presence of large buttresses, tall boles, up to 35-40 meters, and abundant foliage of the dominant species, Pterocarpus officinalis Jacq. and also the long, hanging aerial roots of Clusia rosea Jacq. Nevertheless, at the limits of the Pterocarpus association along the Grande-Rivière-à-Goyave, Nobivier, near Ste. Rose, and in the swamps of Abymes near Pointe-à-Pitre,

Guadeloupe, the pure Rhizophora stands come in contact with it, but only in innundated and saline sites.

The enormous buttress roots of Pterocarpus begin as thin blades spreading out over the soil. Then they increase in thickness and reduce in width, running over the humus, for great distances, ramifying like superficial roots. On the trunks of the trees they become angular, ascending the bole to 6 meters in height and ending in arrow shaped points at least 1 meter in diameter. In Guadeloupe a saprophyte of the Burmanniaceae, Ptychomeria Germaini (Urban) Stehlé, small and devoid of chlorophyll is found on leaf and branch debris between the buttresses. This is a rare endemic which Germain, Dr. L'Herminier's assistant, discovered in the forests of Guadeloupe on dead trunks. The only other species of this genus on the island is P. sphaerocarpa (Urban) Schtr., found at an elevation of 800-1050 meters. P. Germaini is very closely related to P. portoricensis (Urban) Schltr. whose habitat is forest humus and which, together with P. nivea, Griseb. is found at the Valparaiso forest in eastern Cuba. The presence of this endemic species in coastal Pterocarpus forests is a further indication of the primary character of this mangrove and of its relation to inland forests.

On the buttresses, only one cortical epiphyte, Trichomanes Hookeri, Presl., is found in large colonies. This species, with crawling rhizomes, also occurs primarily in dense Antillean forests, in the most unexposed calm, shady, humid, saturated sites. It is a Pteridophyte, with extremely thin transparent, delicate, and brilliant leaf blades with sparse cell layers in the tissues. It surrounds the aerial roots of Clusia rosea Jacq. This fern is in general distributed in the forests of middle elevations in the Greater Antilles, Venezuela, and French Guiana. In the Lesser Antilles it is found in Dominica, St. Vincent, Grenada, and Trinidad. Over the coatings which it forms upon the bark of Pterocarpus trees, seedlings of a Cactaceae develop, with elongated, hanging, slender and spiny stems. This had no flowers and so was not identified, but was probably Cereus trigonus Haw. (Hylocereus trigonus Safford). This species was mentioned also as a member of this same association in Puerto Rico where an endemic royal palm, Roystonea borinquena Cook is also found. Upon the roots and base of the trunk a compact felting composed of the algae Rhizoclonium Hookeri, Kutz is found. Two lianas are abundant here, one is the rare Mucuna Sloanei Fawc. & Rendle which forms purple colored clusters. The other Anthurium acaule (Jacq.) Schott, is confined to the higher branches. The only herbs found on the muddy sites are Hibiscus bifurcatus Cav. and Nephrolepis biserrata (Sw.) Schott.

Small groups of shrubs or small trees are found where soil is present, among them Piper dilatatum Rich., Pavonia scabra (B. Vogel) Stehlé and Montrichardia arborescens (L.) Schott, together with a bushy liana, Dalbergia Ecastophyllum (L.) Taubert, wide-spread and much ramified, and reaching to 8 meters in height. Finally, at the edges where light is sufficient to permit its development, as in the Rhizophora, the Acrostichum stage may be clearly observed. The lianas and shrubs mentioned that are found in both facies constitute floristic analogies. The mud and slime, more or less saline and liquid and the shady habitat are in these two facies present very similar environment. Their identical regression towards Acrostichum aureum L. is a link between the Rhizophora and Pterocarpus associations. Nevertheless, in physiognomy, stratigraphy and floristic composition the distinction of two different facies is clear, as is the resemblance of Pterocarpus forest to certain aspects of the Sloanea forest, particularly the Amanoa and Tovomita associations of the Caribbean Islands.

The differences between these facies is further accentuated by the mode of reproduction of their constitutive components.

Reproduction

In the Rhizophora mangroves, normal reproduction, with rapid germination of the seeds as soon as they fall quite abundantly into the mud is observed in Avicennia, Conocarpus, and Laguncularia while in Rhizophora vivipary is found. The seeds germinate and partially develop while still on the tree. The fruits hanging from horizontal branches, are cylindrical and pointed in shape, 25-30 cms. long and 1 cm. in diameter. This form facilitates fixation of the seeds in mud. These seeds may be seen in the midst of coastal streams, as pioneers in sea water, forming green masses in saline estuaries or at sea at some distance from the shore.

Laguncularia fruit has a wing which facilitates its dissemination by wind and water. The fruit of Avicennia, one-seeded, heart-shaped, compressed, and coriaceus, is late in opening its valves and may remain long periods in the water without losing its germinative capacity. As soon as it reaches mud or slime it germinates and becomes fixed. Natural layering of this species is often found in mangrove swamps.

In Pterocarpus forests, the seedlings are abundant and found in almost pure stands. They come from indehiscent, spongy fruits 3.5-4 cms. long, one-seeded, covered by a wing-shaped membrane, an anemophilous device. They fall from the ends of branches to the semi-fluid or solid mud. The fruits of Clusia rosea are greatly relished by birds, an explanation for the fact that they germinate on the highest Pterocarpus branches. From there the filiform roots hang down till they reach the mud and the tree establishes itself. The other species of this association reproduce sexually without any apparent peculiar adaptation. The peculiar form of the fruits of Dalbergia and Mucuna, which are orbicular husks, flat or biconvex, and short permits them to be easily conveyed by water.

The small spores of Acrostichum and Nephrolepis are abundant and germinate easily.

Evolution and Succession

Both mangrove facies seem stable. The Rhizophora association is a humus and land builder. It facilitates, by means of the screen it constitutes against wave action, the accumulation of mud and detritus either organic or mineral, carried by rivers and tides. Alluvium, sandy debris, shells, and laterites are deposited together with decomposing leaves, roots and branches, all settling to form a muddy, slimy soil which finally becomes firm. At first it is saline then brackish and finally loses all salinity.

On this soil a zonation and finally a succession may be observed. (See Fig. 8)

In saline water Rhizophora is generally found as pure stands. In brackish water the other three species Drepanocarpus, Pterocarpus, and Pavonia are associates. On firm soil Dalbergia is a common associate.

While the Pterocarpus association is sciophilous or hygrophytic the Rhizophora and the Acrostichum associations are heliophilous and may endure low humidity.

Successional relationships may be observed. Between the mangrove associations and xerophilous thickets one finds several stages of transition or intermediate groups in varied edapho-climatic conditions in which both types participate. Conocarpus and Laguncularia may colonize towards the interior upon halophilous sands and coral reefs, which constitute the habitat of Tabebuia, Hippomane, Randia, Coccolobis, Pisonia, or Bucida thickets, varying with the area and with the island.

On open areas of more or less saline mud in the process of transformation to firm land, a continuous coating of algae is observed, comparable to that of similar sites in temperate zones. These are: Microcoleus chtonoplastes Thur. and Lyngbya aestuarii Liebm.

By way of Pterocarpus and Dalbergia vegetation changes to the fresh water swamps or "mud-banks association" of the British islands and Puerto Rico, which is somewhat related to our Amanoa forest, to Guadeloupe's Moronobea forest, to Sainte's Rheedia forests, to Martinique and Dominica's Tovomita forests and to the "swampy flats" of the Carapa-Palmae type from Trinidad.

The successional relationships of Antillean mangroves are described further by Gleason and Cook for Puerto Rico, and in a previous work by the writer (36) for Guadeloupe and Dependencies.

Stages Preliminary to Agriculture and Forestation

In the Caribbean Archipelago the Acrostichum aureum serves to facilitate the iniciation of cultivation on land built up by the two mangrove facies. In contact with the Pterocarpus forest it gives way to plantations of coconuts, Cocos nucifera L. and oil palms, Eloeis guineensis L. in Abymes, Guadeloupe. The Paspalum-Kyllinga palouse which succeeds it in Guadeloupe and the Fimbristylis or Alternanthera palouse at Martinique are suitable for grazing of livestock, including sheep. They constitute intermediate stages of a change to sugar cane culture (Trois-Ilets and Ducos in Martinique) and truck farming (Gosier and Abymes in Guadeloupe).

Acceleration of this transition toward cultivable soil may be made by planting Eucalyptus and Sesbania (Agati) and various leguminous species, herbs or shrubs which tolerate salty soils. A remarkable study on this subject was published by L. R. Holdridge (23)

Biotic Factors

Both mangrove facies have been repeatedly cut, particularly the Rhizophora, since it furnishes an excellent fuelwood, and because it provides tan barks: 22 per cent in Rhizophora, 16 per cent in Conocarpus, and 12 per cent in Avicennia, as shown by the analyses made at Guadeloupe. Nevertheless, as mangroves sprout rapidly they do not disappear except where periodic cuttings are accompanied by drainage.

XEROPHYTIC FORESTS

The littoral, xerophytic, xero-heliophilous forests, both in their virgin condition, as is seen in present relicts, and their derivatives and thorny or deciduous seres, occurring on calcareous sediments, tuffs, volcanic or submarine deposits, on basic or acid igneous rocks, were found in all of the islands of the Caribbean Archipelago. Where rivers have never created alluvial sedimentation, it is probable that mangrove forests were never formed as in Dominica and in some islands of too low elevation to support hygrophytic or altitudinal forests, or too small to have ever contained mesophytic forests, a xerophytic facies was present. As a general rule the naturally dry, sunny, windy coasts with low relief, composed of permeable, sedimentary or volcanic soil have supported xerophytic forests.

Definition, Sub-types and Facies

In his general study on forest types of tropical America, Barbour (1), makes a distinction between "thorn, xerophytic, arid, semi-desert forests" and deciduous or "monsoon, trade-wind, seasonal forests". In a more thorough study this distinction, logically based on different conditions, which applies generally to all Antilles as well as the Continent, must be adapted and modified as a result of observations.

In the Caribbean Archipelago only some islands, such as Curaçao, Margarita and Desirade possess arid or semi-desert vegetation, with open associations of Cactaceae, and even there it is only sporadic and local. Annual precipitation in the typical dry forests of Haiti (Gonaives) and Cuba (Guantánamo) as summarized by Barbour is 21.04 inches (568 mm.) and 16.90 inches (456 mm.) respectively. But, the driest sections of the Lesser Antilles do not have mean annual precipitation of less than 600 mm. (22 inches) and even mean rainfall as high as 1,000 mm. (37 inches) is not common. The average rainfall shown for deciduous forests in Haiti (Port-au-Prince) and Cuba (Unión de Reyes) are 1,459 mm. (54.04 inches) and 1,907 mm. (70.63 inches) respectively. It is believed that both of these classes of forest should appear as only one type, xerophytic. Two subtypes should be distinguished: thorny forest, between 600 and 1,200 mm.

(22-44 in.) precipitation; and deciduous forest between 1,200-1,900 mm. (44-70 in.). Hodge (22) reasonably attributes the upper limit of the xerophytic climax in Dominica to an average rainfall as high as 2,285 mm. (85 in.), but that is certainly the wettest island of the Caribbean Archipelago. Barbour (1) considers 82 inches rainfall as "rain forest" in Haiti.

Deciduousness of leaves is not a reliable character in type differentiation in the Lesser Antilles. Barbour's term "deciduous forest" applies here to an intermediate forest type with a mixture of evergreen and deciduous species, chiefly the former, found generally between the limits of 2,000 to 3,000 mm. (74-111 inches) annual rainfall. In this paper the term "mesophytic forest" refers to that zone. Barbour's "rain forest" corresponds, without any noteworthy change, to the "hygrophytic forest", as here described.

This broader interpretation of xerophytic forests lead to the following classification of subtypes, based upon morphologic or physiognomic features, and of edaphic facies.

1. Thorny subtype.—Equivalent to American term "thorn forests" and Pittier's (30) "espinares" of Venezuela. The soil where this subtype occurs is generally porous and permeable but based upon its origin the vegetation is classified into the following facies:

(a) Sandy facies: Occurring on either white or black sand, containing different marine detritus and coral debris. Thorny thickets of the Lantana-Randia association.

(b) Calcareous facies: Occurring over more or less decomposed sediments of different ages varying with the island. Thickets such as the Pisonia-Fagara association on Marie Galante, the bushwood of Pithecolobium on Grande Terre, and the spiny scrubs such as Anthacanthus on Desirade.

(c) Tuff facies: Occurring over metamorphosed volcanic, porous, submarine tuffs, at times partially covering calcareous soils, as the spiny thickets of Acacia on Guadeloupe (leeward side) and Martinique (southern part of the island).

2. Deciduous subtype.—This is the Caribbean equivalent of the "selvas de folhas deciduas" of Brazil and of Pittier's "chaparral" in Venezuela, but it is not equivalent to the monsoon forest of India whose Antillean homologue is the mesophytic forest. The heaths of southern, Mediterranean France, the "maquis" of Corsica and the littoral xerophytic forest of North Africa offer certain physiognomic similarities to this subtype. In the Caribbean Archipelago it may be divided into the following three facies:

(a) Sandy facies: Comprising the littoral forests of Tabebuia, the Coccoloba bushes and Hippomane shrubs.

(b) Calcareous facies: Buckthorns like those of Dipholis-Erythroxylon on Grande Terre, Guadeloupe, of Bucida in Puerto Rico, of Rhacoma-Guaiacum on Desirade, and of Krugiodendron-Forestiera on Martinique.

(c) Volcanic facies: Shrubs or thickets of Eugenia-Rochefortia over labradoritic rocks at Saintes, of Eugenia-Cordia over basaltic "mornes" on the leeward coast, Guadeloupe, of Fagara-Myrcia over andesitic rocks on Martinique, and of Elaphrium over varied igneous rocks in the different islands.

Location and Range

Both subtypes of this forest exist on the small Leeward Islands from Margarita to Aruba and constitute the climax of their vegetation. This is also true in low islands like Barbados, formed from oceanic sediments and coral cliffs, where they are observed on the coast as well as in the interior, where sugar cane cultivation has left them undisturbed. For example, at Bathseba a form of "Tabebuia" or roble forest is found. It occurs in relicts among cultivated areas on almost all of the small, calcareous islands of Antigua, St. Bartholomew and St. Martin, and on large but flat areas in Grande-Terre, Guadeloupe where summits are not higher than 120 m. (Mont Masselas) and the round mornes of Desirade (280 m. at Morne Fregate) and of Marie-Galante (205 m. at Morne Constant).

On the islands of volcanic origin, on sandy shores and coastal cliffs, this type occupies a narrow belt 1 to 2 kilometers wide covering generally the contours of those islands. At Martinique and Guadeloupe it occurs between sea level and 200 meters elevation. Only occasionally does it reach elevations of 250 to 300 meters. On Dominica, Hodge assigns it an upper limit of 1,000 feet (approximately 340 m.) which is the same as that of the labradoritic heights of Saintes Island, covered by this forest type up to its highest peak (Morne Chameau, 316 m.).

The type is limited in its range, more by amount of water than by elevation, and where precipitation is low it penetrates the interior of the islands and reaches to 200 meters above sea-level, where Tabebuia forests may be found at the summits of dry mountains. On the contrary, on the windward side where fresh or humid winds blow, the mesophytic forests are found at low altitudes.

Soil Conditions

This forest type is pan-caribbean in spite of the diversity of existing edaphic conditions and orogenesis of the Caribbean Islands. The edaphic facies that it presents are physionomically similar since the decomposition of rocks of marine, sedimentary or igneous origin corresponding to sandy, calcareous or volcanic soils always gives way to porous, permeable, and light substrata.

Soils of Volcanic Origin

The bedrock of soils of volcanic origin, in xerophytic forests are diabases, pophyries, tuffs and dark schists at Curaçao and Bonaire, containing thick intercalations of various diabases and dense, dark gray limestones at Aruba. They are phyllites with cristalline limestone intercalations at northern Trinidad, while more than half of the area of that large island is formed of basic igneous rocks, namely: epidiorites, solerites and gabbros. In St. Vincent and Dominica, the igneous rocks covered by xerophytic forests are augites, andesites, hypersthenes and black basalts having fissures and conglomerates. In Martinique there are andesites, dacites and pumices; in northern Desirade, micro-diorites and microgranulites; in Saintes, basalts and labradorites, and at the leeward coast of Guadeloupe, submarine tuffs and balsatic blocks. They are either acid or basic, but the pH is generally 6 to 7.5. The soils derived from these eruptive bedrocks in the xerophytic forest zone are light, powdery, stony, dry and poor. Even though their chemical composition may vary, their physical properties are similar as to great permeability and erodibility.

Soils of Sedimentary Origin

The sedimentary soils of the xerophytic zones of the most ancient islands of the Archipelago belong to different ages. In Trinidad they are limestones with stony or shell sediments from the upper Cretaceous Age; in Curaçao Rudistid limestones: in Bonaire layers of calcic conglomerates sometimes 200 meters deep. In Barbados xerophytic and forest sites are provided by limestones and coral cliffs from the Pleistocene Age, homologues of the mountains with "ravet" rocks of the Miocene Period at Grande Terre, Guadeloupe and of the mountains of Southern Martinique, which belong to the Middle and Upper Oligocene. Lastly, the formations of Anguilla and the Grenadines (Carriacou) are characterized by Aquistanian rocks or Upper Oligocene and in St. Eustatius, Montserrat and Barbuda, by Pleistocene limestones like those of Barbados. The soils derived from these varied calcareous elements are all basic, with a pH generally near 8, fissured, permeable, and porous, readily losing water and solutions of substances needed for plant nutrition.

The texture and mechanical properties of the deep soils which support xerophytic vegetation in the various islands of the Caribbean Archipelago are the source of the homogeneity in physiognomy of the different facies of this forest type. The difference in floristic composition of xerophytic forests is only due to preference for sandy soils with the most powdery constituents, for limestone soils which are the most basic and permeable, or for volcanic soils, the most stony.

Climatic Conditions

The climatic factors, precipitation and rainfall distribution, evaporation and insolation, mean temperature and relative humidity, atmospheric pressure, velocity and frequency of the winds and storms, and cloudiness, constitute superimposed influences acting on xerophytic forests.

The general result of these actions is the distinction of the two subtypes, thorny and deciduous, and their facies.

Before making an explanation of the combined action of these factors the individual effects should be analyzed.

Precipitation and Rainfall Distribution

In the two largest islands of the French Antilles; Guadeloupe (Grande Terre) and Martinique, where regular and accurate metereologic records have been kept over long periods, it is possible to study the effect of this factor on forest formations.

The thorny sub-type represented in northern Guadeloupe, on the calcareous leeward shores by thickets of Acacia, Pithecolobium and Fagara and after man's action by Haematoxylon substitution, offers a mean annual precipitation of 1,100 - 1,270 mm. in 90-100 days per year. For the 5-year period 1930-34 the Beauport Station at Port Louis has reported 1,221 mm. in 90 days, the Duval Station at Petit Canal 1,271 mm. in 100 days and Ste. Marthe Station at St. François 1,154 mm. in 104 days.

Even though Revert in his study (31) states that in the southernmost part of the island, at Ste. Anne, Ste. Luce and Diamant, and in the east, at Caravelle Pointe, the annual precipitation is lower than 1 meter (37 inches), pluviometers in those regions have shown it to exceed that amount. In a study made at Ste. Anne-Caritan, Salines at an altitude of 1 meter the average precipitation recorded for the years 1932 and 1933 was 1,330 mm. in 126 days. At Carabelle, considered by this author to be the driest site in the island, in a year of observations made recently at the lighthouse by the Metereologic Service 1,100 to 1,200 mm. have been recorded, with a period of drought occurring during the 4 months from January-May, and a total of 100 rainy days. A period of 30 days without precipitation occurs there and a little over 50 per cent of the total rainfall is due to a few heavy showers which are received between July and September.

This relatively low rainfall, the prolonged drought during dry winter season, the heavy, violent showers, and the poor utilization by the vegetation of water thus received on a porous soil accounts for the thorns, the deciduousness, and the microphilous character of primitive forest types.

The forests of Tabebuia, Croton, and Elaphrium, deciduous species, are found in the various islands on both the windward and leeward sides.

In Martinique the smaller acis may be schematically represented by a line joining Trinité to Fort de France, which also represents the direction of the moisture-laden winds. The means for a period of 50 years for these points, both at 5 meters altitude, show almost identical high precipitations of 1,800 to 1,920 mm. distributed in 160 to 250 days per year. Table 5 presents the data from 1892-1936 for Fort-de-France as compared to Trinité (Galion Mill), both near the sea.

Table 5.—Comparative Precipitation in the Xerophytic Forests of Martinique on the Leeward and Windward Shores. (1892-1936)

Period (every 5 years)	Fort-de-France (Leeward side)	Trinité (Galion) (Windward side)
	mm.	mm.
1892 - 1896	2463.5	2288.8
1897 - 1901	2068.4	1917.8
1902 - 1906	1991.6	1550.6
1907 - 1911	1882.4	1350.3
1912 - 1916	1979.2	1817.1
1917 - 1921	1505.9	1709.5
1922 - 1926	1644	1833
1927 - 1931	1887	1850
1932 - 1936	1860	1979.9
Total	17,282 mm.	16,297 mm.
Annual mean	1,920 mm.	1,810.77 mm.

An average annual precipitation of 1,900 mm. is certainly the upper rainfall limit of the xerophytic forest in the Caribbean Archipelago. The biologic optimum is found in zones of less rainfall, such as at Martinique near St. Pierre and near Précheur, both in the north where the average is 1,412 mm. in 126 days; and at Vauclin in the South, with 1,670 mm. in 117 days.

Table 6 presents the average rainfall and monthly rainfall distribution during the 6-year period 1932-1937. These are the periods that will be used for comparison with the different facies, with the principal sectors of Martinique, and with other forest types.

Table 6.—Precipitation and Rainfall Distribution in the Xerophytic Forest. Fort- de-France Observatory (Martinique).(1932-37)

Month	Precipitation	Days of Rain	Month	Precipitation	Days of Rain
	mm.			mm.	
January	106.55	21.16	July	217.16	24.66
February	51.80	16.83	August	234.28	25.66
March	51.58	15.66	September	233.17	21.16
April	52.35	16.16	October	219.38	22.50
May	141.20	19.16	November	214.18	23.83
June	131.25	22.50	December	107.60	21.

Total - Annual Rainfall	1760.50 mm.
Monthly Rainfall	146.70
No. of days with rain per year	250.28
No. of days with rain per month	20.85

Amount of rainfall alone is not sufficient to explain the xerophytic nature of the vegetation. In Martinique (1,760 mm. at Fort-de-France), Guadeloupe (1,271 mm. at Petit Canal), and in Dominica (2,025 mm. at Roseau) the precipitation is relatively high for a xerophytic zone at sea-level and along the leeward coast. The precipitation curve shows that in the various xerophytic zones of Guadeloupe and Martinique as well as in most of the other islands a pronounced dryness is observed during February, March, and April, the driest month varying with the island, and the maxima take place in September, October and November and exceptionally in July. Certain months between January and May have only 5 or 6 days of rain, other months, between July and November, show 18 to 20 days.

If one bears in mind the fact that during a few days with sudden and violent rain, the moisture exceeds that needed but is lacking on other periods of the plant's vegetative cycle, and the fact that the soil is so porous that it loses its water immediately after it is received, and the need of about 400 kilograms of water to manufacture 1 kilogram of plant matter, it is more readily understood why species adapted to xerophytic habitats are found here and why they show convergence characters.

Insolation and Evaporation

Insolation contributes to the dryness of the environment by incresing evaporation. In temperate regions evaporation is considered as of great importance, and has been studied in its relation to vegetation and agriculture. But there insolation and heat are less than on the dry Antillean coasts, and rainfall is distributed more or less uniformly throughout the year even in xerophytic forests. In subtropical climates, and particularly in the Caribbean islands, evaporation should be carefully studied to determine its influence on vegetation. On the dry, rocky slopes of Morne Chameau at an elevation of 280 meters in the xerophytic forests of Eugenia-Rochefortia, evaporation proved to be extreme, since in April 1936 29°C was recorded by a dry thermometer and 22°C by a wet thermometer. The presence of spines or thorns, laticiferous or colored saline products in the tissues, the small size of the leaves which are coriaceous or waxy, the falling of leaves during the spring when evaporation is at its highest, all are adaptations to this limiting factor.

The only observations regarding evaporation over sufficiently long periods are believed to be those made by the Metereological Service of Martinique at the Fort-de-France Observatory, and published annually by Romer (33). As this Station is located in the midst of a xerophytic zone and in the deciduous sub-type, leeward side and volcanic facies, where vegetation has been thoroughly studied, the mean annual and monthly evaporation in millimeters and the insolation in number of hours, for the 5-year period have been determined for the period 1933 to 1937, inclusive. The result of those computations appear in Table 7.

Table 7.—Mean Evaporation and Insolation in Xerophytic Forest. Fort-de-France Observatory (Martinique) Altitude 82 meters. (1933-37)

Month	Mean Evaporation	Insolation	Month	Mean Evaporation	Insolation
	mm.	Hours		mm.	Hours
January	4.14	212.16	July	3.55	215.24
February	4.22	218.79	August	3.15	237.32
March	4.90	257.44	September	2.90	199.71
April	4.70	243.95	October	2.82	199.81
May	4.22	227.19	November	2.82	205.54
June	3.90	215.75	December	3.90	218.84

Annual evaporation	45.22 mm.
Mean monthly evaporation	3.76
Annual insolation	2,651.74 hrs.
Mean monthly insolation	220.14 hrs.

The evaporation was measured by means of a Piche evaporometer, under colonial type shelter consisting of sugar cane grass covering. The maximum occurs in March, 4.90 mm. (may be in March or April, varying with the year and the region) and the minimum in October or November (2.82 mm.). Similarly, the maximum insolation occurs in March (257.44 hours) and the minimum in October (199.81 hours). Table 7 provides an explanation for the changes in the physiognomy of xerophytic forest. It is dependent upon extremely high evaporation lasting from December to March and being gradually reduced from March to November. Each year similar relationships may be found with very few exceptions in most other islands of the Archipelago. In some islands the maximum might be in April instead of March and the minimum might occur in November but the general appearance of the curve (Fig. 9) will be the same more or less.

Mean Temperature and Variations

In xerophytic forest mean temperature is not as important a climatic factor as precipitation and evaporation. Upon examining Table 8 which shows mean monthly temperatures for Fort-de-France over a period of 6 years one observes that the mean annual temperature is 25.64°C (78.15°F) the maximum occurring in June (26.70°C or 80.06°F) and the minimum in January (24.40°C or 75.92°F). A regular and gradual decrease is observed starting in June and ending in January, but with a second maximum in September, then a regular gradual increase from January to June.

Table 8.—Mean Temperature and Relative Humidity in the Xerophytic Forest Region. Fort-de-France Observatory (Martinique) Altitude 82 meters. (1932-37)

Month	Mean Temp. Centigrade	Mean Relative Humidity	Month	Mean Temp. Centigrade	Mean Relative Humidity
January	24.40	75.37	July	26.13	80.43
February	24.45	71.45	August	26.27	79.93
March	24.99	72.40	September	26.48	79.33
April	25.66	71.30	October	26.34	79.97
May	26.32	74.77	November	25.79	81.44
June	26.70	78.21	December	24.55	75.40

Mean: Temperature 25.64 Centigrades
Relative humidity 76.66 per cent

For Dominica, at the Roseau Botanic Station, also only slightly above sea-level in the leeward section of the xerophytic forest the annual mean temperature is 26.11°C (79°F) and the average minimum temperature is 23.88°C (75°F). Although temperature variation is a somewhat greater in Dominica the mean is nearly the same as for Martinique and Guadeloupe.

Variation in the extreme temperatures exerts a noticeable influence on xerophytic forests. Table 9 shows these monthly variations. Maximum, minimum and mean temperatures within the year are compared in Fig. 10.

Table 9.—Mean, Minimum and Maximum Temperatures in Xerophytic Forest Region Fort-de-France Observatory (Martinique). Altitude 82 meters (1932-37)

Month	Mean Minimum °C	Mean Maximum °C	Month	Mean Minimum °C	Mean Maximum °C
January	21.28	27.16	July	23.38	28.90
February	21.12	27.63	August	23.22	29.33
March	21.44	28.46	September	23.36	29.66
April	21.99	29.34	October	23.40	29.38
May	23.30	29.66	November	22.86	28.73
June	23.30	29.59	December	21.47	28.73

Annual Means: Mean minimum 22.51° C
Mean maximum 28.88° C

Table 9 shows the mean maximum for Martinique to be the same as that given by Hodge (22) for Dominica (Roseau Botanic Station). The difference between the extreme monthly maximum and minimum is only 8.54°C.

Daily variations in temperature are generally slight, the greatest occurring during the clear days of April. The difference between extreme monthly means is 3°C, very slight, as is typical of the tropics.

Within the xerophytic region the absolute minimum temperatures always occur during the middle of January and may be as low as 17.5°C (63.5°F). Absolute maxima of as high as 33°C (91°F) take place in May to June and September to October. Judging from observations made at Fort-de-France in the xerophytic region, the following rule may apply to the xerophytic region: the region has 20 to 40 days annually during which the temperature equals or exceeds 30°C (86°F), one half of which occurs in May and one third or one fourth in September, and 10 or less days when the temperature drops to 20°C (68°F) or lower, of which one half occurs in January or February and most of the balance in December, all being within these three months.

These temperature data for the xerophytic region in Martinique are applicable in the whole Caribbean Archipelago. Martinique is located in the middle of the insular arch formed by the islands, and is of average size. Temperature in the Antilles increases towards the south and towards the continent and diminishes towards the north, but the differences are not important and the data presented are therefore applicable without appreciable changes.

Atmospheric Humidity

In Table 7 the relative atmospheric humidity, as well as the mean temperature, is given for xerophytic forests at Fort-de-France. Humidity is high, varying between 71.30 percent in April and 81.44 percent in November, and the average is 76.66 percent. Absolute humidity or vapor tension has a very regular variation, the minimum of 17 mm. occurring in February and the maximum occurring in September is 22 mm. (means of three observations taken at 7 a.m., noon, and 5 p.m.). In the xerophytic region of Martinique the maximum tension takes place generally towards noon and coincides sometimes with the minimum of relative daily humidity; thus there is a clear sign of temperature influence. Generally diurnal variation of vapor tension is about 10 percent. Variations in temperature and relative humidity are as a rule simultaneous and opposite. The influence of temperature on relative humidity is so manifest, that on xerophytic sites (Fort-de-France) vapor tension is higher than in hygrophytic forests (Morne-des-Cadets) during the same periods and on the same leeward coast, while in the latter region, at a higher altitude, the humidity is much higher.

In Guadeloupe the same relationship is apparent. The mean relative humidity at Point-à-Pitre, in the xerophytic region, is at its maximum in November (83.3% at 5 p.m.) and minimum in February and March (70.3%), figures which are very similar to those of Fort-de-France. In Table 10 the monthly mean relative humidity for Pointe-à-Pitre are shown.

Table 10.—Relative Humidity in the Xerophytic Forest Region
Bacteriology Laboratory at Pointe-à-Pitre, Guadeloupe
Altitude 50 meters. (1925-1928)

Month	Humidity at 7 a.m.	Humidity at 5 p. m.	Month	Humidity at 7 a. m.	Humidity at 5 p. m.
January	86.6	74.1	July	83.4	74.8
February	85.3	70.3	August	84.1	77.9
March	85.0	70.3	September	85.2	77.5
April	79.3	72.1	October	88.5	80.6
May	81.4	72.5	November	89.9	83.3
June	79.8	72.3	December	89.6	78.6

Means: Humidity at 7 a. m. 84.84%
Humidity at 5 p. m. 75.35%

As a general rule the vapor tension of atmospheric water in the xerophytic forests of the Lesser Antilles is higher at noon that at 7 a. m. and 5 p. m., but this rule is not without some exceptions in March and April. The minimum vapor tension occurs principally during the night but according to data obtained by using hygrometers and dry and wet bulb thermometers, tension differs very little from that at 7 a. m. and 5 p. m.

Relative humidity, as well as evaporation, is very high at Fort-de-France and Roseau, both located in the xerophytic region on the leeward side. Pointe-a-Pitre, on the windward side, also possesses a very high evaporation.

Storms

Storms are sudden and violent. Their frequency at Fort-de-France, as recorded by months, is presented in Table 11.

Table 11.—Barometic Pressure and Frequency of Storms in Xerophytic Forest
Fort-de-France Observatory, Martinique. Altitude 82 meters. (1932-1937)

Month	Mean Pressure	Days of Storm	Month	Mean Pressure	Days of Storm
	mm.			mm.	
January	760.50	0	July	760.95	4.83
February	761.33	0	August	759.98	6.33
March	760.80	0	September	759.43	8.83
April	760.45	0.16	October	758.99	8.50
May	760.28	1.50	November	758.43	6.66
June	760.28	3.00	December	759.78	0.33

Annual Means : Pressure 760.18 mm.
Days of storm 3.07

Table 11 shows that there are no storms in the dry season, January to March, few from April to June and December, and abundant from July to November with maxima in September and October days. The total number of stormy days per year with thunder and lightning averages 37. In Martinique storms are most frequent in the south-east.

In the xerophytic region, storms are of tremendous violence; at Saline de Ste. Anne, Martinique undoubtedly one of the driest parts of the island, and where the thorny subtype is present occasional heavy rains occur. Deep gullies found there are an unmistakable indication of their intensity. In 1933, a year with few rainy days in Martinique, the maximum daily precipitation recorded by the pluviometer at Ste. Anne was 160 mm. (5.92 inches) followed by Alma, in the hygrophytic forest region = 124.75 mm. and by Prefontaine in the mesophytic forest region, with 123.4 mm.

This heavy rainfall intensity in xerophytic forests is general throughout the Caribbean and presents a new factor explaining the intensive erosion and a cause for the absence of soluble soil nutrients.

These violent storms create torrential coastal rivers in floods. Romer, gives remarkable descriptions of the typical storms in Fort-de-France. An interesting description follows:

"Rain storm of August 3, 1932.- In the morning the sky was covered with cirrostratus, alto-stratus and alto-cumulus and some cumulus. At about 10:30 a. m. there appeared on the horizon broad dense cumuliform masses. Rainfall started on the slopes with thunder. At 11:25 a. m. the wind, which had been negligible, blew NNE at 4 Beaufort units force and 1/4 hr. later became weak. At about 12:30 p. m. moderate rainfall reached Fort-de France. Storm continued until 2 p.m. over the station and on the slopes. At 2 p.m. the rivers suddenly flooded the lower side of town. At 2:30 p.m. storm ended. At 3 p.m. flood disappeared. Later the weather was calm.

These storms, although not frequent, are always accompanied by heavy rainfall, low atmospheric pressure, electrical phenomena and wind. They unquestionably exert an influence on the vegetation.

Barometric Pressure

Comparative studies of mean atmospheric pressure in xerophytic forests (Fort-de-France) and hygrophytic forests (Morne-de-Cadets) show a similarity, as is usually the case in tropical regions, with two well-defined maxima and minima, but the highest maximum occurs in February at Fort-de-France, and in July in Morne-des-Cadets, and the lowest minimum occurs in November at both stations.

At Fort-de-France the barometric variation amplitude during the day is 1 mm. in July and 2 mm. in November, and during the night 1.5 mm. in January and 2.31 mm. in July. The extremes are 4.5 mm. and 0.15 mm. The daily variation in barometric pressure is fairly regular. Any influence it may have upon vegetation is not direct, but indirect, as it affects weather.

Cloudiness

Cloudiness at Fort-de-France is shown in Table 12. Cloudiness is related inversely to insolation and affects evaporation, a factor which has a pronounced influence upon deciduousness in xerophytic forests. The minimum cloudiness occurs in March, the month in which leaves fall and xerophilous trees flourish, and the maximum occurs in June when trees are in full leaf.

Table 12.—Wind Velocity and Cloudiness in Xerophytic Forest
Fort-de-France Observatory (Martinique)
Altitude 82 meters, 1932-1937

Month	Mean wind Velocity m/sec.	Mean Nebulosity	Month	Mean wind Velocity m/sec.	Mean Nebulosity
January	5.62	5.22	July	4.97	5.59
February	5.02	5.16	August	4.62	5.60
March	5.46	4.63	September	3.65	5.66
April	5.85	5.58	October	3.26	5.94
May	5.27	5.99	November	3.70	5.66
June	5.45	6.25	December	5.27	5.15

Means ; Wind velocity 4 m/sec.
Cloudiness 5.53

The sky is completely cloudy on about 75 days per year, while only 6 days are completely clear (cloudiness less than 2). The sky is generally covered with clouds during longer periods in September and June. Half of the days with clear sky are in February.

Wind

In every island of the Caribbean Archipelago, it is possible to differentiate 3 types of wind which influence the vegetation of xerophytic regions: (1) the trade winds, with direction varying between N-NE and S-E, (2) hurricane winds, and (3) local winds, sea breezes and land breezes which result from relief. The first two types are found on the dry coast in all of the islands. They also have an analogous influence on the physiognomy and the biology of littoral forest vegetation contributing to a special dry aspect and convergence. Local winds are related to the particular form of different islands. They are marked in Guadeloupe, Dominica and Martinique, along shores, near coastal cliffs, and on sheer mountain slopes descending towards rivers. They are less active in islands with less rugged topography, such as Curaçao, Barbados, Marie-Galante and St. Bartholomew. St. Bartholomew, in addition to trade-winds blowing from the east or northeast, sometimes winds from the south or rarely from the west are felt.

Table 12 shows the mean daily wind velocities in meters per second, averaged for each month. The average velocity is 4.81 m/sec. which corresponds to a velocity of 17 kilometers per hour, a moderate to strong wind. The trade winds are dominant and blow from northeast to east-northeast 82 to 90 percent of the time. Winds from other directions are generally due to hurricane disturbances.

The highest velocity recorded in Table 12 during 6 consecutive years was during the month of April; lowest in October. The winds blow at relatively high velocity during the 3 months when evaporation, dryness and insolation are highest and cloudiness and precipitation lowest.

Some adaptations of the plants of xerophytic forest to the high evaporation here are deciduousness, laticiferous ducts, colored, viscous, saline and aromatic saps in the trunks, less tomata and abundance of anthocyanic pigments in the microphilous, coriaceous leaves with thick blades, and pubescence.

The combined influence of wind and attendant evaporation is intense physiological drought. Leaves fall, and the reactions and changes occurring in the ovaries and in the fruits under formation are sufficient to allow for the transportation of soluble nutrients to all parts of the plant which, lacking leaves, become dormant but not at absolute rest.

Along with these permanent winds, whose percentages according to direction are : 40 percent E-NE and more than 30 percent exactly towards the east, with a velocity never below 1 m/sec and above 15 m/sec during any time in the day, one must also include the hurricane winds.

Among one of the most violent and recent hurricanes is that which from September 12 to 20, 1928 passed from Guadeloupe to Puerto Rico and southeast Florida. This hurricane destroyed part of Pointe-a-Pitre and caused tremendous damage to trees and crops. In Guadeloupe big trees in xerophytic forests on the coasts were thrown. In St. Bartholomew, located in the north, the 1937 hurricane destroyed 200 houses, 13 ships and devastated the vegetation.

Aridity Index

An index of aridity has been established by Martonne which provides a good indication of the capacity of a given site to produce a normal forest or to be used in cultivation. This index is obtained by dividing mean annual precipitation in millimeters by the mean centigrade temperature plus 10. If this index is below 20, forests cannot be established and cultivation will not be successful unless irrigation is used. If the index lies between 20-30 irrigation is desirable but not indispensable, and if the index is higher than 30 forest is the climax.

In the xerophytic forest region of the Caribbean Archipelago the index is always 30 to more, showing that forests can be established and the land may be cultivated successfully with or without irrigation.

In Fort-de-France the index is 49.35. Hot regions such as at Caravelle, Diamant and Ste. Anne in Martinique and St. François and Anse Bertrand in Guadeloupe the index is 29.72. For St. Bartholomew it is 27.77.

In those areas in the Caribbean Islands where the thorny subtype is found the index varies from 17 to 34, with the mean 25, confirming the writer's opinion that their climax is not desert or semi-desert vegetation. The index for the deciduous subtype lies between 34 and 50, with a mean of 40. Between 50 and 55 the aridity index still corresponds to a deciduous forest but constitutes the upper limit of xerophytic forest, with the appearance of evergreens, decrease in microphylly and transition to mesophytic areas, as in Trinité, Martinique. This may be classified as an intermediate xero-mesophytic zone.

Upon analysis of this index, it might be argued that it fails to consider unequal rainfall distribution. It is true that precipitation in the various xerophytic regions is often irregularly distributed, but there are no very long periods with marked dryness. In the driest localities of Martinique and Guadeloupe there have been not more than 20 months during a period of seven years which may be considered dry, that is, when precipitation is not double the mean temperature. The longest period of drought recorded during this period, as reported by Revert (31), lasted 6 consecutive months in Simon and in Diamant, and 4 months in Ste. Anne. This only instance of marked drought is not enough to justify the classification of this region under Barbour's desert or arid zones if a comparison is made with St. Louis, Senegal, at the same latitude in Basse-Terre, where the aridity index is 11.

Hythergraph

The comparative hythergraphs of xerophytic and hygrophytic forests appear in Fig. 5. The utility of the hythergraph in the study of climate has been given in the introduction to this tudy under the subtitle "Types, Subtypes and Facies". It is regrettable that observations similar to that of Martinique are lacking in most of the other Lesser Antilles. A complete study of xerophytic forests should include similar studies in the drier islands and in localities presenting vegetation of the thorny subtype, in order to compare the hythergraphs representing the facies of this subtype with those of the deciduous subtype. Even though there exist mean monthly rainfall data for the driest sections of Guadeloupe and Martinique as well as for smaller islands, hythergraphs cannot be prepared because no temperature records are available.

Hypothesis of Insular Desiccation

It is commonly believed, both in Martinique and Guadeloupe, that these islands, and later other islands in the Caribbean, are subject to a progressive desiccation, particularly on the coasts, that will eventually modify the climax and eliminate gradually the facies of the xerophytic forests. This desiccation, a result of merciless felling and cutting of the forest, has become more intense each year ever since the first days of European colonization. Bassieres found in 1922 that records show a gradual reduction in rainfall at Fort-de-France and Trinité. On the contrary, Revert (31) in 1932 states: (1) that no definite proof has as yet been found that progressive desiccation is under way since the 17th century and that most indications favor temperature and precipitation stability; (2) that felling or reforestation do not influence rainfall distribution since that depends only on relief and dominant winds; and (3) that one may exploit the forests without fear of undesirable climatic consequences. The writer is inclined to disagree with these theories, particularly the last but thinks forest depletion is indeed always disastrous socially and economically.

Influence of Exposure, Topography and Relief upon Climate

Knowledge of the climatological conditions under which xerophytic forests thrive would not be complete unless the influence of exposure, topography and relief for every island is taken into consideration. Based on exposure, two different aspects may be observed (1) windward, where the direct action of trade-winds from the east is manifest, and leeward, where dryness is more marked. Precipitation varies from 1.5 to 2 times more in the former.

In Fig. 2, Revert shows for Martinique higher precipitation in the windward side. In Guadeloupe and Dominica the mesophytic forests are found nearer the shore on the windward side.

Variation from this general rule is caused by topography. The irregularities of rainfall distribution at Fort-de-France, and its relatively high rainfall despite its location on the leeward side seem to be explained by the fact that east-southeast and east-northeast winds pass over the large plains of Robert and Lamentin and do not lose their water before reaching the projections of the town. The town of Roseau in Dominica, located also in the leeward side, receives less rainfall than Fort-de-France because the nearby relief shelters it better from the moisture-laden winds. Riviere-Salée and Prefontaine Garden, in the southern part of the island receive more than 2.20 meters annually due to the fact that they are located at the base of slopes which create condensation of precipitation. These places, due to the relief and the orientation of the mountains are fresh and humid spots in the midst of dry lands.

STRUCTURE AND COMPOSITION

The simultaneous action of certain groups of climatic or edaphic factors accounts for the structure of vegetation, its general and floristic composition, its seasonal aspects, and the particular appearance of xerophytic forest and its subtypes and facies in the Lesser Antilles. The structure of the trees and shrubs in this forest type from the root system to the phyllotaxy and leaf cycle, the aspect of thickets, scrubs, brushwood and heath, and the presence of spines and microphylly in communities of pure xerophytic vegetation constitute some of the adaptations to difficult natural conditions.

Structure

The composition of this forest type presents certain common characters which provide its peculiar physionomic aspect. The roots are rarely superficial; trunks and branches are dense, numerous, often spiny and long; secretions such as latex, resin, or gum are common; bark is thin, often smooth, and periodically shedding; wood is dense, heavy, colored, and durable; leaves microphyll, with few stomata, sometimes spiny or even absent, coriaceous, deciduous; flowers small, vivid colored; flowering period short, and in harmony with foliation; and round fruits with seeds sometimes protected with a fleshy aril and have good germinative capacity and longevity.

Root System and Buttresses

The trees and shrubs making up the various facies of xerophytic forests possess root systems determined by specific causes related to the structure of the species and its branch system, by certain edapho-climatic causes such as precipitation and insolation, which start the disintegration of rocks or the crumbling of the soil, and finally by the permeability and porosity of the soil. These conditions have resulted in the production of long taproots, well adapted for reaching subterranean water levels and nutrient zones which might be present in such a heterogeneous site. The roots near the most favored places are shorter.

The angle of geotropism of the roots is, in most arborescent species not very wide and is equivalent to the angle of heliotropism of the principal branches. This makes for greater strength and stability of the plant. Such root disposition permits the most chasmophytic trees with thick roots to grow on sheer littoral cliffs and rocks.

Aerial roots and plank buttresses are rare in xerophytic forests. Nevertheless they are not totally absent in these or in the littoral roble forests of Tabebuia pallida Miers. In the gommiers, Elaphrium simaruba (L.) Rose, Croton and others, certain proliferations are seen at the base of the root collar and sometimes prominent plant-buttresses. On young trees they are not noticeable but in adult trees, on rocky soil where rooting is difficult, or on compact sands on abrupt slopes where roble is a pioneer species, round, elongated and cylindric buttresses and twisted roots are developed which facilitate tree establishment and development.

Trunk and Branching

Trunks are generally short and the branches start near the root collar. The branches are often long, inflexed, hanging, intermingled or bushy. The bushy, impenetrable, dense appearance is common. On the drier sites and on poorer soils spiny trees may be abundant.

Spines are found on trunks, branches, and branchlets, as in Guilandina crista L. Small where they are sharp and hooked, in Pithecolobium unguis-cati (L.) Mart. resembling cat claws, in Anthacanthus microphyllus

Nees, more or less curved, and in Fagara caribaea (Lam.) Krug et Urb. and in F. spinifex Jacq., Celtis iguananea (Jacq.) Sarg., Pisonia aculeata L., P. Helleri Standl. and P. subcordata Sw. In Fagara microcarpa they are found on the leaf veins, on the leaves of Comocladia dodonaea (L.) Urb., and on the petioles of Parkinsonia aculeata L. Acacia muricata (L.) Willd, amourette or acacia-riviere, has narrow small spines. A. riparia H.B.K., pompon, has small hooked spinules, while A. paniculata Willd. and A. macracantha Humb. & Bonpl. have trunk branches, and branchlets covered with white, erect, sharp, spines inserted at right angles, and paired at their insertion.

Branches are often reddish or of a rusty color, as in Myrcia paniculata Krug et Urb. var. coriacea (DC.) Duss and var. imrayana (DC.) Duss. The bark is often bitter and astringent as in diaballe, Pithecolobium unguis-cati (L.) Mart., mahot-piment, Daphnopsis caribaea Griseb. and quinquina-piton, Exostema caribaeum (Jacq.) R. & S.

Essential oils and aromatic constituents are often found in branches, branchlets and leaves, as in the lepineux jaunes or bois noyers, Fagara flava (Vahl) Krug & Urb. and F. monophylla Lam., dogwoods, Dodonaea viscosa Jacq. and D. Ehrenbergii Schlecht and finally barbasco or cannelle blanche, Canella winterana (L.) Gaertn. The species having colored or astringent substances in all their aerial parts are abundant, and among the most common in the Archipelago are Picramnia pentandra L., Guaiacum officinale L., Ichthyomethia piscipula (L.) Hitchc. and Eugenia lambertiana DC.

Trees and lianas containing latex are also abundant, and in the various facies in the xerophytic forests specially the very laticiferous Apocynaceae, Rauwolfia Lamarckii DC. and Plumiera alba L. and Asclepiadaceae such as Ibatia maritima (Jacq.) Dcne., Metastelma and Decastelma. In a previous article on the classification of trees which secrete latex, gums, resins, and coloring matter published in the Caribbean Forester (Vol. 4, No. 3) a list of 70 species were mentioned for Guadeloupe and Martinique without including those secreting tannins and phlobaphene. Thirty of these species are found in xerophytic forests. The affinities and correlations between the different physico-chemical characteristics of the secretions and the botanical families were given, with particular reference to the aromatic resins and elimi gums of the Burseraceae, bitter substances of the Meliaceae and combustible juices of the Rutaceae. Gums and resins develop normally in various Leguminous trees, especially in the Mimosaceae.

The physiologic role of latex and bitter or astringent substances is in the transportation of nutrients through the tissues, while gums are merely wastes. The observed reduction or disappearance of latex and its impoverishment when chlorophyll assimilation weakens or disappears favors this belief concerning its role. Gum production is believed to be related to the production of carbohydrate reserves, the accumulation of water needed in transporting soluble materials, and may facilitate cicatrization of tissues during leaf fall or after wounds. Wind and heat seem to favor the production of some gums such as gum Arabic.

Wood Structure

The wood of xerophytic forest trees present more marked characteristics as to hardness, density, coloration, strength, and durability than those of other forest sections. These characters are generally interrelated and the fibrous and colored woods are often dense, strong and heavy, as with Coccoloba, Cordia and Eugenia. Hardness is due to thickness and lignification of membranes, small size of ducts and similar lignous elements, creating a fine-grained, compact texture. This is a general feature, and is especially conspicuous in the Myrtaceae. The development of ducts is limited by the intensity of internal liquid movement, which thus is responsible for their small size, their limited number and the great thickness of annual growth rings. The woods are hard due to the numerous fibers. The woods may be classified as excessively hard, such as Guaiacum officinale L., very hard; and hard, depending on the thickness of the membranes. Densities vary from 0.70 to 1.25, with few exceptional woods of 0.3 or 1.4. The specific gravities and colors of the more common woods are listed in Table 13.

Table 13.— Specific Gravities and Colors of Caribbean Xerophytic Forest Trees

Species	Common Names	Density	Color
Guaiacum officinale L.	gaiac, lignum-vitae, guayacán	1.25	yellowish brown, black heartwood
Amyris elemifera, L.	bois chandelle, bois lepuni, tea, torchwood	1.10	yellow
Coccoloba grandifolia Jacq.	raisinier-grandes-feuilles moralón	1.05	dark red
Coccoloba uvifera L.	raisinier, bord-de-mer, sea-grape	1.00	blackish brown
Dipholis salicifolia (L.) A. DC.	acomat batard, bustic	0.95	reddish brown
Hypelate trifoliata Sw.	white iron-wood	0.90	yellow
Fagara flava (Vahl.) Krug & Urb.	bois jaune, noyer, satin-wood, yellow sander	0.90	yellow

Table 13.—Continued

Species	Common Names	Density	Color
Ichthyomethia piscipula (L.) Hitch.	bois à énivrer, enivrage, fish poison	0.90	brown
Citharexylum fruticosum L.	bois carré, cotelette, fiddlewood	0.88	red
Cordia alliodora (R. & P.) Cham & Schl.	bois de rose, capá prięto, Spanish elm	0.85	brilliant brown
Guettarda scabra (L.) Lam.	bois madame, goyavier bâtard, velvet-berry	0.85	red
Tabebuia pallida Miers	poirier gris, poirier blanc, roble, cedar	0.80	pink or grayish pink
Colubrina reclinata (L'Herm.) Brong.	bois mabi, ebonywood	0.80	brown
Acacia muricata (L.) Willd.	amourette, tendre à cailloux tamarindo cimarrón, spineless acacia	0.78	reddish brown
Colubrina ferruginea Brongn.	greenheart, soaptree	0.70	yellow
- - - - - -	- - - - - -	- - -	- - - - - -
Hura crepitans L.	sablier, sandbox tree, javillo	0.46	grayish white
Elaphrium simaruba (L.) Rose	gommier rouge almácigo gum tree	0.35	brilliant brown

Hura crepitans and Elaphrium simaruba are probably second growth species, as indicated by their rapid development and their intolerance of shade.

Color is varied but always vivid, the heartwood darker and the sapwood pale, frequently glossy. The sapwood in lignum-vitae is well-defined, yellowish or light brown, while the heartwood is deep brown or black. This wood contains a greenish, bitter resin. In lignum-vitae the rays are clearly layered and only one row of cells in width. The height of the layers is equivalent to about 100μ and in each layer the rays are very close (about 20-25 per millimeter). The tracheids are generally isolated, possess very thick membranes, and measure 100-150μ in diameter. The tissue between the tracheids is formed by the rays, fibers, and parenchyma. The hardness of the wood is due to the great thickness of the membrane, with lumen extremely reduced. The wood parenchyma is very reduced, represented only by some scattered cells between the fibers. This is one of the most characteristic species of the primary xerophytic forest type of the Lesser Antilles but, as in Puerto Rico, it has been subject to such intense exploitation that it is disappearing from most of these islands.

Odor

The woods of certain species in this forest possess typical odors either agreeable or disagreeable and even fetid. This is due to the presence of certain tannic substances and essential oils formed in the leaves and accumulating in the wood. It is a sign of durability. The production of these odorous substances is related to insolation and atmospheric ventilation. The wood of Cordia alliodora (R. & P.) Cham. has an agreeable rose odor, Fagara flava (Vahl), as well as the F. caribaea (Lam.) Krug & Urb., has a strong disagreeable odor which keeps termites away and makes it suitable for use underground and in water. Species belonging to a same genus may possess quite different odors.

Among the species in the xerophytic forest possesing disagreeable odors are: bois fourmi, Guettarda parvifolia, Sw., bois caca, Solanum triste, Jacq., bois de mèche, Capparis indica (L.) Fawc. & Rendl., bois noir, C. cynophallophora L. var. normalis Eichl. and mahot-bré or mapou rivière, Cordia collococca L.

Marked taste is found both in leaves and wood. Some taste sweet, but most are bitter. The Simarubaceae and specially the bois amer or peste a poux, Picraena antillana (Eggers) Stehlé, bois amer or bitterwood P. excelsa Lindl., and the bois poisson or graines-dorées, Picramnia pentandra Sw. often contain quassin, a substance responsible for the bitterness of their tissues.

The woods of this forest are believed to be better conductors of heat than species in other regions, a fact which is related to their higher density.

Wood durability in the air or in fresh or sea water and underground is also more common with xerophytic woods than others, due to the natural impregnation of resins, oleoresins and essential oils which keep insects, fungi, bacteria and other wood-destroying agents away. Guaiacum, Acacia muricata (L.) Willd. and Fagara caribaea are durable under water.

Forest Physiognomy and Leaf Morphology

Physionomic aspects

Due to variations in dryness during certain months, light, and evaporation in the xerophytic forest, four physionomic aspects may be distinguished, two for each subtype. These are sometimes clearly separated in situ, but may be contiguous or intermingled. They are: (1) cactus scrub, the open, semi-wooded, park aspect made up of Cactaceae and Agave thickets; (2) thorn bush, a thorny, dense, impenetrable brush of Leguminaceae, Acanthaceae, and Rutaceae; (3) beach thickets, spineless, deciduous thickets, very dense and bushy, with small and abundant leaves; and (4) littoral or coastal forests, relatively open forests of tall spineless deciduous trees.

The thorny thickets of Cactaceae and Agaves, corresponding to Gleason and Cook's (18) "jungle of shrubbery" in Puerto Rico and to certain forms of Pittier's (30) "chaparral", form a transition between thorny forests and savanna, and are the most littoral of all plant formations of drier sites. This aspect is found in Saintes Is., Desirade, on the beaches of Curacao, on Antigua, Saba, and St. Bartholomew, on the rocky islets of Fourche and Coco, and in the most arid and rocky sites constitutes the so-called "semi-desert" vegetation of the Caribbean Archipelago. The most xerophytic elements do not occur in Guadeloupe, Martinique, Dominica, and St. Lucia, which are relatively wet islands even on the coasts. This association is formed by the few species adapted to these unfavorable conditions. Tree height varies from 0.5 to 5 meters.

The thorny bush is taller and denser than the cactus scrub. The flowers are abundant, colored, ornamental, and odorous, gum and resin secretions are abundant and some lianas climb the stems and branches. From Margarita to St. Martin these thickets with the same physionomic aspect but varied floristic compositions, occur in littoral dry sections near the cactus scrub. They are found in all the Antillean islands, not only in the islets where they figure among the pioneers of the stabilized vegetation of sandy shores but also in the larger antilles such as Trinidad and Guadeloupe. The height of this vegetation varies from 3 to 6 meters. It is necessary here to make a distinction between two physionomic aspects of the thorny bush: one is a primary formation consisting of Rutaceae and Acanthaceae and some Leguminoceae, the other is second growth, consisting of Mimoseae and Caesalpiniaceae or even substituted by naturalized acacias and campeches in degraded areas. The forest of "picaniers" Solanum sp. (Desirade) and "croc-chiens", Pisonia sp. (Marie-Galante and Martinique), "lepinés", Fagara sp., "amourettes" Anthacanthus sp., (Desirade and Guadeloupe) or Acaciella curassavica (Curaçao) which are native species should be differentiated from introduced secondary vegetation of similar aspect, including exotic species such as Acacia nilotica (L) Delile, introduced campeches, Haematoxylon campechianum L. and bushes of "arrêt-boeufs" or "banglins" Mimosa pigra L., Acacia suma Kunth. and A. sundia Roxb.

The beach thickets of Euphorbiaceae (Croton), Myrtaceae (Eugenia), Erythroxylaceae (Erythroxylon), Polygonaceae (Coccoloba), and Burseraceae, (Elaphrium), Rhamnaceae (Krugiodendron and Colubrina), varying in composition in the different islands, possess numerous small, green thin reddish leaves, form the littoral forests known as "ti-boumes", "ti-feuilles", bois vinettes" "raisiniers" "bois rouges", "bois de fer" "gommiers" or "bois-mabi" which constitute the equivalents of the "beach" or "coastal" thickets of Puerto Rico (18). The aspect is more forest-like than the thorny thickets and although its origin is different, its aspect is similar to that of Mediterranean thickets. The "garrigue rhamnoide" of sothern France and the "maquise" of Corsica possess a similar physiognomy to this Caribbean thicket. The height of this vegetation varies from 4 to 10 meters. It is the first forest vegetation found inward from the shore, and it may develop a few meters from the sea.

The fourth aspect, the coastal forests are sometimes open such as the "poirier", Tabebuia-Drypetes forests (Marie Galante), but usually they only form high bushes growth under which one may walk freely, as those of "bois à mancenilliers" or "manichil", Mancinella sp. The height of the vegetation varies between 8 and 20 meters. The aspect of Tabebuia forests is similar to that of certain evergreen oak thickets in the European and North African Mediterranean coast. Tabebuia sp. is deciduous and flowers abundantly 2 or 3 times each year. The flowers are pink or rose, appearing with the new leaves. This is not a large forest. It forms a strip along the coast with certain interruptions where other subtypes are found and where cultivation has been done. It is the best developed xerophytic vegetation in the Caribbean Islands and the rare relicts remaining are very beautiful. In the Folle Anse forest, between Grande-Anse and St. Louis, Marie-Galante it attains its optimum development.

This forest receives 1.40 to 1.80 meters of precipitation annually with an average of 1.60 meters, and all metereologic data for the Fort-de-France region are applicable, because in spite of the extension of agriculture, the "poirier" forest climax is seen reestablishing itself, and there are still natural formations not far from the weather station, between 80 and 150 meters elevation. The altitude may reach even 200 meters (600 feet) in the larger islands. It is in this forest that the first epiphytic phanerogams (Bromeliaceae) are found. Parasites (Loranthaceaes), on the other hand, are found even on certain species of the thorny bushes and in the shrubs of deciduous beach thickets.

Seasonal Aspects and Deciduousness

In every one of the xerophytic forests just described above, different seasonal aspects result from reactions to climatic and edaphic conditions. As a whole, the appearance of any forest is the same during the same months of any year. The preponderant factors responsible seem to be temperature and rainfall.

In the islands in the center of the Caribbean Archipelago the writer has observed from Barbados to Desirade the following seasons:

Dry winter season.— Trees lose their leaves, sometimes totally, sometimes partially; the branches are naked; the leaves, brown and dry, accumulate on the soil. During this season the wind is strong, light and evaporation are extreme, rainfall is less abundant and sometimes totally absent. It is the period when the atmospheric phenomena exercise a convergent action upon the vegetation, causing a cessation or abatement of normal functions and of the transportation of soluble and nutritive material. The aspect reminds one of forests in temperate regions during autumn.

Spring season.— During the last days of April a change is noticed which affects in a general way the entire aspect. Temperature rises, heavy rains fall, atmospheric humidity increases and insolation diminishes. During the first days of May the first thunder is heard. The first leaves begin to appear, whitish or pale green, covering the trees with lacy foliage before the color darkens. The first flowering period takes place, sometimes even before the leaves appear, as in _Erythrina_, or after the leaves, as in _Tabebuia_.

Rainy season.— This period is generally considered to be between July 15 and October 15 in the Antilles, but according to metereologic data and judging by the action of climate on xerophytic vegetation is begun during June, when flowers fall and form a beautiful pink rug underneath _Tabebuia_ trees. The rains fall regularly and temperature increases.

Autumn season.— This season, known to Guadeloupe and Martinique peasants as St. Martin's autumn, starts in August and ends in December. Most of the species which did not flower in the dry season flower in this season.

The most common woody species of the dry forests flower again for the second time and even for the third time, including gaiac, _Guaiacum_; poirier, _Tabebuia_; mahot-piment, _Daphnopsis_; flambeau-caraïbe, _Pilocarpus_; latanier du pays, _Coccothrinax_; and merisier local, _Malpighia_. The Myrtaceae with fugacious flowers (_Eugenia_ and _Myrcia_) flower either in May-June or in the course of this autumn season.

The deciduous character is manifest in xerophytic forests and is an outstanding feature. However, not only the leaves are lost, but also branches, twigs, and bark.

The separation of leaves and branches takes place by a process which is seen in the most common tree species and lianas of the xerophytic forests. Leaf fall takes place as follows: By suberization a cushion is formed before the leaves fall, a preliminary to cicatrization. Then the middle lamella gelatinizes and only the vascular bundle is left to attach the petiole to the branch and finally only the sclerenchyma. Thus the only connection between the leaf and branch is an inert woody axis which can be broken by the weakest breeze. The green leaf turns yellow and later brown.

This falling of leaves and branches is clearly synchronized with florescence. More rarely it is produced at the time of fruiting, as with corossol-diable or corossol à chien, Ibatia maritima, Griseb, a pubescent, shrubby liana common to the dry, rocky coasts.

The principal species whose leaf fall is total during the dry season are typical of this forest type, and are shown for Guadeloupe, Martinique and Dominica in Table 14.

Table 14.—Leaf Fall and Flowering Period of the Most Common Species in the Caribbean Xerophytic forest

Species	Common Names	Leaf Fall	Flowering
Pisonia subcordata Sw. var. typica Heimrl.	mapou gris	Feb.-March	April-May
Erythroxylon brevipes DC.	bois vinette, Bresillette	Jan.-March	March-May
Erythrina corallodendron L.	Immortel	Jan.-March	Jan.-May
Ichthyomethia piscipula (L.) Hitch.	Bois à énivrer	Feb.-March	April-May
Cassia emarginata L.	Casse savane	Feb.-March	Feb.-April
Tabebuia pallida Miers.	Poirier gris Poirier blanc roble, cedar	Jan.-March	Feb.-May July-August and Oct.-Nov.
Elaphrium Simaruba (L.) Rose (Bursera gummifera L.)	gommier rouge gum tree, almácigo	March-May	May-June

Leaf Morphology and Raunkiaer's Leaf Types

Leaf morphology gives the vegetation a unique appearance. It is one of the essential features of the physiognomy and aspects of the different regions and seasons of these forests. Its apparent characteristics are: presence or absence of leaves (displaced by hairs, spines or areolas as in Leguminous species and Cactae); leaf insertion and grouping at the base in acaulescent rosettes (as in the Agaves); varying leaf forms, from linear to ovate; and small leaf size (Raunkiaer's microphyllous in Myrtaceae, Erythroxylaceae, and Rhamnaceae).

Among the most typical microphyll species is the spiny shrub of the dry coast of Antigua, Castelaria Nicholsoni (Hook) Small, the chicharron of Anguilla, Reynosia uncinata Urb.; croc-jambe, Anthacanthus microphyllus (Jacq.) Nees in Desirade and Guadeloupe (Grande Terre); the crab-prickle or amourette, Volkameria aculeata L. of Barbados, the box brier or petit-coco, Randia mitis L., on most of the islands from Anguilla to Trinidad on Curaçao, and Krameria ixina L. from St. Eustachius, Antigua to Bonaire and Curaçao.

Together with these tree and shrub species of small leaves of the rhamnaceous type certain macrophilous species may be found, such as the Agaves, whose leaves measure 1 to 3 meters long, 10 to 25 centimeters wide, and raisinier grandes-feuilles, Coccoloba grandifolia Jacq., measuring 50 to 80 centimeters in width. They are seen as big green spots in the bushy small-leafed landscape. But generally speaking the microphilous type predominates, with occasional micro-mesophyll leaves.

Leaf Texture

As with leaf form, leaf texture is also adapted to the dry habitat. Extreme evaporation is responsible for the abundance of spines, hairs, tomentum, adaptations which assure certain protection. Stomata are few. The leaves are firm, chartaceous, coriaceous, or membranous and the epidermis is often covered with a protective waxy layer. The leaves may be hairy-like, as in Castelaria Nicholsoni (Hook.) Small, or may possess a silky tomentum, as in Sophora tomentosa L., Dipholis salicifolia, (L.) A.DC., Acrodiclidium salicifolium (Sw.) Griseb, Melochia tomentosa L. and Krameria ixina L.

Leaf color varies not only with species but with season, contributing differences in physiognomy due to location and season. The leaves are green, pale green, bluish green during the rainy season, and during the dry season they turn yellow, red, and brown before falling, an aspect similar to the autum in temperate regions. In addition to the gray or rusty hairs which may cover the leaf blades and petioles, yellow, pink or red pigments impregnate the leaf tissues, creating an intense coloration peculiar to this forest. This yellowing and reddening of the leaves occurs principally in February and March.

The most vividly colored species are those of the Euphorbiaceae and the Verbenaceae and especially the ti-baumes of genus Croton and the grand baume Croton corylifolius Lam. and bois carré or bois côte, Cytharexylum sp.

Essential oils and other aromatic or odorous secretions in leaves, branches and wood are abundant. Many of the leaves, particularly among the Rutaceae, Malpighiaceae, Euphorbiaceae, Myrtaceae, Burseraceae, Terebenthaceae, Canellaceae, and Rahmanaceae, have numerous small cavities on their surfaces, full of odorous juices or secretion schizo-lysigenous glands.

In all the forest types of the Caribbean islands trees are found whose leaves are odorous or fetid or producing secretions but their representation is highest in the xerophytic forests. The odor of the leaves, as well as their appearance and color is another resemblance of this type to the rhamnaceous "garrigue" of southern France.

The leaf types of Raunkiaer may serve as a means of differentiating the four different physiognomic aspects already described. Their dissimilarities constitute another distinctive character of these formations.

The species characteristic of the Agave and Cactae associations are of the macrophilous type or aphilous, where leaves are absent and are replaced by spines. Sometimes small deciduous leaves appear, as in Opuntia but, more generally, the joints are devoid of leaves and the upper areolas carry long spines, as in Cephalocereus. The spines in these Cacti are yellow, yellow-brown or yellowish green.

Table 15 shows the scientific and vernacular names of the most common spiny species of the Caribbean Archipelago from Anguilla to Curaçao. They are the species forming the spiny or thorny, open, cactus scrub, of the drier sections and are the nearest Caribbean counterpart of the semi-desert vegetation of Mexico. Their optimum development is found in Desirade (Leproserie and Phare) in Curaçao, Margarita (El Valle and Pt. Moreno), Coche Islet, Antigua, and Ste. Bartholomew (Fourche Islet).

Table 15.—Leaf Types of the Most Common Species in the Cactus Scrub (Cactaceae and Agaveae)

Scientific Name	Native Name	Leaf Type
Cactus intortus Mill.	Tête à l'Anglais, Turk's head	areolae of 7-13 brownish spines
Neomammillaria nivosa (Link) Britt. & Rose	Snow cactus	4-5 yellow or yellowish brown spines
Opuntia Dillenii (Ker-Gawl.) Haw.	Raquette douce Prickly pear	1-4 yellow spines or spineless
Opuntia Tuna Mill.	Grosse raquette	3 yellow spines
Opuntia antillana Br. & R.	Bull suckers	3-6 yellow spines
Opuntia triacantha (Willd.) Sweet	Raquette volante	3 white, acicular
Consolea rubescens (Salm-Dyck) Lemaire	Petites raquettes	1-6 acicular areolae, spineless
Consolea moniliformis (L.)Br.	Petites raquettes volantes	3-8 yellow spines
Cephalocereus nobilis (Haw.) Britt. & Rose	Cierge	brownish-yellow acicular spines
Cephalocereus Urbanianus (K. Schum) Britt.& Rose	Pomme-cierge	yellow acicular spines

Table 15.—Continued

Scientific Name	Native Names	Leaf Type
Cephalocereus Royeni (L.) Britt.& Rose	Sebucan, dildo	greenish-yellow, acicular spines.
Agave Dussiana Trel.	Karata, century plant, agave	macrophyll, oblong-lanceolate
Agave barbadensis Trel.	Karata, century plant, agave	macrophyll oblong-lanceolate
Agave evadens Trel.	Karata, century plant, agave	macrophyll oblong-lanceolate
Furcraea tuberosa Ait.	Karata, century plant, agave	macrophyll oblong-lanceolate

The most abundant leaf types in the thorny bush aspect are no doubt microphyll simple leaves and mesophyll bipinnate leaves often with pinnae subdivided into microphyll leaflets, or as in Fagara, trifoliate or simply pinnate.

Table 16 shows the principal species of the thorny bush with native names and leaf types. The large number of pinnately compound leaves ovate in form with linear, oblong, or elliptic leaflets is evident.

Table 16.—Leaf Types of the Thorny Bush Facies

Scientific Name	Native Names	Leaf Type	No. of Leaflets	Size and Form	
				Leaf	Leaflet
Acacia muricata (L.) Willd	tendre à cailloux	bipinnate 8-10 pinnae	20-32	mesophyll elliptic	microphyll oblong
Acacia macrantha Humb.& Bonpl.	acacia piquant, wild tamarind, stink casha	bipinnate 30-60 pinnae	15-35	mesophyll elliptic	microphyll linear
Acacia paniculata Willd.	fleur d'amour acacia blanc	bipinnate 12-18 pinnae	30-60	mesophyll ovate-elliptic	microphyll linear

Table 16.—Continued

Scientific Name	Native Names	Leaf Type	No. of Leaflets	Size and Form: Leaf	Size and Form: Leaflet
Acacia guadeloupensis DC	amourette, pompons blanc	bipinnate 10-16 pinnae	20-40	mesophyll oval elliptic	microphyll oblong
Acacia curassavica L.	petit amourette	bipinnate 10-16 pinnae	20-40	mesophyll oval elliptic	microphyll oblong
Guilandina crista (L.) Small	oeil de chat, canique, gray nickers	bipinnate 6-16 pinnae	10-16	mesophyll elliptic	microphyll elliptic
Pithecolobium unguis-cati (L.) Mart.	diaballe, crab-prickle black bead	bipinnate 2 pinnae	2	mesophyll elliptic	microphyll ovate-oblong
Ichthyomethia piscipula (L.) Hitchc.	bois enivrant, poison-fish dogwood	pinnate	6-10	mesophyll elliptic	microphyll elliptic or oblong
Anthacanthus spinosus (Jacq.) Nees	amourette croc-jambe picanier prickly brush	simple	-	microphyll obovate	
Anthacanthus microphyllus (Jacq.) Nees	amourette croc-jambe picanier pickly brush	simple	-	microphyll obovate	
Castelaria Nicholsoni (Hook.) Small	thom bush	simple	-	microphyll elliptic-ovate	
Fagara spinifex Jacq.	lepineux blanc, bois chandelle, niaxagato	pinnate	3	microphyll ovate	microphyll elliptic
Fagara trifoliata Sw.	lepineux rouge bois flambeau noir, torch-wood	pinnate	3-8	microphyll ovate	microphyll elliptic

Table 16.—Continued

Scientific Name	Native Names	Leaf Type	No. of Leaflets	Size and Form Leaf	: Leaflet
Fagara caribaea (Lam)Krug & Urb.	Lepiné blanc	Pinnate	12-14	mesophyll elliptic	microphyll elliptic
Fagara microcarpa (Griseb.) Krug & Urb.	lepiné rouge, bois noyer	pinnate	10-14	mesophyll elliptic	microphyll lanceolate
Fagara monophylla Lam.	lepiné jaune yellow prickle	simple		mesophyll elliptic	
Randia mitis L.	bois lance, petit coco, box brier, Christmas tree	simple		microphyll subrhombic	
Malpighia linearis L.	bois royal stinging bush	simple		microphyll linear lanceolate	
Celtis iguaneus (L.) Sarg.	croc-chien gratle-jambe, cockspur	simple		microphyll ovate	
Pisonia subcordata Sw.	mapou mampoo lobloby	simple		mesophyll ovate	

Leaf form in cactus scrum and thorny bush is homogeneous as a rule. However, this is not a characteristic of the beach thickets. In this type, the leaves are more usually simple and microphyll size predominates, but there is also present a mixture of larger-leaved species in the micro-mesophyll range.

The dominant leaf form is ovate or elliptic, sometimes obovate, with transitions. The wide mesophylls are represented only by Coccoloba uvifera (L) Jacq. which often forms pure stands, the trees often inclined due to wind action. More detailed information on leaf types is furnished in the Table 17.

Table 17.—Leaf Types of the Beach Thickets

Scientific Name	Native Names	Leaf Types
Croton astroites, Dryand.	ti-baume, maran	microphyll, ovate-oblong and ovate-lanceolate
Croton balsamiferum Jacq.	ti-baume, sage, yellow balsam	microphyll, ovate oblong and ovate-lanceolate
Croton Dussii Urb.	Baume bâtard	microphyll, ovate oblong and ovate-lanceolate
Croton Guildingii Griseb.	petit-baume	microphyll, ovate-oblong and ovate-lanceolate
Ricinella pedunculosa Mull-Arg.	espinillo, escambrón, ricinella	microphyll, oblong to obovate
Reynosia uncinata Urb.	chicharrón	microphyll, obovate to ovate
Krugiodendron ferreum (Vahl) Urb.	bois de fer, block ironwood ebony wood	microphyll, ovate
Colubrina ferruginosa Brongn.	raton, snake bark, greenheart, soap tree	micro-mesophyll, ovate to elliptic
Colubrina reclinata (L'Her.) Brongn.	bois mabi, mambee, naked wood	micro-mesophyll, elliptic to ovate-lanceolate
Sarcomphalus domingensis (Spreng.) Krug & Urb.	cacao-rojo	micro-mesophyll elliptic to orbicular
Eugenia Lambertiana DC.	Merisier jaune	microphyll ovate
Eugenia ligustrina (Sw.) Willd	bois ti-feuilles, merisier noir, birch berry	microphyll, oblong or elliptic
Eugenia rhombea (Berg.) Krug & Urb.	merisier rouge, restopper	microphyll, elliptic to ovate-lozengic
Anamomis fragrans (Sw) Griseb	bois d'Inde bâtard, goyavier bois	microphyll, elliptic to obovate

Table 17.—Continued

Scientific Name	Native Names	Leaf Types
Myrcia paniculata Krug & Urb.	merisier ti-feuilles bois fustet	microphyll, ovate to obovate
Coccoloba uvifera (L) Jacq.	raisinier bord de mer, sea grape, uva de mar	meso-macrophyll, orbicular or more wider than long
Coccoloba diversifolia Jacq.	bois rouge, raisinier bois, mountain grape red wood	microphyll, elliptic to ovate
Coccoloba venosa L.	raisinier bâtard, raisin coudre chiggery grape	micro-mesophyll elliptic to obovate
Elaphrium simaruba (L.) Rose	gommier-barrière gommier rouge, gum-tree, almácigo	mesophyll, compound of 3-9 pairs of leaflets ovate-oblong or obovate
Rochefortia cuneata Sw.	Bois d'ébène vert, bois vert	microphyll obovate
Pilocarpus racemosus Vahl	Flambeau caraïbe, flambeau noir	mesophyll, elliptic-circular
Dipholis salicifolia (L) A.DC.	acomat-bâtard, bustic	microphyll lanceolate
Erythroxylon brevipes DC.	bois vinette bresillette	microphyll, ovate
Forestiera rhamnifolia Griseb.	caca-ravet, graines bleues bâtard	microphyll, ovate-elliptic
Krameria ixina L.		microphyll, oblong-lanceolate

The coastal forests differ from the previously described aspects in leaf type. Leaves of size intermediate between microphyll and mesophyll are the most common, measuring generally from 6 to 12 centimeters in length. True mesophyll leaves are not rare, even among simple leaves, but this size is the most general among the compound leaves. Ovate, obovate or sphathulate leaf form is frequent. The most marked macrophyll leaf is that of Coccoloba grandifolia Jacq. and of the poiriers or robles of genus Tabebuia. The leaf types of the most common species in this forest appear in Table 18.

Table 18.—Leaf Types of the Most Common Species in the Coastal Forest

Scientific Name	Native Names	Leaf Type
I. Folle-Anse Forest (Marie Galante)		
Tabebuia pallida Miers subspec. pentaphylla Bureau & Schum.	poirier blanc	macrophyll, 1.5-5 micro-mesophyll leaflets - oblong to ovate
Hippomane mancinella L.	mancenillier	micro-mesophyll ovate
Drypetes serrata Krug & Urb.	café-bois	micro-mesophyll, ovate-lanceolate
Drypetes alba Poit.	café-marron	micro-mesophyll, ovate-lanceolate to ovate-elliptic
Eugenia aillaris (Sw.) Willd.	merisier pays	micro-mesophyll, elliptic, ovate or ovate-lanceolate
Anamomis fragrans (Griseb.) var. Brachyrhiza (Krug et Urb.) Stehlé	bois d'inde marron	micro-mesophyll, obovate
Ixora ferrea (Jacq.) Benth.	bois de fer rouge, bois piquet	mesophyll, oblong to elliptic
Exostema sanctae-luciae (Kentish) Britten	quinquina caraibe, quinquina-piton	mesophyll, oblong to elliptic
Ardisia guadelupensis Duchass.	bois petit-chique	mesophyll, elliptic to ovate-elliptic
Ximenia americana L.	bois puant, prune bord de mer	micro-mesophyll elliptic ovate
Xylosma buxifolium A. Gray	attrape-sot	microphyll ovate to obovate

Table 18.—Continued

Scientific Name	Native Names	Leaf Type
Ficus laevigata Vahl var. lentiginosa (Vahl) Urb.	figuier blanc	micro-mesophyll ovate-elliptic
Fagara flava (Vahl) Krug & Urb.	bois noyer	mesophyll, pinnate, 3-11 microphyll, ovate-elliptic leaflets
Dipholis salicifolia (L) DC.	acomat bâtard	micro-mesophyll, lanceolate-acuminate
Coccoloba grandifolia Jacq.	bois rouge, raisinier grandes-feuilles	macrophyll, ovate-orbicular
Maytenus elliptica (Lam.) Krug & Urb.	bois citron	micro-mesophyll, elliptic to ovate
Rhacoma crossopetalon L. forma typica Urb.	ti-bonbon	micro-mesophyll, lanceolate
Erythalis fruticosa L.	bois chandelle noir	micro-mesophyll, lanceolate to spathulate-suborbicular
Acrodiclidium salicifolium (Sw.) Griseb	bois fourmi, bois chique	micro-mesophyll, lanceolate or oblong-lanceolate
II. Elsewhere in the Caribbean Archipelago		
Tabebuia pallida Miers Subspec. dominicensis (Urb) comb. nov	poirier gris poirier du nord	leaf simple, mesophyll, ovate-orbicular
Tabebuia pallida Miers Subspec. heterophylla (DC) comb. nov.	poirier rouge, red cedar	compound leaf, meso-macrophyll, 3-5 microphyll, oblong leaflets
Guaiacum officinale L.	gaiac, lignum vitae, guayacán	mesophyll, 2-3 microphyll ovate, unequal leaflets.
Canella winterana (L.) Gaertn.	Canellier bâtard, canelle blanche, barbasco	mesophyll, spathulate-ovate

Table 18.—Continued

Scientific Name	Native Names	Leaf Type
Guettarda scabra Lam.	goyavier-bâtard, velvet-berry	micro-mesophyll ovate to oblong-elliptic
Guettarda parviflora Vahl	bois gligli, bark olive,	microphyll, spathulate to elliptic
Bucida buceras L.	berry	
Homalium racemosum Jacq.	acomat-hêtre bois mille-branches ébène jaune	mesophyll elliptic-oblong
Croton corylifolius Lam.	bois pays, grand baume, baume grandes feuilles	mesophyll, ovate to suborbicular
Eugenia tapacumensis Berg.	bois grillé	mesophyll, elliptic or elliptic-ovate
Eugenia pseudopsidium Jacq.	bois plié, goyavier bois goyavier marron	mesophyll, ovate-elliptic
Elaeodendron xylocarpum (Vent) DC var. caribaeum Urb.	bois tan, prune bord de mer, marble-tree spoon tree, nut moscat	micro-mesophyll oblong, elliptic-obovate
Gyminda latifolia (Sw) Urb.	petit merisier	obovate or obovate-oblong
Trema Lamarchiana (Roem. & Schult.) Bl.	orme petites feuilles caca-ravet	microphyll, ovate-lanceolate
Lonchocarpus Benthamianus Pittier	bois savon-nette	mesophyll, pinnate, 3-4 pairs of microphyll ovate leaflets
Bourreria succulenta Jacq.	acomat côte-lette, bois cabri bâtard	micro-mesophyll, obovate-oblong or obovate-circular

Table 18 lists the tree species of this forest in the order of thin frequency, on Marie Galante, where optimum development is found and for the various other islands of the Caribbean Archipelago.

This forest includes various plant associations, differing as a result of microclimatic or edaphic conditions. Part (I) of Table 18 presents species in a well-developed association on the calcareous white sands of Marie-Galante. It is the Tabebuia pallida-Drypetes serrata association, already described (36).

The undergrowth of this forest includes shrubs found also in humid forests from 300 to 900 meters in elevation, Neurolaena lobata (L) R. Br., Gonzalaguina hirsuta (Jacq.) Schum. and among the small trees are Ixora ferrea (Jacq.) Benth., which in Guadeloupe thrives at 600 meters altitude. Drypetes serrata Krug & Urb. which is found also at the base of Mt. Pelee, is represented by numerous beautiful trees from 20 to 25 meters in height. Dipholis salicifolia A. DC. is often more than 10 to 12 meters tall here, yet elsewhere it is only a small tree only 4 to 6 meters in height. In Fig. 11 a profile of the trees and shrubs of this facies of xerophytic forest is shown.

Floristic and Stratigraphic Composition

In discussing the composition of the xerophytic forest generally the dominant families are presented, then the variations in the different facies of the two subtypes and finally the stratification, as compared with the closely related mesophytic forest.

Dominant Families

The dominant families in the associations examined were not the same for both subtypes. Five families are found invariably in the thorny subtype and in them are included the woody or semi-shrubby species. They are, in descending order of importance for most of the islands, Cactaceae, Leguminoceae-Mimoseae, Rutaceae, Amaryllidaceae, and Acanthaceae. Among the herbaceous plants the families Malvaceae, Gramineae, and Bromeliaceae are most important.

In the facies of the deciduous subtype the families of arborescent species are, in descending order of their general abundance, Euphorbiaceae, Rhamnaceae, Myrtaceae, Erythroxylaceae, Polygonaceae, Celastraceae, Burseraceae, Bignoniaceae, and Asclepiadaceae. Certain families, such as the Canellaceae, Rhamnaceae, and Zygophyllaceae, are in the archipelago, confined exclusively to this subtype.

The Rhamnaceae are particularly prominent on xerophytic sites on most of the islands. Colubrina reclinata (L'Herm) Brongn., bois mabi, is found on almost all coasts. C. ferruginosa Brongn soap tree or greenheart, is found from Antigua to Barbados, and Krugiodendron ferreum (Vahl) Urb., ebony wood, is found from Puerto Rico to St. Vincent and Bonaire, while the thorny Sarcomphalus domingensis (Spreng.) Krug & Urb, which is above all, a plant of the Greater Antilles, is found on the coast of Anguilla.

The variation in dominance of the principal families on the various islands, and differences in their importance in the subtypes, aspects, and communities, and in the development of the forest cover in this formation makes impossible the expression of representation of the various families in percentages which would have any real value. It is believed better to discuss those species which are typical of the vegetation and those represented, but not confined to this forest.

Facies of the Thorny Subtype

The thorny subtype is regulated by the microclimatic characters described generally in previous pages. The extremes of dryness, evaporation and insolation are very marked, with broad annual and daily variations. Rainfall data both as regards amount and distribution throughout the year, show wide differences in the same region. Data from a metereologic station at Lajus, Martinique, located in the most xerophytic area of the thorny subtype are presented for the years 1933 and 1934 in Table 19.

Table 19.—Precipitation in Xerophytic Forest, Thorny Subtype Lajus Station, Corbet (Martinique), Altitude 5 meters.

Month	Precipitation 1933	Precipitation 1934	Means	Month	Precipitation 1933	Precipitation 1934	Means
	No.	No.	No.		No.	No.	No.
January	116.00	52.30	84.15	July	205.00	64.90	134.95
February	44.25	27.50	35.87	August	314.75	93.70	204.22
March	0.00	24.30	12.15	September	440.00	107.50	273.75
April	36.00	12.20	24.10	October	193.50	71.20	132.35
May	43.25	0.00	11.62	November	254.25	56.20	155.22
June	98.25	75.10	37.55	December	95.00	174.20	134.60

Mean Annual for 1933-34 = 1299 mm.

Table 20.—Number of Days with Rain in Xerophytic Forest, Thorny Subtype Lajus Station, Corbet (Martinique), Altitude 5 meters

Month	Rainy Days 1933	Rainy Days 1934	Means	Month	Rainy Days 1933	Rainy Days 1934	Means
	No.	No.	No.		No.	No.	No.
January	18	10	14	July	21	3	12
February	9	7	8	August	16	12	14
March	0	5	2.5	September	18	12	15

Table 20.— Continued

Month	Rainy Days 1933	Rainy Days 1934	Means	Month	Rainy Days 1933	Rainy Days 1934	Means
	No.	No.	No.		No.	No.	No.
April	3	2	2.5	October	12	6	9
May	7	0	3.5	November	17	9	13
June	10	6	8	December	19	16	17.5

Mean Annual Rainy Days = 119

These data show periods of extreme dryness. During five months, from February to June, rainfall in millimeters is less than twice the mean temperature in degrees centigrade, and in years such as 1934 which is not exceptional, January is also a dry month. In other islands like Curaçao and St. Bartholomew dryness appears to be even more extreme but no accurate data are available.

The powdery, sandy, calcareous or volcanic soil where this forest develops is permeable and subject to extreme evaporation. Based upon the structure and physical properties of the soil, the following facies of the thorny subtype may be distinguished:

Sandy facies.— This facies is found on coastal sands. Dunes are rare here and generally low, and the sandy coastal belt is usually very narrow. These coastal sands are white when they originate from coralline or foraminiferous decomposition or disaggregated calcium carbonate or they are black with brilliant mica when they are the products of disaggregation and crushing of basalts, pyroxenes, andesites, labradorites or other minerals of igneous origin. These contain a relatively high proportion of magnesium and of titanium oxide.

The plant associations and communities belonging to the sandy facies of the thorny subtype are (1) the Solanum thickets, made up of Solanum racemosum Jacq. var. igneum (L.) O.L. Schulz, found in St. Martin, St. Martin, St. Bartholomew, Saba, St. Eustatius, St. Kitts, Antigua, Guadeloupe, Martinique, Barbados, St. Vincent, Bequia, Moustique, and Grenada; (2) the impenetrable thickets of Caesalpinia (Guilandina), Bonducella Fleming at St. Bartholomew, Caesalpinia crista (L.) Small, and C. ciliata Berg. in the French Antilles, the Lantana involucrata-Randia mitis of Guadeloupe; and (3) the different lepinés, of Fagara on Marie Galante, Saintes Is., Grande Terre, Guadeloupe and Martinique. In the Venezuelan island of Margarita and at Coche Islet, Antigua this facies is made up of the low spiny bushes of Castelaria Nicholsoni (Hook) Small.

This arid forest is similar throughout the American tropics in physiognomy and floristic composition. In addition to the similar environment, the sands and dryness, ocean currents contribute to similarities in composition. Guppy explains that the great ecuatorial current transports to the Antilles the seeds of estuaries and coasts of the Guianas and Brazil. The analogy of this to the corresponding formations of southern countries is very marked. Heavy seeds, such as those of genus Guilandina, may be carried by the sea over long distances. Fawcett and Rendle state that Sloane has collected seeds of gray "canique", Caesalpinia Bonducella L. on the northwestern coasts of Ireland and Scotland.

Spiny thickets of cacti and agaves, although not confined to this facies, are best developed here, on the flat sands of the dry coasts of Marie Galante, Anguilla, Margarita, Coche, Curaçao and on calcareous agglomerates forming sheer cliffs at St. Anne, Martinique, at Fourche, Coco, St. Bartholomew, at Morne du Fort Napoleon, Saintes Is., on the western bluffs of Grand Savanna, the northern slopes of Spanish Mountain on Dominica and the gully cliffs of Bathseba, Barbados. They are open associations whose species are sometimes endemic to the Lesser Antilles, but more often they are of wide distribution in the American tropics.

Johnson, described this forest environment in the Lesser Antilles near Venezuela as "plains, with the melon-cactus symmetrical tree-like Pereskia and the candelabra-shaped, tall Cereus eburneus Salm - Dyck." These latter species dominate in this dry plain and offer more marked affinities to their semi-desert counterpart in the South American tropics than to those of the Antilles. The principal species characteristic of the islands of Margarita and Coche as mentioned by Johnston are: Cereus caripensis, (H.B.K.) DC., C. eburneus Salm Dyck C. Jamacaru DC., C. margaritensis Johnst (endemic), C. Swartzii Griseb, Mammillaria simplex Haw, Opuntia leptocaulis DC., O. Tuna Mill. Pereskia opuntaeflora DC., most of which are Mexican, Chilean or Brazilian. Among the Agavae: Agave americana L. and Furcraea foetida (L.) Haw. bring out a relationship between this association in the Antilles and the dry sections of South America. These species are found on the leeward coast of Guadeloupe on Desirade and Sothern Martinique, on Barbados together with Agave barbadensis Trel.tree, at St. Bartholomew with Cephalocereus nobilis (Haw) Britton & Rose and Neomammillaria nivosa (Link) Britton & Rose, on Guadeloupe, Martinique and Grenada with C. Urbanianus (Schum.) B & R, and also on Antigua and the Greater Antilles:

Limestone Facies.— This facies is distributed almost throughout the Caribbean Archipelago and even though the origin and constitution of the limestone forming it varies from one island to another, the mechanical and physical properties of derived soils are similar. This limestone is sometimes mixed with debris, but it is often pure, 95 to 98 percent calcium carbonate, as shown by analyses made at Grande Terre and St. Anne. The limestones of Antigua and St. Martin seem to have been formed in calm, deep waters, in contrast to those of the upper Cretaceous Age in Curaçao, which are similar to those of the Greater Antilles, and of volcanic origin.

Rainfall data from 1880 to 1931 for the French part of the island of St. Martin, an area supporting this facies, show the annual average to be 1029 millimeters. The driest month is March, with 39 millimeters, followed by February, January and April. The four wettest months are: November (138 mm.), September (129 mm.), October (125 mm.), and August (103 mm.). The aridity of the site is thus not due solely to rainfall deficiency but also to the fact that water rapidly passes through the permeable calcareous layers to the subsoil. The limestone vegetation is different from that found in other types of soils and even though climatic influence predominates, the influences of calcareous soil should not be underestimated.

The plant associations in the limestone facies are numerous and many spiny communities have been described for the various islands. The most important associations are: (1) Pithecolobium - Acacia, on Guadeloupe (Grande Terre), Martinique, and Barbados characterized by Pithecolobium unguis-cati (L.) Mart., various acacias, and Comocladia Dodonaea (L.) Urb.; (2) Pisonia-Celtis, on Marie-Galante, St. Bartholomew, and St. Martin; (3) Athacanthus microphyllus-Canella Winterana, on Desirade; and (4) the spiny associations with evergreen aspect where the bois royaux of genus Malpighia, especially Malpighia linearis Jacq., dominate, principally in the small, flat dry, calcareous islands.

Facies on tuffs.— Submarine tuffs of volcanic origin often mixed with sedimentary limestone, as on the leeward coast of Guadeloupe and southern Martinique, and on calcareous soils in the southern regions of Barbados are located at low elevations, exposed to the direct influence of insolation and possess a marked xerophytic climax vegetation.

The two most typical associations are: the "thickets" of Fagara sp. and of Acacia sp. The most important lepinés, bois flambeaux, yellow-prickle or torchwoods of genus Fagara which dominate in different regions are: F. spinifex Jacq., F. trifoliata Sw., F. caribaea (Lam.) Krug. & Urb. and F. monophylla Lam. and among the "amourettes" of the genus Acacia are: A. guadalupensis, DC., A. muricata L., A. westiana DC. (Senegalia Britton & Rose) A. macracanthoides Bert. (Poponax B. & R.) and A. curassavica L. (Acaciella B.& R). This latter association has been previously designated the Senegalia-Poponax or Senegalium guadelupense association, on the leeward coast of Guadeloupe.

Facies of the Deciduous Subtype

The dominance of the thornless vegetation in the deciduous subtypes is related to the less marked dryness of the environment. The deciduous forest thrives in the central Antilles in an annual rainfall of 1300 to 1600 millimeters rainfall distributed in 100-140 days per year.

Its facies may be distinguished by soil structure although the influence of this factor on the distribution of vegetation is secondary to climate in importance.

Sandy facies.— This facies is found in all of the islands, but within this facies certain physiognomic differences are seen, such as the bushy communities of Coccoloba uvifera, L., and of Hippomane mancinella L., and the taller coastal forests of Tabebuia pallida. Very often these aspects of the sandy facies occur separately, but they may also be found intermingled. Many agents exert an influence on the environment and on the vegetation of this facies. The Coccoloba association grows in areas where the wind is violent, the presence of Hippomane seems to be more related to the humidity of the sands, and the presence of Tabebuia is related to the depth and texture of the soil, where its extensive roots system penetrates.

At the limit of the Coccoloba forests and the transition between the Tabebuia forests and the spiny Acàcia, near Bourg, Martinique, there is a metereologic station. Rainfall data from this station appear on Table 21 and show that annual precipitation is 1412 millimeters, received in 126 days and that there are three dry months, February, March and April. The maximum rainfall falls in July, August, and November. There is no prolonged drought.

Table 21.—Rainfall Distribution in the Xerophytic Forest Region, Deciduous Subtype, Sandy facies. Precheur Station: Bourg, Martinique Altitude, 8 meters. Means for 1932-37

Month	Precipitation	Days of Rain	Month	Precipitation	Days of Rain
	mm.	No.		mm.	No.
January	89.44	12.20	July	205.25	14.83
February	48.63	7	August	195.33	14.83
March	48.92	7.40	September	183.55	11.66
April	27.78	5.16	October	142.38	12.38
May	69.40	8.20	November	195.18	12.33
June	111.54	12.20	December	95.21	7.83

Total: Annual Rainfall 1412.61 mm.
Number of Days per year 126.02

The Coccoloba uvifera L. thickets have been studied and described in this region by Boergesen (3) and by Paulsen (4) for the Danish Is.; by Gleason and Cook (19) for Puerto Rico and the Virgin Islands; by Ciferri (10) for Hispaniola; by Questel for St. Bartholomew; by Domin (13) and Hodge (22), for Dominica; and by the writer (39) for Guadeloupe and Marie-Galante, Desirade, Saintes Island, and Martinique. The Hippomane and Tabebuia forests have similarly been described.

In the poirier forests the dominant species, Tabebuia pallida Miers., with its three sub-species, varying with the region, forms from 50 to 90 percent of the vegetation. Where not pure it forms a homogenous association with Drypetes in Marie-Galante, Lonchocarpus in Saintes Island and François and Robert, Martinique or with Rochefortia and Fagara in other regions.

Study of leaf morphology and wood structure has led to the separation of three subspecies of Tabebuia pallida which give different forest aspects as here described.

1. Tabebuia pallida heterophylla Forest: This subspecies has 1 to 5 leaflets, usually 3, elliptic or oblong, about 5 to 7 centimeters long. Its wood is dense, and durable, whitish rose or yellowish, very compact, with intermingled fibers, and with very fine grain. The flowers are pink, and the fruit is a small capsule, 5 to 10 centimeters long. Other names applicable to this subspecies are: T. triphylla DC. (1845), T. berterii Griseb (1864) non DC., T. heterophylla DC. Britton (1915), and Tecoma eggersii Kraenzlin (1921). It is the "poirier rouge" of the French Antilles and St. Bartholomew, and the "red cedar" of Dominica and Barbados. The littoral thickets which it forms are not more than 10 meters tall. On southern Martinique it is widely distributed at Trois Islets and on the leeward coast in Fonds Bourlet, Fonds Lafayette, Morne Capot and Morne Cauwin. The association does not grow above 100 meters elevation, even on sheer coastal cliffs. It is found together with the cactus scrub on Fourche and Coco Islands. It has a strong tendency to colonize.

2. Tabebuia pallida pentaphylla Forest: The leaflets of this subspecies are nearly always in groups of five, somewhat larger than the previous subspecies, ovate or obovate, 8 to 12 centimeters long. The capsule is 10 to 15 centimeters long. The wood is greyish white or pale, with varied vessels and less compact fibers than in the previous subspecies. The most important names which have been applied to this subspecies are: Bignonia leucoxylon L. non Tabebuia leucoxyla DC., Tecoma pentaphylla, Juss (1789), T. leucoxylon Mart. (1845), Tabebuia pentaphylla Hemsl. (1882), and Tabebuia pentaphylla leucoxylon Kuntze (1891). This is the "poirier blanc" or "poirier marbré" of the French Antilles and the "white cedar" of the British islands. It grows from 8 to 25 meters in height, most commonly about 15 meters, and 30 to 80 centimeters in diameter, exceptionally 1.00 to 1.30 meters. This subspecies is found in Folle Anse forest, Marie-Galante, where it forms a part of what has been described as the Tabebuia-Drypetes association. The other species of the association appear in the first part of Table 18, in the order of their frequency. This species makes up 50 percent of the stand. It forms forests of some importance on sandy coasts of decomposed limestones or stony volcanic soils more or less disaggregated, in the xerophytic regions of the Lesser Antilles from Saba to Tobago and Curacao. It is also found in the Greater Antilles, Central America and Venezuela.

3. Tabebuia pallida dominicensis Forests: Tabebuia pallida Miers, subspec. dominicensis (Urb.) comb. nov. is apparently different from the previously described subspecies, due to its greater

size, its abundant, spreading foliage, its elliptic, ovate, obovate or suborbicular leaves similar to those of Coccoloba, generally with only 1 leaflet 8 to 16 centimeters long but occassionally three and rarely five leaflets thicker and fleshy underneath, rather than coriaceous, as are the leaflets of the other subspecies. The petioles are swollen at their insertion, the flower is rose-mauve or violet, paler, and with the corolla margin more undulating, but with no essential structural difference from the other subspecies. The fruit is longer (15-20 cms.) and wider than in the others. The wood is golden or glossy yellowish, and seems less dense and less fibrous than that of the other subspecies. This species is the "poirier gris", "poirier frisé", "poirier canelle" or "poirier du Nord" of Martinique, the "poirier du pays" of Guadeloupe and the "poirier" of Dominica where it is often confused with the other subspecies.

This species makes up the climax forest vegetation on the windward coast of Martinique where it constitutes 35 percent of the forest, and from Grande Riviere to Trinité, at Basse-Pointe, Marigot and Lorrain. In the thickets of Usine Vivé in Lorrain and Usine du Galion in Trinité growth appears to be optimum, as magnificent specimens are found. It has a dwarf aspect in the madreporic cliffs of Anse-Bertrand, Portes d'Enfer and Pointe de la Vigie at the extreme northern part of Grande Terre in Guadeloupe but reaches 35 meters in height along the Macouba, Lagarde, Potiche and Grand Rivière Rivers in Martinique.

Limestone facies.— This facies is located in the drier regions at low elevation and often near the shore; the soil is generally formed of coralline debris and varied marine sedimentary deposits. In the different islands it is designated "roches a ravet", "mornes calcaires", "plateaux calcaires", "limestone hills" and "limestone gullies". Table 22 presents precipitation at St. Anne-Caritan Station at the extreme southern part of Martinique in this facies on nearly pure calcareous soil (97% $CaCO_3$). No month is without rainfall, but three months: January, March and April receive less rain in millimeters than twice the temperature in degrees centigrade, and are therefore dry months by metereological definition.

Table 22.—Precipitation and Rainfall Distribution in the Xerophytic Forest Region - Deciduous subtype - Calciphilous Facies. St. Anne Caritan Station, Martinique, Altitude 1 meter Means for 1932 and 1933

Month	Precipitation	Days of Rain	Month	Precipitation	Days of Rain
	mm.	No.		mm.	No.
January	50.27	10.5	July	164.87	16
February	56.37	5.5	August	100.12	9.5
March	43.12	6.5	September	64.50	9

Table 22.—Continued

Month	Precipitation	Days of Rain	Month	Precipitation	Days of Rain
	mm.	No.		mm.	No.
April	14.87	5	October	249.12	14
May	43.97	6.5	November	367.70	19
June	120.67	13	December	54.37	11.5
	Total:	Annual Rainfall		1329.95 mm.	
		Number of days per year		10.50	

In the limestone region at St. Anne, at Marin and Vauclin, Martinique the rhamnaceous thicket of Krugiodendron ferreum (Vahl.) Urb. and Forestiera rhamnifolia var. martinicensis are seen on the localized sedimentary deposits which are not abundant throughout the island. This association, which has been described previously (39) is the homologue of Gleason and Cook's semi-xerophytic vegetation of "San Germán limestone", a Krugiodendron ferreum-Elaphrium simaruba association.

The writer has seen apparently thrifty lignum-vitae, Guaiacum officinale seedlings growing in these limestone thickets. Formerly this species was abundant here but merciless exploitation lead to its gradual disappearance. It has been found also on Desirade, on Morne Tuder, on the calcareous soil near the Cemetery as well as in Guadeloupe. Grebert (19) found this species on Grande Terre at Triage de l'Anse-Bertrand. The writer has collected specimens in the limestone hills of Marie-Galante and Grande Terre. It is also found in similar xerophytic forests on St. Martin, St. Bartholomew, Barbados, Grenada, Tobago, Trinidad, Margarita, Bonaire, Curaçao, Aruba, in the Greater Antilles and on the continent in Panama and South America. Guaiacum sanctum, "guayacán blanco", is also found in the limestone facies of xerophytic forests.

In the limestone region of Grande Terre a Dipholis salicifolia-Erythroxylon brevipes association predominates with Bucida buceras L. as the more abundant other species. This tree, which is not found in Martinique is very abundant in the thickets of Morne-à-l'eau in Port Louis and Anse Bertrand, Guadeloupe, where it is a large tree with long, spreading branches. It produces a compact, durable, elastic wood much used in carpentry and general construction. It is also found in the limestone region of Antigua, St. Vincent, Barbados, and Margarita, and in the greater Antilles from the Keys of Florida to Panamá. The ovules are fertilized by insects as stated by T. Cook. The present role of this tree in the limestone facies on Grande Terre lead to the belief that a Bucida buceras forest, with or without Guaiacum in association, constituted the climax of the limestone facies in these islands, as in Puerto Rico, where it has been described as the climax of xerophytic forests on Ponce limestone, in shale hills, and lower mountain slopes although it is nearly absent today (18).

Volcanic facies.— This facies is found in the younger islands, subject to recent volcanic eruptions. Igneous rocks along the coasts support varied flora but below 250 meters elevation it is generally xerophytic. At elevations between 250 and 300 meters an intermediate or xero-mesophytic forest is found. The volcanic facies, penetrating the interior and found on slopes is more humid than the previously described facies. The precipitation at Vauclin, Martinique, seems to be representative of this facies. Table 23 presents data collected at that Station.

Table 23.— Precipitation and Rainfall Distribution in the Xerophytic Forest Region. Deciduous Subtype, Volcanic Facies Vauclin Usine Station, (Martinique) Altitude, 10 meters 1932-37

Month	Precipitation	Days of Rain	Month	Precipitation	Days of Rain
	mm.	No.		mm.	No.
January	66.33	9.33	July	141.66	10.66
February	43.16	7.00	August	187.16	12.66
March	32.33	6.16	September	215.83	11.66
April	54.83	5.83	October	283.00	12.00
May	110.16	7.50	November	329.83	14.50
June	122.83	8.83	December	82.66	10.16
	Average Annual Rainfall			1669,78 mm.	
	Average Annual Number of Rainy Days			116.29	

The vegetation is a rhamnaceous thicket in certain islands, such as Saintes, whether on labradoritic dark prismatic and zonated rocks, or on basaltic rocks on both windward and leeward sides, such as at Morne-Chameau, where the vegetation is an *Eugenia ligustrina-Rochefortia cuneata* association having a microphilous character and marked bushy physiognomy. The floristic composition of this association has been described (36). On other islands, such as Dominica, ancient volcanic residues and littoral lava deposits are occupied by xerophytic thickets on both leeward and windward sides. The associates are species of *Eugenia*. *Eugenia monticola* (Sw.) DC., known as "merisier" dominates along the basaltic streams on the leeward coast of Guadeloupe between Basse Terre and Deshaies, and *E. pseudopsidium*, Jacq., *E. nigroupunctata* L. and *E. confusa* DC. known as "merisier petites feuilles" are found on the basaltic "mornes" of Houelmont and Grosse Montagne de Deshaies. *Cordia alliodora* Cham., *Lonchocarpus benthamianus* Pittier and *Homalium racemosum* Jacq. are climax species of volcanic slopes in most of the Caribbean islands. At Vauclin, Martinique, on the mountain slopes between 200 and 300 meters elevation a primitive xero-mesophytic relict is found where *Eugenia gyrosperma* Urb., an endemic species, dominates.

Among the most common associations of this facies, on the andesi-labradorites or on the andesites of Martinique, at Trois Ilets, Diamant, Vauclin and Caravelle, is a Fagara microcarpa-Myrcia paniculata var. imrayana association, with many Myrtaceous associates common to similar associations in most of the Caribbean Islands.

Stratigraphy and Intermediate Xero-Mesophytic Facies

In the thorny aspects of the cactus scrub and the Acacia, Fagara or Anthacanthus thickets no stratification may be seen. Even the classic differentiation between shrubs, herbs, and lianas is generally difficult, as certain Cacteae may be herbs or lianas and certain Agaves may be arborescent or herbaceous. The other species might be classified as shrubs, underbrush or small trees but definite layers do not exist. Few herbaceous plants, Gramineae, Malvaceae and terrestrial Bromeliaceae are found. Two parasitic lianas, Cuscuta americana L. and Cassytha americana L. are occasionally seen, but no epiphytes are found. Some Papilionaceae of genera Centrosema and Galactia and of the Asclepiadaceae Metastelma and Marsdenia, climb over the bushes.

In the dense thornless deciduous littoral thicket, described in Table 17, a clear distinction between herbs, undershrub, shrubs, and trees is evident. Gray lichens adhere to the barks and the mistletoes, Phoradendron trinervium (Lam) Griseb., P. mucronatum (DC) Krug & Urb., and P. randiae (Bello) Britton, attach themselves to the branches of Croton, Eugenia, Pithecolobium and Randia. Epiphytes are rare and limited to the Bromeliaceae, Tillandsia utriculata L., and a fern, Polypodium phyllitidis L.

The coastal forests of tall deciduous trees, whose associates are listed in Table 18, are stratified, as shown in the coastal forest of Marie-Galante. This forest is dominated by trees 18 to 25 meters tall, with open crowns, and sometimes buttressed. Tabebuia trees form 50 to 60 percent of dominant trees, the balance being Drypetes and Hippomane. The subordinate trees, 12 to 18 meters tall are Ixora, Acrodiclidium, Dipholis and Ficus. The shrub layer, 8 to 12 meters tall, consists of Eugenia, Anamomis, Exostema, Ardisia, Ximenia, Erythalis, and others. The lower shrub layer is made up of Neurolaena lobata (L) R. Br. and Gonzalaguina hirsuta (Jacq.) Schum. Two arborescent phanerogams are prominent because of their aerial, hanging, and normal roots. They are Ficus laevigata var lentiginosa, and Clusia rosea L. The latter becomes fixed on the branches of Tabebuia even at 10 to 15 meters height. Ficus laevigata var. lentiginosa is a species typical of the Antilles. It has numerous sub-varieties, described by Warburg. That from Marie-Galante may be classified as subvar. obliquicuspis (Warb) Urb. These subvarieties behave ecologically as different but related species and so their taxonomic differentiation is also related to their different ecologic behaviour. The subspecies cerasicarpa and obliquicuspis are found in the xerophytic forests, and dwell in the sands and maritime cliffs of Gosier, Rivière Noir and Pères at Guadeloupe, in the dry coasts of Case-Pilote and Precheur and in the sandy shores of Pointes des Negres between Fort-de-France and Schoelcher, Martinique, where it is called "aralie-cerise". This littoral species produces on its trunk and spreading, often horizontal branches a mass of adventitious roots 1 to 2 centimeters in diameter, hanging vertically until they reach the soil where they curve inward and run over the surface. This form, rare in xerophytic forests, is characteristic of vegetation in humid zones. This is the only such species in this forest but is rather common.

The herbaceous epiphytes include two Pteridophytes, Psilotum nudum Griseb. and Polypodium phyllitidis L., on trunks and shrubs, and three phanerophytes among which two are monocots Oncidium altissimum (Jacq.) Sw. (Orchidaceae) and Wittmackia lingulata Mez (Bromeliaceae), and a dicotyledon, Peperomia conulifera Trel. var stehleae Trel. nov., all three growing on twigs and branches. Peperomia develops on the crevices of trunks, buttresses, roots and decaying stumps where organic debris and humus accumulate.

Lianas include Gouania lupuloides (L) Urb., Hyperbaena dominguensis (DC) Benth. Centrosema virginianum (L) Benth. and Heteropteryx purpurea (L) H.B.K. var antillana Ndz. all widely distributed in the Caribbean Archipelago in similar habitats. A herbaceous layer is found on the edges of this forest on sandy soils including Gramineae, and two prostrate species, Euphorbia (Chamaesyce) prostrata Ait. and Tribulus cistoides.

It is only in this littoral forest of Marie-Galante that clear stratification is seen in the xerophytic region. However, other littoral xerophytic forests may possess certain scattered elements similar to those mentioned. The limestone facies is the most favorable to the development of herbs and may be characterized by certain associates. In a "poirier" and "mapou" thicket in Grande Terre, near St. Anne, at between 80 and 120 meters elevation, the following pteridophytes grow: Dryopteris subtetragona (Link) Maxon, D. dominguensis (Spreng.) Maxon, Tectaria heracleifolia (Willd.) Underw., Andianthum tenerum Sw., and at the base of the tree trunks or on Miocene limestone rocks grows Polypodium aureum L. In the thickets making up the relicts of limestone vegetation on Morne Vent and Cadette at Vauclin, Martinique, at between 100 and 200 meters elevation the herbaceous layer consists of Dryopteris subtetragona (Link) Maxon, D. dentata (Forsk) C. Chr., Tectaria incisa Cav., Adianthum latifolium Lam., and in the humus accumulations in the buttresses, Polypodium aureum L. and P. polypodioides (L) Watt. The limestone vegetation of most islands, such as at Grande Terre and Barbados has, besides these three ferns in the herbaceous layer mingled with Gramineae of genera Paspalum and Digitaria, three other ferns: Anemia hirta (L) Sw., A. adiantifolia (L) Sw., and Asplenium dentatum L. On Desirade, Marie-Galante, St. Bartholomew, and many other small islands the forest cover is formed by prostrate phanerophytes, including Evolvulus, Stylosanthes, Hybanthus and Euphorbia, and, more erect and in clusters, two terrestrial orchids, Oncidium tetrapetalum Willd. and Tetramicra elegans (Hamilt.) Cogn. and the following Piperaceae: Peperomia barthelemyana Trel. in St. Bartholomew and P. balineorum Trel. & Stehlé in Guadeloupe. The palmate palm, Coccothrinax martinicensis Becc., is found in Guadeloupe and Barbados, and the pinnate species, Rhyticocos amara Becc. and Acrocomia aculeata (Jacq.) Lodd., are both found on Guadeloupe, Dominica and Martinique.

The volcanic facies contains saxiphilous terrestrial orchids, particularly Epidendrum ciliare L., in beautiful white clusters and

E. papilionaceum Vahl., E. nocturnum L., Oncidium guttatum L. Rchb. on St. Bartholomew, St. Kitts, Saintes Is., and St. Vincent, Saba, Grenade, and Goyave, Brassavola cucullata (L) R. Br. and various other orchids. In addition, the following herbaceous Piperaceae, endemics of the Caribbean, are present: Peperomia persuccosa C.DC. at Houelmont and Monts-Caraïbes, Guadeloupe; P. myrtifolia (Vahl) A. Dietr. with its var. major Trel. and P. questeliana Stehlé & Trel. on St. Bartholomew; P. dolosa Trel. on Saintes Is.; P. Broadwayi C.DC. and P. rupertiana C.DC. var genuina and var rosetteana Stehlé on St. Vincent, Martinique, Dominica, Guadeloupe and Antigua; P. conulifera Trel. var typica Trel. and P. pustulaebacca Trel. nov. (Blackman's rocks) on Barbados etc.

The presence of plated cryptophytes, such as the lichens, Rocella caribaea Darb. and other Usneaceae, the terrestrial mosses, Hyophiletum macrocarpae and Barbuletum agrariae, of the Pottiaceae, and the xerophytic hepatica, Riccia dussiana; the Polyporous Ganoderma and Fomes, contributes to accentuate the xerophytic character of this forest.

The xero-mesophytic, (Gleason & Cook's "semi-mesophytic", and Hodge's "semi-xerophytic") facies may be seen in nearly all the islands of the Caribbean Archipelago. In all but the small islets these are areas which, because of their topography, their position more to the interior, or their higher rainfall or elevation possess a vegetation similar to both xerophytic and mesophytic habitats, yet without apparently having evolved from either. This facies may be considered as xero-mesophytic. It is found not only on limestone but also on volcanic soils, as rainfall distribution and humid winds are the predominant environmental factors. Table 24 shows the rainfall distribution for Trinité, Martinique, a station within this facies. This is the "milieu" of the Tabebuia pallida Miers subspec. dominicensis Urb. nov. on the windward side of Martinique.

Table 24.- Rainfall Distribution for the Xero-mesophytic Region, Usine du Galion Station, Trinité, Martinique Altitude 5 meters, 1932-37

Month	Precipitation	Days of Rain	Month	Precipitation	Days of Rain
	mm.	No.		mm.	No.
January	97.16	13	July	181.73	18.33
February	57.28	8.66	August	229.51	20
March	29.96	6	September	195.63	18.50
April	55.86	7	October	280.96	18.66
May	179.80	13.83	November	395.83	18.33
June	133.10	15	December	112.53	14.83
	Average Annual Rainfall			1949.35 mm.	
	Days of Rain per Year			172.22	

The "roble colorado" of Puerto Rico, Tabebuia haemantha (Bert.) DC., seems to be the ecological equivalent of T. pallida dominicensis. This facies is found on the mountains between Fort-de-France and Tivoli or La Redoute, between 150 and 350 meters elevation. The most common species here are: Tabebuia pallida Miers subspec. pentaphylla (Juss.) Bureau and Schum. and Fagara martinicensis Lam., yellow prickle or "epineux jaune", the latter with short thick round buttresses resembling the foot of a pachyderm and with yellow spines covering the trunk, branches and petioles. This species is found also on the dry rocky coasts, cliffs, and calcareous and basaltic mountains of Saintes Is., Marie-Galante, Desirade, Martinique, St. Lucia, Montserrat, and Trinidad, and in the Greater Antilles. The numerous plant relicts where it dominates in this intermediate facies are subject to varied edaphic conditions, often characterized by accumulation of organic debris, on soil or between rocks. Although it sometimes is found near the dry edge of hygrophytic forests, such as at Camp de Balata (400 to 450 meters elevation), it never penetrates the interior of humid forests. It is found in the mesophytic forests of the lowland white sands of Puerto Rico, with Mammea americana L. and Calophyllum calaba Britton.

A forest of varied species, relatively heterogenous, with Tabebuia and Fagara dominating, must have constituted the original climax, together with species now found at such locations, including Cordia alliodora, Bourreria succulenta, Laugeria resinosa, Citharexylum fruticosum, Gymnanthes lucida, Coccoloba grandifolia, Casearia guianensis, and the shrubs, Chiococca alba, Psychotria undata var. chimarroides (DC.), Eugenia monticola, Piper medium, Cornutia pyramidata, and lianas of the Sapindaceae (Paullinia) and the Convolvulaceae (Ipomea). The epiphytes and parasites of littoral xerophytic forests and those of Folle Anse forest are found here, and stratification becomes more and more irregular and indefinite.

Reproduction

A discussion of reproduction in the xerophytic forests would not be complete without considering fruiting, flowering, seeds and germination.

Flowering.— The xerophytic forest is characterized by profuse flowering with one to three short flowering periods each year, usually two. Flowering is evidently synchronized with appearance of new leaves, and the flowers are intensely colored and emit strong, generally agreeable odors. Species which produce abundant flowers are Tabebuia, Citharexylum, Fagara, Erythalis. Flowering takes place during the dry months or at the end of the dry season.

Flowering twice a year occurs in Tabebuia, Guaiacum, and Coccothrinax. The flowers of Tabebuia are among the largest in the xerophytic forests. The following flowers are white: Guaiacum, Coccothrinax, Cordia, Bourreria, Erythalis, Homalium and Citharexylum among arborescent species, and Metastelma, Paullina and Centrosema pubescens (Benth.) Kuntze among the lianas. Vivid-colored flowers are very abundant, red , scarlet, coral, pink, yellow, and blue.

While these colors attract insects, the fragrance of the flowers is a more important factor in attracting both insects and birds. Bees visit the following genera, attracted by the pollen having an exquisite honey perfume; Amyris, Chiococca, Ixora, Haematoxylon, Jacquemontia, Capparis, Casearia, Acacia, Croton, and others. Insect pollination is typical of xerophytic forests. This feature is less evident in mesophytic forests and of minor or no importance in hygrophytic forests. Some of the birds instrumental in pollination are: Orthorhynchus exilis, Eulampis jugularis, E. holosericeus, Dendraeca petechia, D. plumbea, Tyrannus rostratus and Certhiola flaveola. The yellow butterflies of genera Callydria, Eurema, Junonia and Anartia jatrophae or nocturnal Sphingideae as the tobacco moth, potato moth, also Erebus odorata and the sugar-cane moth-borer, Diatrea saccharalis are also important. Other effective insects include Pseudo-neuroptera such as the dragon-flies, the bees, wasps, the ichneumanfly, Xylocopa brasilianorum and X. aeneipennis found on Convolvulaceae, Cucurbitaceae and Bignoniaceae.

Fruiting.—As fertilization is facilitated by insects, birds and wind, fruiting is very abundant. The fruit is frequently a drupe or a globular pulpy berry, as in Bourreria, Cytharexylon, Picraena, Dipholis, Eugenia, Myrcia, Erythroxylon, Canella, Elaeodendron and Malpighia. Less commonly it is follicular, opening by means of two valves, as in Fagara and Pilocarpus; a globular syncarp, as in Ficus; or a long dehiscent capsule, as in Tabebuia, Tecoma and Doxantha; or a more or less lomentaceous pod as in Erythrina, Ichthyomethia, Sophora, Acacia and Cassia.

Seeds and germination.— The dissemination and germination of seeds are facilitated by natural agents such as wind, rain and heat which are very favorable for these processes in xerophytic forests. The seeds of Tabebuia and Tecoma are equipped with lateral, light, membranous, transparent white wings adhering to flat seeds carried easily by the wind. The large number of seeds per fruit (30-50), the abundance of fruit produced, the wide dissemination by wind, the two fruiting periods per year, and high germinative energy are among the factors favoring reproduction of Tabebuia, and account for the wide distribution of this species despite the intensive exploitation to which it is subjected. Wind dissemination is provided for by tufts of long, thin hairs in Metastelma, Ibatia, Marsdenia, Calotropis and Asclepias of the Asclepiadaceae. The seeds of the "cotonniers du pays", Gossypium barbadense and G. marie-galante are provided with an epidermis full of filiform fibers like long silk.

Seeds or fruits provided with viscous glands or with spines as for example Pisonia and Boerhaavia and Plumbago adhere to whatever comes near them and may fix themselves to bird's wings. They are thus carried over large distances. They are found on even the smallest Caribbean islands.

Another special reproduction adaptation is the covering of smooth compressed seeds with a pulpy sweet aril, such as in certain shrubby species of the Celastraceae (Maytenus), in Guaiacum, and in Pithecolobium.

Maytenus elliptica (Lam.) Krug & Urban, known as "bois citron", "bois flamand", or "cuero de sapo", is found from St. Eustatius to Grenada. It produces an ovate-obovate fruit 10 to 15 millimeters long with seeds almost totally immersed in a violet aril. M. guyanensis, Griseb. or "cafe bois" has a drupaceous fruit containing two ovate flat seeds covered dorsally and over half of the ventral surface by a rose aril. Pithecollobium unguis-cati (L.) Mart. known as "griffe-chat", "diaballe" "callier diable", crab prickle, and cat's claw, has a spiral, sinuate and compressed pod with flat, black, lenticular, glossy seeds, 5 to 10 millimeters long surrounded by a pulpy, abundant, white, sweet aril. Guaiacum officinale L. and G. sanctum L. produce elliptic or ovate bi-angular seeds with a nearly straight brown or black embryo 1 centimeter long, 0.5 centimeter wide, and completely surrounded by an orange or reddish aril that falls off readily.

The physiological role of this aril is probably for protecting the seed and facilitating its germination, acting as a store of nutritive substance during the first stages of germination. Certainly, they serve to prolong germinative capacity, isolating the grain from the exterior. Such fruits and seeds are rare in hydrophytic or mountain forests, and the species possessing them are characteristic of xerophytic forests.

Seed germination in this forest is generally very rapid when conditions are favorable. The fruits generally mature during rainy seasons and when temperature increases, both factors favoring germination. If maturity is not reached at that time, viability may be maintained through a dormancy period. The large quantity of seed produced by the plants of the xerophytic forest accounts for the continued existence of this formation despite heavy seed mortality between time of dissemination and germination, due to unfavorable edaphic and climatic conditions.

Evolution and Succession

The best development of the xerophytic forest type is at present difficult to see because of regressive succession due to erosion, volcanoes, hurricanes and earthquakes or to human interference. Succession toward the true climax is rare, as paraclimax often result from the above factors.

Subclimaxes

The xerophytic forest climax has been replaced in most islands by degraded forest where Elaphrium simaruba dominates and shrubby species are abundant, such as certain "ti-baumes" (Croton) and as are herbs and lianas of the Malvaceae, Gramineae, and Leguminoseae.

The Bucida buceras forest climax in Guadeloupe (Grande Terre), the Tabebuia pallida climax at Dominica, Martinique, and Barbados and even the Guaiacum officinale climax in St. Bartholomew, Desirade, Bonaire, Margarita and Coche have become a Bucida-Elaphrium subclimax in Guadeloupe and Puerto Rico, a Tabebuia-Elaphrium subclimax in southern Martinique and Dominica and a Guaiacum-Elaphrium subclimax in Martinique and other islands.

Where storms, wind and heat exert their erosive influence, diminishing the fertility of the soil, Elaphrium invades littoral thickets on stony and dry sites. This characteristic helps it to subsist in thorny associations, yet allowing Tabebuia, Bucida, and Guaiacum to develop their seedlings under its shade and thus working toward the re-establishment of the true climax.

Elaphrium simaruba is absolutely independent of edaphic conditions and constitutes, together with other species of the same environment like Capparis and Croton, the sub-climax forests in the sandy, limestone, and volcanic facies of most Caribbean islands. The climatic conditions and the lack of humus found at present are unfavorable for growth of climax forests, has allowed it to invade openings and become dominant in the subclimax. Parkinsonia aculeata behaves much in the same way with Guilandina in the different thorny facies of xerophytic forests.

Paraclimaxes of Native Species

The native arborescent species have found in the natural or created modifications of the forest cover in xerophytic sites, especially in subclimaxes, stabilized favorable conditions for growth, and in places have formed stands. Among them are Chrysobalanus icaco L. forming secondary thickets after Tabebuia forests have disappeared, Lantana involucrata L. on sands, and Croton sp. on soils of calcareous or volcanic origin on areas formerly occupied by xerophytic forests.

It is difficult to ascertain exactly the role of climatic, edaphic or biotic factors in the development of these paraclimaxes. Thickets where Croton dominates, represented by many endemics for each island or related islands, is puzzling. They are interpreted by the various botanists and foresters in very different ways. Boergesen (3) and Paulsen (4) regarded them as of climatic origin (C. balsamiferum Jacq.) in the Danish Antilles. Gleason and Cook (18) believe their development expresses pronounced aridity intensified by the general absence of soil (The xerophytic forest of the Ponce limestone: Croton rigidus (Mull-Arg.) Britton, C. lucidus and C. discolor Willd.).

Some species seem to be related to edaphic conditions, such as Croton corylifolius Lam. and typical species of xerophytic climate on andesi-labradorites or derived sands in Martinique and basaltic slopes in Guadeloupe. Croton thickets may also be of edapho-climatic origin, such as those of Croton niveus Jacq. in various islands as Margarita, D. populifolius Lam. in Martinique, C. astroites Ait. in Desirade and Grande Terre, and C. milleri Johnston, in the low plains of Margarita, between El Valle and Punta Mosquito. The presence of other Croton stands is related to disturbances, coppicing power, and ability to withstand browsing, such as those of C. balsamiferum Jacq. C. flocculosus Geiss., C. guildingii Griseb. and C. dussii Urb.

Paraclimaxes of Exotic Species

Among the numerous species introduced in the Lesser Antilles for cultivation, forage or shade, some, after becoming naturalized, have become spontaneous, and have taken part in regressive succession forming paraclimaxes.

Tabebuia-Hippomane and Coccoloba forests on sands where humidity is high are colonized by Thespesia populnea and Terminalia catappa, species of Asiatic origin. In the Pisonia and Bucida thickets dominating in calcareous slopes a paraclimax of Morinda citrifolia L. a species of the East Indies, Australia and the Pacific Islands, and of Poinciana regia L., may be seen.

Thorny species are often replaced by introduced substitution paratypes. Native Fagara and Acacia thickets have become converted in many places to thickets of Haematoxylon or Acacias, such as A. nilotica, A. farnesiana, A. tortuosa, A. sundra and Neltuma juliflora.

In Guadeloupe and Martinique, as well as in most Caribbean islands these paraclimaxes, of acacia and campeche occupy a large area of coastal forests and have acquired an aspect similar to the original thickets. Even the cactus scrub has been invaded by introduced species, such as Pereskia grandifolia Haw., Nopalea cochenillifera (L.) Salm-Dyck. This latter species is a pioneer of calcareous soils in Grande Terre (shores of St. François and Anse-Bertrand) and on dry powdery soil at Ste. Luce, Martinique.

Stages Leading to Cultivation and Reforestation

Study of the successional vegetation of the different facies of xerophytic forests may lead to the discovery of indicators of the suitability of the soil for agriculture or forest management or of the successional stages to come before returning to the climax.

It is known that thorny stands may be replaced by campeche whose shade provides an excellent environment for germination of mahogany and lignum-vitae seeds. But the evolution towards a forest climax must be preceded by the re-establishment of the lost environment and elimination of the secondary forest.

In savannas which were formerly forested, the scattered trees or shrubs of Erythrina, Sophora, Pithecolobium, Haematoxylon, Tamarindus and Gliricidia permit the development of more tolerant Gramineae under their shade. Then shrubs and thickets may be established. Isolated thickets thus established and protected will serve as a starting point for the regeneration of the forest.

The presence of groups of mosses such as Hyophiletum microcarpus, Riccia, and Barbula is an indicator of conditions suitable for regeneration. Thickets of Croton, Haematoxylon, Dodonaea or other related species may also serve as key points for the first stages of natural re-establishment of the climax. The forester may aid nature in this succession by encouraging natural regeneration and by assisting all favorable factors.

Biotic Factors

Man's influence on the xerophytic forests is manifest throughout the Caribbean even before the time of Columbus. This forest was cut for cultivation of manioc, yautía, and sweet potatoes, and to provide materials for huts and canoes.

When the colonists arrived, forests were cleared for raising tobacco, ginger, indigo, and sugar-cane. Land clearing and burning destroyed the primitive vegetation and resulted in degenerate thickets and brush. Erosion of humus and topsoil followed. In some places the soil is almost completely sterile. This cutting and cultivation have taken place in all the facies of the xerophytic forest.

Grazing has contributed in this transformation, for domestic animals prefer certain plants to others. For example sheep and goats do not eat Croton and Lantana, but are fond of Aegyphila and Bourreria. Thus Croton thickets tend to extend themselves in the sites where browsing takes place.

At present sugar-cane culture occupies a large area in most of the Lesser Antilles. It has displaced the forest in the sandy and limestone facies. Coconuts have occupied the shores since 1660 when they were introduced to the Lesser Antilles. Cultivation is done successfully behind the curtain of Hippomane and Coccoloba acting as windbreaks.

At the beginning of colonization, cultivated areas only occupied a narrow belt along the coast, but they penetrated the interior rapidly. Certain cotton varieties adapted to the Caribbean Islands and were cultivated by the first French colonists in the Lesser Antilles where they settled on St. Vincent, St. Christopher, Marie-Galante, and Desirade, and also in Haiti. Its culture has been extended noticeably in the limestone facies.

There is need for a sound equilibrium between forest, pasture and culture in the xerophytic forest region.

MESOPHYTIC FOREST

Mesophytic forests are found in the central and higher parts of Caribbean islands having maximum elevation less than 1500 feet, in islands with small area or without marked relief, and in the more elevated islands, such as Dominica, Guadeloupe and Martinique, between the upper limit of xerophytic forest and the lower limit of humid forest. Cutting of this forest has greatly reduced its extension, and it is only through relicts that the study of the original mesophytic forest can be made.

Definitions, Subtypes and Facies

The mesophytic forests of Martinique have already been described (46). More recently, Hodge, in a brief paper on the "Vegetation of the Lesser

Antilles" has described one of the aspects of this forest as "semi-xerophytic" forest in Dominica. Later, he designated it "transitional belt or transitional forest" (22), reserving the term "mesophytic" for the mountainous forest vegetation of the interior. The island of Dominica is particularly rainy, and the elevated forests of the interior correspond to what is here termed "hygrophytic" forest, since the atmosphere is frequently saturated. Since mesophytic forest is intermediate in character, it is limited in extent. These mesophytic forests are Caribbean homologues of what Pittier calls "selvas veraneras" (30).

This forest is classified among the most humid of "deciduous" forests by Barbour under the subtype "moist deciduous" (while the term "dry deciduous" corresponds to the xerophytic type of this paper). However, the term "deciduous" and the other synonyms, "monsoon forests" (East Indies), "trade wind forest", and "seasonal forest" of tropical America, do not seem very appropriate in describing this Caribbean forest. Deciduousness is only partial, and the action of the wind is only one of the important climatic influences, the amount and distribution of precipitation being equally important.

The intermediate character of this forest between xerophytic and hygrophytic forest is not only shown in topography (between the coast and the interior), elevation (1500-1800 feet), climate (1900-2700 mm. precipitation or 70-100 inches), and edaphic conditions (often on lateritic clay and shales besides calcareous or volcanic soils) but also in the physiognomic aspect of vegetation. Because of this fact the term "mesophytic forests" is considered to be the most suitable.

The different physiognomy found on leeward and windward sides of the island tempt one to differentiate two subtypes, "oriental" and "occidental", but the study of relicts shows that no true distinction exists. The same species occur in both sides but in slightly different proportions so that the direct influence of the wind is not a predominant factor. True subtypes in this forest are a homogenous forest with obvious dominants and a heterogenous forest. These are subsequently divided into facies based upon soil types.

Location and Extension

This type of forest is located in the most populated sections of the Lesser Antilles, where land is favorable for cultivation and transportation is easy. These conditions explain the widespread destruction of the mesophytic forest.

From the Leeward Islands to the northernmost Lesser Antilles this forest is found in different but similar facies. The island of Margarita, only 67 kilometers in length and 32 kilometers in width, possesses two peaks attaining 795 meters, between which the plains are covered with mesophytic forest. Johnston (loc. cit.) in describing that island in 1909 stated that, "In general, the mountains are covered with forests from 300 meters to the summits, and in the valleys forests grow even at a lower elevation". The description he made of this forest from 400 to 500 meters and the species he enumerated constitute clearly a mesophytic forest, while from 500 meters to the summits hygrophytic forests appear. In other islands of the Lesser Antilles, such as St. Lucia and St. Kitts, the same relationship is found. That is plainly seen on the maps of Dominica made by Hodge and the writer's maps of Guadeloupe (36).

In the botanic map (Figure 3) it occupied not only the zone indicating where it may be seen today in an undisturbed or degraded form but also is found in mixture with agriculture. It occupied a large part of the area now in sugar-cane plantations particularly on windward coasts.

Hodge (22) reports it as a transitional vegetative zone at 1000 feet elevation. On Barbados, only relicts of this forest are found, in Turner's Hall and Forster Wood.

Edaphic Conditions

While xerophytic forests develop on sand, igneous rocks and calcareous mountains, mesophytic forests develop on lateritic or clayey soils but nearly never on calcareous marine sediments and very rarely on volcanic soils. Water utilization by plants in mesophytic forest is better than in the xerophytic forest for when water comes in contact with this soil, it does not percolate rapidly but infiltrates slowly, remaining available for a longer period.

Volcanic Soils

Differences in type of forest on volcanic soils are due to its physical nature, topography or differences in precipitation and altitude.

Regardless of the physical characteristics of volcanic soils, their structure is always uniform. According to Giraud (17) the average composition of the Martinique rocks is represented by andesite, as in Guadeloupe and Saintes. He determined the composition to be as shown in Table 25.

Table 25.—Average Composition of Volcanic Rocks in the Mesophytic Forests of Martinique

Compound	Composition %	Compound	Composition %
SiO_2	63.88	CaO	6.32
TiO_2	0.31	Na_2O	3.17
Al_2O_3	18.30	K_2O	1.09
Fe_2O_3	1.97	P_2O_5	0.09
FeO	4.32	H_2O	0.19
MgO	2.71		

Calcareous Soils

Mesophytic forest on sedimentary soils is rare because these soils are generally found at low elevations on the Caribbean islands in xerophytic climates. Nevertheless, limestones and white sands in the interior or not far from the coast, but protected or subject to very high precipitation, support vestiges of mesophytic forest, as at Vauclin and Ste. Anne in southern Martinique.

The chemical analysis of a soil at Ste. Anne, Caritan, Macabou and Vauclin sustaining a beautiful "mahogany du pays", mesophytic forest over a calcareous substratum is reported in Table 26.

Table 26.—Chemical Composition of Calcareous Soils in Mesophytic Forest Region, Martinique

Location	Composition			
	N	P_2O_5	K_2O	CaO
Grand Macabou (Vauclin)	0.10	0.06	0.11	5.2
Caritan (Ste. Anne) I	0.25	0.10	0.15	20.55
Caritan (Ste. Anne) II	0.12	0.06	9.18	5.10

The physical nature of this soil, which is more important from the standpoint of vegetation, appears in Table 27.

Table 27.—Physico-chemical Composition of Calcareous Soils in Mesophytic Forest, Martinique

Location	Stones	Gravel	Coarse Sand		
			Calcareous	Siliceous	Organic
Vauclin: Macabou	8.00	20.00	64.70	140.50	4.80
Ste. Luce: Trois-Rivières	1.24	19.87	540.35	178.31	12.96
Ste. Anne: Caritan	140.20	57.20	216.70	145.20	19.27

Table 27.—Continued

Location	Fine Sand			Clay	Humus	Nitrogen	Calcium
	Calcareous	Siliceous	Organic				
Vauclin:							
Macabou	27.60	369.90	--	346.40	2.70	1.08	51.60
Ste. Luce:							
Trois-Riviere	50.41	69.89	4.67	111.71	10.59	0.14	338.50
Ste. Anne:							
Caritan	142.48	49.68	13.88	201.11	14.28	2.47	205.51

Lateritic Soils

Laterite soils are formed from lateritic decomposition and found over labradorites in Guadeloupe, on andesi-labradorites or andesites in Martinique, on other similar rocks, or on calcareous soils from whose transformation they originate.

Clays originating from decalcification are found in Barbados and Guadeloupe, but are rare in Martinique (Anse Macabou, Vauclin and Caritan at Ste. Anne). In the volcanic islands a red clay, known as "matari" in Guadeloupe and "pays de l'ocre" in Martinique, develops through laterization of igneous rocks. Such clays are red when iron salts dominate and yellowish orange when aluminum salts predominate.

Where slope is not too great and precipitation is abundant conditions favor laterization in mesophytic regions where deep layers of red or gray clays 12 to 18 meters thick sometimes resembling kaolin are seen. Their origin is certainly diverse. They are "lithochrome" stages comparable to the colored soils of continental tropical America and related to red Mediterranean soils, and Brazilian "roxa" soils. Their genesis by decomposition of igneous rocks seems to be related to the rainfall factor and alternating dry and wet seasons. Blanche (loc. cit.) reports the following characters for the industrial plain regions where rainfall conditions are favorable (1.50 to 3.00 meters annually), "High clay content which makes work in that soil difficult, weak clay-humic complex; rapid decomposition of organic matter, pH 6-7, calcium needs varying from three to five tons. The profiles are generally: A-Horizon, 0.60 meters, B-Horizon 0.6 to 6 meters and even up to 15 meters, with a B-Horizon when aluminum (yellow ochre) accumulates and a sub-horizon B2 when iron accumulates (red ochre).

Laterites are seen in most islands on slopes and mountains in valleys and on plains.

Table 28 shows the physical and chemical composition of some soils in the process of laterization in mesophytic forest in Martinique.

Table 28.—Physical and Chemical Composition of Lateritic Soils in Mesophytic Forest, Martinique

Location	Stones	Gravel	Coarse Sand Calcareous	Coarse Sand Siliceous	Coarse Sand Organic
Saint Joseph (Rivière Blanche)	0.00	2.40	1.80	250.90	6.20
Lamentin (Favorite	0.35	2.45	0.97	136.33	4.71
Marin (Morne Mitan)	0.35	4.98	1.24	98.95	11.06
Fort-de-France (Plateau Didier)	105.66	43.23	3.57	46.22	-
Sainte-Luce (Trois Rivières)	16.57	5.35	1.71	221.53	16.00
Riviere Salée (Hab. Laugier)	12.28	36.75	3.19	227.99	-
Sainte-Anne (Propr. Caritan)	0.90	-	2.49	243.18	17.90

Table 28.— Continued

Location	Fine Sand Calcareous	Fine Sand Siliceous	Fine Sand Organic	Clay	Humus	Nitrogen	Calcium
Saint Joseph (Rivière Blanche)	7.50	186.00	-	352.90	54.60	2.02	6.28
Lamentin (Favorite)	2.79	251.43	20.21	503.91	0.90	0.99	3.76
Marin (Morne Mitan)	7.01	237.88	20.04	605.30	13.19	2.03	2.53
Fort-de-France (Plateau Didier)	2.79	190.06	-	300.86	4.70	0.50	6.19
Sainte-Luce (Trois Rivières)	10.52	207.41	8.04	506.43	6.44	1.26	6.20
Riviere Salée (Hab. Laugier)	2.13	224.91	12.99	441.44	14.33	1.35	5.32
Sainte-Anne (Propr. Caritan)	22.98	177.35	22.23	497.19	15.78	2.02	16.08

Edaphic Relationships with Mesophytic Forest

The analyses presented show differences in the structure of volcanic, calcareous and lateritic soils. Nevertheless, there are certain analogies worth mentioning, particularly in lateritic soils. These include: small content of stones and gravel, high siliceous content in coarse and fine sand, little organic matter, nitrogen, and humus, as compared to hygrophytic forests, and the reduction in calcium content and a corresponding accumulation of clay which may make up from 30 to 60 percent.

The St. Joseph region (Rivière Blanche, Rabuchon) in the mesophytic zone, is transitional between the xerophytic forest of the Fort-de-France shore and the hygrophytic forest in the central mountain mass. This intermediate forest type, which is common to most Caribbean islands, owes its existence to edaphic factors.

Blanche reports (loc. cit.) that the substratum in the xerophytic forest "where precipitation is less than 1.50 meters annually, has generally a profile with an insignificant A-horizon (0.2 meters) and B horizon absent. When precipitation is more than 2 meters annually the formation of superficial soil is possible. In the cultivated zone the organic layer is thicker and in the humid forest zone (precipitation 4 meters) the organic layer is very thick". These differentiations indicate the conditions prevailing in the three different forest types in the Caribbean islands. While the eluvial A-horizon has a mean depth of 0.50 meters in volcanic or lateritic mesophytic regions it is only 0.10 meters thick in the xerophytic forests of southern Martinique.

Percolating water passes rapidly through xerophytic soils without modifying them, while in the case of mesophytic soils it stays in contact with the soil longer, decomposing it. The humus content, nevertheless, is relatively restricted because the decomposition of organic matter does not produce a true humus, as in hygrophytic forests. The acidity is high, pH between 4.8-6.5. In the humid forest the lateritic layer is covered by decomposing organic matter that forms a true forest humus layer which is very thick in heterogenous, many-storied, dense forests, but less prominent in forests with sparse undergrowth.

Ecologically, edaphically, and topographically intermediate soils in progressive and continuous series between dry and humid forests are seen at St. Joseph and Plateau Didier at Fort-de-France. Mesophytic forest soils on alluvial plains are found at Lamentin, on lateritic soils at Marin (Morne Mitan) and St. Luce. Mesophytic soils on decalcifying clays are found at Ste. Anne and Ste. Luce and on calcareous, slightly corroded soils in Vauclin, Ste. Luce and Ste. Anne. The last two soils, all found south of the Fort-de-France-Lamentin-Francois line in Martinique, correspond to quite different mesophytic forest facies. A wide cultivation break (nearly half the width of the island) has separated, for over four centuries, these southern mesophytic forests. The homogenous mesophytic forests, with one or two clearly dominant species on these two soils may be distinguished as a subtype, differing from the heterogenous mesophytic forests of other soils

Certain islands possess only two forest types, xerophytic and mesophytic. This is true in Bonaire and in Barbados, where the mesophytic forest is not intermediate but the most extreme. These forests present, therefore, characters analogous to the isolated stands of southern Martinique, relatively homogeneous, and related in their floristic composition to the physical and chemical nature of the soil. In the largest or highest islands, from St. Vincent to St. Kitts, the heterogenous, intermediate subtype is seen in stages or in a zone at Castries heights, St. Lucia, at St. Joseph, Martinique, at Gourbeyre, Guadeloupe, at Pointe Ronde, Dublanc, Milton, on the Atlantic side of Dominica, and at the base and on the slopes of Mount Misery, St. Kitts.

This interpretation of edaphic influences in mesophytic forests seems to agree best with observations. It agrees with the interpretations of soil specialists such as Vageler and Erhart and with the principles of such French geologists as Lacroix (25, 26), Giraud (17), and Gignoux, and with those of the Swiss geologist, Senn, all of whom have been interested in petrographic formations in the Caribbean Archipelago.

Even though the forest reflects climate more than soil, the influence of edaphic factors is no less real, and contributes to the formation of facies in all forest types, particularly the mesophytic forests.

Climatic Conditions

Rainfall and Rainfall Distribution

Regions wrongly considered as dry as in southern Martinique and on the leeward coast of Dominica and Guadeloupe, rainfall is nevertheless sufficient to create a well-watered region but the retention of this water is inadequate. In the so-called semi-desert of southern Martinique, there are several mesophytic forests, such as at Riviere Pilote (Prefontaine and Baudelle), at Marin (Morne Gommier), at Anse d'Arlet (Plateau Larcher) and even at Ste. Anne (Caritan) and Ste. Luce (Bois de Montravail). These mesophytic relicts demonstrate that this forest, as well as the xerophytic forest, formerly occupied a larger area. Though the general climate has not changed and the microclimate only slightly, erosion has occurred as a result of cutting, and regressive succession has gradually produced the present situation.

Precipitation, the study of remaining forests, the progress made by certain species in their tendency to invade and to recolonize soils, leading towards the reconstruction of destroyed climax, are the indicators which have guided the writer in an attempt to trace and describe, as far as possible, the primitive aspect of mesophytic forests. The mesophytic forests occupy a zone receiving 70 to 100 inches annually. Comparing maps of Martinique shown in Figures 1, 2, and 3 it can be determined that mesophytic forests coincide with Revert's precipitation zone receiving 2 to 3 meters of rainfall annually and brings out the fact that the region now used for sugar cane culture was once mesophytic forest. Similar relationships are found in Guadeloupe, Dominica, and other islands.

The following tables show rainfall distribution in the different mesophytic forest regions. The heterogenous subtype is represented in Tables 29, 30, and 31. In Table 29 are shown the results of observations on the windward side, at the northeast of the island bordering the pioneer forest of the xeromesophytic section previously described. Table 30 shows data for the same subtype between Fort-de-France (xerophytic) and Balata (hygrophytic) at the lower limit of the mesophytic forest, in the leeward side. The data for the upper limit of the same subtype appear in Table 31.

Table 29.—Rainfall Distribution in Mesophytic Forests. Heterogenous subtype. Windward Side. La Tracee Station (Martinique) Altitude 250 meters, 1932-34

Month	Precipitation	Days of Rain	Month	Precipitation	Days of Rain
	mm.	No.		mm.	No.
January	127.10	20	July	275.80	21
February	100	15	August	282.10	20
March	73.50	14	September	290.	21
April	110.	12	October	307.	20
May	221	15	November	422.50	24
June	223.10	20	December	263.	21

Total annual rainfall 2695.10 mm.
No. of days with rain per year 224

Table 30.—Rainfall Distribution in Mesophytic Forest. Heterogenous Subtype. Leeward Side. Tivoli Station. Ecole d'Agriculture (Martinique) Altitude 280 meters. 1939-1942

Month	Precipitation	Days of Rain	Month	Precipitation	Days of Rain
	mm.	No.		mm.	No.
January	108.	15	July	274.70	26
February	72.40	11	August	213.20	29
March	85.60	12	September	278.	22
April	82.50	12	October	239.60	20
May	110	14	November	404.10	23
June	277.80	29	December	116.10	21

Total annual rainfall 2262 mm.
No. of days with rain per year 234

Table 31.—Rainfall Distribution in Mesophytic Forest. Heterogenous Subtype. Central Martinique, St. Joseph Station. Altitude 200 meters. 1932-37

Month	Precipitation	Days of Rain	Month	Precipitation	Days of Rain
	mm.	No.		mm.	No.
January	172.58	20	July	296.71	21
February	112.68	17	August	316.72	23
March	117.96	15	September	322.47	22
April	147.08	15	October	299.60	23
May	200.62	17	November	437.85	26
June	219.28	22	December	167.87	22

Total annual rainfall 2811.42 mm.
No. of days with rain per year 243

Data for the homogeneous subtype, recorded on the southern part of the island, are presented in Table 32. It is curious that high precipitation occurs at such a low region and in the south, considered as the driest portion of the island. The Riviere Pilote valley lies at the base of Renee, Morne Caraibe and Regale heights, whose elevation is more than 300 meters, sufficient to cause heavy condensation. This instance is very interesting in that it proves clearly that topographic location is a powerful factor in microclimate. Similar examples are to be seen in other islands of the Caribbean Archipelago and account for the presence of mesophytic formations where one expects to find xerophytic forests.

Table 32.—Rainfall Distribution in the Mesophytic Forest. Homogeneous Subtype. Rivière Pilote Station, Jardin d'Essais de Préfontaine. Altitude 100 meters. 1932-37.

Month	Precipitation	Days of Rain	Month	Precipitation	Days of Rain
	mm.	No.		mm.	No.
January	190.23	25	July	254.21	28
February	114.15	20	August	281.36	26
March	84.33	18	September	281.50	26
April	72.80	18	October	349.36	26
May	200.48	22	November	406.26	28
June	233.16	26	December	212.26	27

Total annual rainfall 2680 mm.
No. of days with rain per year 290

From the four previous tables we see that the most humid month is always November, with more than 400 millimeters precipitation in 23 to 28 days. The hottest month is February in Tivoli and St. Joseph, March in La Tracee, and April in Riviere Pilote. There is no dry month in the mesophytic region, since all areas receive a precipitation higher than twice the mean temperature.

Insolation and Evaporation

As none of the stations in the mesophytic region report precise data on evaporation and insolation only conclusions of certain general observations made at Guadeloupe and Martinique can be presented here.

Annual evaporation is about 36 millimeters, with extremes 30 to 42 millimeters. Maxima occur in February, March and April and minima in September, October and November. This is less than in xerophytic forest, yet more than in the hygrophytic forest.

The number of hours of sunlight presents less monthly variation than in xerophytic forests, and is highest in February and April. The number of hours varies from 2000 to 2200 per year. Insolation and evaporation are not as high in this region as to cause total defoliation of arborescent species. The deciduous species that are found scattered here lose leaves only partially except in intensely dry years.

Temperature

The only exact temperature data in the mesophytic forest, Martinique, are those presented in Table 33.

Table 33.— Temperatures in Mesophytic Forest. Jardin de la Tracee Station. Gros Morne, Martinique. Altitude 250m 1932

Month	Mean °C	Minimum °C	Maximum °C	Month	Mean °C	Minimum °C	Maximum °C
January	25.5	21.3	29.6	July	26.9	23.5	30.2
February	25.0	20.3	29.6	August	27.3	23.5	31.2
March	26.1	21.3	30.9	September	27.4	22.9	31.9
April	27.0	23.1	30.9	October	26.6	22.5	30.7
May	27.0	23.3	30.8	November	25.5	22.0	29.0
June	26.8	23.7	30.0	December	25.3	21.0	29.6

Averages: Mean Temperature 26.3°C
Minimum Temperature 22.3°C
Maximum Temperature 30.3°C

Data on variations in temperature in mesophytic forests are presented in Curves VI, VII, and VIII, (Figure 12). A slight difference is observed between these curves and those for xerophytic forests, while a definite analogy is seen between variations here and in hygrophytic forests. Maximum temperature is generally as high in mesophytic as in xerophytic forests but minimum temperature is always lower in the former.

Humidity

Atmospheric humidity in the mesophytic forest region lies between that for xerophytic forests and that for hygrophytic forests. The mean relative humidity for the xerophytic forest is 76.66 percent, (varying from 70-85) and for the hygrophytic is 79.90 percent, with variations between 72 and 79 percent. The mean minimum relative humidity recorded is 30 percent at 1 PM and the mean maximum at 6 AM is 90 percent.

Storms

Storms are generally very frequent in xerophytic forests, 37 per year. In the humid forests they vary from 24 to 30 per year (Morne des Cadets). in mesophytic forests an average of 30 storms occur annually. They are most numerous in September and October, starting in May, but never occurring from January to April. Differences are found, depending upon topography and orientation of the region.

Atmospheric Pressure

The mean pressure is 760.18. No variation by forest regions is found. Its direct action is not important.

Cloudiness

Cloudiness here is believed to be comparable to that of Table 12, judging by observation in the absence of recorded data. Cloudiness is related to insolation, the minima corresponding with the drier months. Cloudy days in September, June, and November are more numerous than in xerophytic forests. There are about 100 days with a completely covered sky and there is practically no day with completely clear sky (cloudiness lower than 2).

Wind

Winds in mesophytic forest are fairly regular from east to west but vary somewhat from east-northeast to east-southeast. Wind action is important, as it increases evaporation, brings rainfall, and causes disintegration of the soil, reducing the coarseness of its elements and increasing the water infiltration capacity. For these reasons this forest type has been designated "trade-wind" and "monsoon". However, the writer does not consider wind alone an essential factor, since other more important climatic factors are involved. Even the very definition of these winds seems to be subject to debate among metereologists. The regularity in the direction of the said "trade" winds is not as constant as is commonly thought and, according to students such as the late French colonial meteorologist Henry Hubert, the use of the term "trade-winds" except on the African coasts leads to misinterpretations. This designation should be restricted to the very regular fresh winds blowing in the North and Northeast and at the west margin of the anti-cyclones (comprising Madeira, the Canarys, and the Azores). The Caribbean winds offer irregularities in force and direction, blowing from the east and east-southeast after travelling over a hot sea, will not present the normal characteristics which permit them to be classified as these same "trade-winds". If there are occasionally trade winds in the Antilles, it is certainly exceptional. Frolow, chief of the Martinique Metereologic Service shares this view. For the same reason the term "monsoon" should be reserved to Asiatic or African winds.

Romer states that in mesophytic and cultivated areas "the mean wind velocity is 5 meters per second in a normal day. It starts blowing at 6 to 7 AM, steadies in the east-northeast at about 10 AM, then there is a tendency to turn to the usual direction at 4 PM at 9 or 10 PM it weakens until next morning. During the dry season the wind tends to blow from the southeast in the morning". Mean wind velocity is 18 kilometers per hour.

Hurricanes menace every year all sections of the Archipelago and specially the mesophytic forests, due to their position. Bougenot described the effect of hurricanes on vegetation as follows: "Herbs were burned as if by fire, trees uprooted and plantations were all lost; destruction was complete." The trees of the mesophytic forests always are uprooted or broken. On slopes, coffee plantations are destroyed. Even many years after hurricanes pass traces of its damage are still evident.

Aridity Index

E. de Martonne's formula for the aridity index as applied to mesophytic forests on the windward section of Martinique may be expressed as follows:

$$i = \frac{2695}{26.3 + 10} = 74.24$$

The limits of i here are from 52 to 75, as compared to 27 to 50 for xerophytic forests.

Hythergraph

Hythergraph III, Figure 13 was made with the coordinates recorded in Table 34.

Table 34.—Coordinates of Hythergraph III, Mesophytic Forests (Tracee, Martinique)

Month	Temperature	Precipitation	Month	Temperature	Precipitation
	°C	mm.		°C	mm.
January	25.5	127.10	July	26.9	275.80
Februay	25.0	100.	August	27.3	282.10
March	26.1	73.50	September	27.4	290.
April	27.0	110.	October	26.6	307.
May	27.0	221	November	25.5	422.50
June	26.8	223.10	December	25.3	263

The temperature axis is very similar to that in the xerophytic forest, but the precipitation axis is more similar to that of the hygrophytic forest region. The form is different from the other two because no lines in the poligons intersect.

Precipitation Coefficient

Emberger established a precipitation coefficient presenting the advantages of including in an indirect way the action of evaporation, as well as temperature and precipitation in climatic synthesis;

$$C = \frac{P}{2\left[\frac{M + m}{2}\right](M - m)} \cdot 100$$

P = mean precipitation in millimeters
M = average of the maxima for the hottest month in °C
m = average of the minima for the coolest month in °C

He found the coefficient to be 70.6 for Perpignan and 69.5 for Narbonne, thus classifying that coastal region as "temperate Mediterranean climate". Even though it may not be completely adaptable to another climate, it provides an interesting synthesis of climatic influences.

Applied to the xerophytic forest type at Forte-de-France, where "m" is 21.12, "M" is 29.66, and "P" is 1760.3 mm. C equals 405. Applied to the mesophytic forest type with mixed angiosperm evergreens and deciduous species at La Tracee, where "m" is 20.20, "M" is 31.9, and "P" is 2695.10, then C equals 445. In the hygrophytic, evergreen, many-storied, humid forest, the difference is quite noticeable. At Morne des Cadets (Leeward side) the coefficient is 635. In the highest points in the hygrophytic forest, at Deux-Choux, at the base of Pitons du Carbet, and at the lower limit of altitudinal forests, the coefficient is 1105.

On estimating the index value for the numerous sections where climatic records and knowledge of their vegetation are available, we think that the following classification of forest types according to variations in the precipitation coefficient is approximate.

Caribbean Xerophytic forests-Thorny subtype -	C = 180 to 250
Caribbean Xerophytic forests-Deciduous subtype	C = 250 to 420
Caribbean Mesophytic forests (Mixed)	C = 420 to 500
Caribbean Hygrophytic forests (Evergreen)	C = 500 to 1100
Caribbean Altitudinal forests (Dwarf)	C = 1100 ≠

Seasons

The continental homologues of the insular mesophytic forests have been called "seasonal forests" and "spring forests", in order to indicate clearly the influence of the seasonal cycle on this type of forest. The seasonal cycle causes appreciable changes in the aspect of all the facies of both subtypes.

In every island of the Caribbean archipelago two seasons, dry and rainy, have been differentiated. One must recognize that, although only two seasons are marked, there are two transitional periods, in the course of which weather is less stable and differentiation is somewhat difficult. The best seasonal classifications seem to be those of Dr. Carpentin, Chief Navy Physician, for Guadeloupe, and of Romer, former Metereological Engineer for Martinique.

These two classifications establish four seasons which present clearly the climatological characters of the mesophytic forests.

Dr. Carpentin offers the following division:

1. The cool season - from December to April, divided into a rainy period (December to January) and a dry period (February to April)

2. A first transitional season, or stormy period; May and June.

3. Stormy season - from July to October, divided into a semi-rainy period (July and August) and a semi-stormy (September and October).

4. Second transitional season, reduced to the month of November.

Romer's classification for Martinique is as follows:

1. Cool and dry season, from January 15 to April 15. Dry weather, winds East to ENE, temperature varies between 16 and 30°C (60.8-86°F); mean temperature, 25.2°C (77.36°F); mean precipitation, 200 millimeters (7.4 inches); Forty eight days with rain.

2. Hot and relatively dry season, from April 15 to July 15. Temperature, 22 to 32°C. (71.6 to 89.6°F); mean temperature, 26°8C (80.24°F); mean precipitation, 410 millimeters (15.18 in.); 52 days with rain.

3. Hot and wet season, from July 15 to October 15; the stormy period; heavy rains; hurricane menace; variable winds, frequent, and followed by calm weather; temperature, 23 to 34°C (73.4-93.2°F); mean temperature, 27°C (80.6°F); mean precipitation, 670 millimeters (24.81 in.); 59 days with rain.

4. Cool and rainy weather, from October 15 to January 15, transitional season leading to dry weather; temperature, 19-31°C (66.2-87.8°F); mean temperature, 25.8°C (78.44°F); mean precipitation, 465 millimeters (17.22 in.); 55 days with rain.

This latter classification gives four equally long periods and seems most reasonable since it is in accord with observations of the influence of climate on vegetation. It is possible to demonstrate that the seasonal changes in forest vegetation correspond with this scheme. During the cool and dry season, the first and most abundant ascent of the sap starts. It continues vigorously during the transition or hot and dry season. Flowering of deciduous species in the mesophytic forests occurs principally during the first season and that of evergreens during the second season. The second ascent of sap, of shorter duration, starts at the end of the third season and continues during the last season. The flowering of species which had not done so in the first season and of those which flower twice occurs also during this last season. Leaf fall occurs always as is the case with xerophytic forests, during the cool dry season and new leaves appear during the warm, relatively dry season. This cycle appears to be a general rule in the mesophytic forests of all of the islands of the Caribbean Archipelago.

Structure and Composition

As in xerophytic forests the edapho-climatic influence on the structure and composition of mesophytic forests is of a fundamental nature. It accounts for the formation of a humus layer and the availability of sufficient soluble nutrients for the development of large trees. This influence is more noticeable here than in xerophytic forests. Flowering is less abundant here and flowers are less intensively colored; the increase in vegetative development seeming to correspond with a decrease in formation of reproductive organs.

Structure

No thickets or bushes are found in primary mesophytic forests and even if a limited number of spiny species grow among the others they do not contribute in giving this forest a thicket-like appearance, and never dominate. It is a high forest, taller and denser than that of dry regions, but less so than that of rainy and more elevated regions. It has more woody or suffrutescent undergrowth than dry forests and fair stratification and epiphytism. The marked alternating seasons previously described result in partial falling of leaves and concentric growth layers in the wood.

Root System and Buttresses

In mesophytic forest, trees have generally deep, strong roots, particularly in loose soil. The regularity of depth of roots in the subsoil is a marked difference from the root systems of dry forests. The superficial roots are found in very well drained soils but are not extensive. There are no buttresses or root swellings. Inga, Andira, and Cedrela, the most common trees of mesophytic forests, have roots grouped at the base, resembling elephant's feet. In rocky and sandy soil suffering from intense erosion fluted roots may appear. In the intermediate xero-mesophytic forests uniform swellings are found at the soil level, as in Simaruba and Amomis. Such trees have a strong deep taproot. Clusia, and Ficus and epiphytes found in mesophytic forest possess aerial roots.

Trunk and Branches

Trunks are straight, powerful, and clean-boled as in Swietenia and Simaruba, which are commonly without branches to 12 to 15 meters. Some boles are short and thick, with the principal branches ramifying rapidly and profusely, and are covered with dense foliage, as in Inga and Lonchocarpus. Some mature trees are 90 feet tall and more than one meter in diameter. Others are small, not more than 25 to 35 feet in height, such as Daphnopsis.

The genera mentioned above are not only the most common but those which dominate in consociations. The form of the trunks and branches of these trees create the aspect of this forest. It is possible therefore to designate the various facies of the homogenous type as Amomis or Swietenia forest, Calophyllum forest, forests of Inga, Simaruba, or Daphnopsis and of the heterogenous subtype, the Andira-Lonchocarpus forest.

The bark of the trees is most commonly smooth, gray, grayish white, or reddish gray, or it sometimes falls off in thin, scaly plates as is true with Amomis caryophyllata (Jacq.) Krug and Urb. This species has some superficial swellings appearing on the trunk. In Daphnopsis caribaea Griseb. the bark is fibrous and detaches in strips used for making ropes. In Simaruba amara Aubl. the bark contains a bitter substance similar to quassin, and in Calophyllum antillanum Britton it contains an oleoresin. Mammea americana L. secretes a gumresin known as "mami" resin.

Crowns are broad and extend horizontally or slightly obliquely. The branches bearing the flowers, located on the periphery of the crown are often glabrous, or pubescent with a grayish or reddish tomentum, but very rarely hairy or spiny. The only laticiferous species found in mesophytic forests are: Ficus urbaniana Warb., F. crassinervia Desf., Clusia rosea Jacq., and F. laevigata Vahl var. lentiginosa (Vahl) Urb. subvar. cerasicarpa (Warb.) Stehle & Quentin and subvar. crassipetiolata (Warb) Stehle & Quentin which are light-demanding, rapid-growing, probably second growth species.

Wood Structure

The structure and quality of wood is the same in mesophytic forests as in xerophytic forests, including density, heat conductivity, elasticity and resistance.

The elasticity and resistance have been calculated by Lallemand by comparison with Quercus robur L. (taken as unity) using samples one centimeter square and 20 centimeters long, and placing the load at the center. The rupture load of the oak sample used for comparison was 32 kilograms. Elasticity was determined by the deflection of the sample during rupture. Table 35 shows the density (water = 1), elasticity and resistance thus obtained, classified according to forest types.

Table 35.—Comparison of the Mechanical Properties of Woods in Mangrove, Xerophytic, and Mesophytic Forests.

Scientific Name	Common Name	Density	Elasticity	Resistance
I. Mangrove				
Conocarpus erecta L.	mangle gris	1.056	1.173	1.431
Hibiscus tiliaceus L.	bois flot	0.401	0.842	0.525
II. Xerophytic				
Amyris elemifera Willd.	bois chandelle	1.165	0.947	2.259
Erythroxylum ovatum Cav.	bois vinette	1.140	0.674	1.712
Eugenia pseudopsidium Jacq.	goyavier-bois	1.290	1.367	2.840
Buchenavia capitata (Vahl) Urb.	bois gligli	1.111	1.157	1.156
Coccoloba diversifolia Jacq.	bois rouge	1.102	1.315	1.743
Fagara flava (Vahl) Krug & Urb.	noyer	0.988	1.052	2.025
Fagara martinicensis Lam.	lepineux jaune	0.895	1.111	1.000
Coccoloba uvifera (L.) Jacq.	raisinier bord-de mer	0.890	2.105	0.778
Eugenia axillaris (Sw.) Willd.	mérisier	0.850	1.578	1.119
Aegiphila martinicensis Jacq.	bois cabrit	0.730	0.947	0.963
Cordia alliodora Cham.	bois de rose	0.700	1.157	0.960
Exostema sanctae-luciae (Kentish) Britten	bois tabac	0.675	0.738	1.056
Hippomane mancinella L.	mancenillier	0.651	0.736	0.653
Pisonia subcordata L.	mapou gris	0.552	1.157	0.836
Hura crepitans L.	sablier	0.506	0.709	0.609
Myrcia splendens DC.	brésillette	0.504	1.526	1.853

Table 35.—Continued

Scientific Name	Common Name	Density	Elasticity	Resistance
III Mesophytic				
Amomis caryophyllata (Jacq.) Krug & Urb.	bois d'Inde	1.320	1.211	1.812
Acacia muricata (L.) Willd.	tendre à cailloux	1.235	1.368	2.653
Sideroxylon foetidissimum Jacq.	acomat	1.164	1.509	1.515
Hymenaea courbaril L.	courbaril rouge	1.117	1.105	2.312
Hymenaea courbaril L.	courbaril jaune	1.107	1.105	2.312
Mammea americana L.	abricotier pays	0.990	1.000	0.790
Guazuma ulmifolia Lam.	bois d'orme	0.837	1.105	1.837
Inga vera Willd.	pois doux	0.769	1.947	1.078
Calophyllum antillanum Britton	galba	0.750	0.947	1.278
Genipa americana L.	genipa	0.730	3.263	0.962
Simaruba amara Aubl.	bois blanc	0.715	1.052	1.375
Cedrela odorata L.	abajou rouge	0.596	1.053	0.867
Sapindus sapindaria L.	savonnette montagne	0.515	0.875	1.712

Part I of Table 35 shows two of the common species in mangrove forests, one with high density, from a primary type and the other only 40 percent as strong, from a secondary association.

Part II shows the mechanical properties of the 16 most common species in xerophytic forests whose properties may be easily compared. They are classified in order of decreasing density. The highest elasticity is that of Coccolobis uvifera (L.) Jacq. (2.105) whose density, nevertheless, is only 0.890. Part III shows the 12 most common mesophytic species. It appears that, as a general rule, a higher density is shown as compared to previous types, since 5 out of 13 have densities greater than unity and two are between 0.8 and 1.0. Elasticity is generally higher in the mesophytic than in xerophytic forest. Similarly, resistance of woods of mesophytic forests is higher.

The density of certain particularly interesting woods of mesophytic forest trees do not appear in this table, but some indication of their mechanical properties appear in Table 36. Table 36 shows that most of the common species found in mesophytic forests have a density from 0.7 to 0.8.

Coloration

Table 36 describes the color of wood of nine dominant species of mesophytic forests, and the differentiation between sapwood and heartwood.

Seven out of 9 are red (whitish rose to reddish brown). In general, mesophytic forest woods are less diversely colored than those of xerophytic forests. They are fine, easily polished red woods.

Table 36.—Density and Mechanical Properties of Woods of Mesophytic Forest Trees

Scientific Name	Native Names	Density	Mechanical Properties
Myrcia leptoclada DC.	guépois, guayabacón	0.90	light brown, yellowish or reddish, very dense, very hard, close-grained, very elastic and very resistant.
Margaritaria nobilis L. f. var. antillana (Mule. Arg.) Stehlé	bois mille branches, bois diable, higuillo, gongle hout, roehout.	0.87	whitish rose, satiny, heavy, dense, high shrinkage, elastic, resistant.
Lonchocarpus latifolius (Willd.) H.B.K.	savonette-rivière, savonette grandes-feuilles, savonette grand bois, savonette rouge, palo hediondo, forte ventura.	0.78	reddish white, medium heavy, and medium hard, medium shrinkage, very fissile, elastic, very resistant to bending and rupture.
Swietenia mahagoni Jacq.	mahogany, caoba, acajou de Saint Domingue	0.77	reddish, veined heart, mottled, fine, close grain, lighter sapwood, darkens on exposure to air, medium heavy, medium hard, shrinkage slight, fissile, very elastic, takes good polish, very resistant.
Vitex divaricata Sw.	bois à agoutis bois lézard, higuerillo, péndulo blanco	0.75	reddish, turns brownish black in water; gray, hard, sapwood occupying 1/4 or 1/5 of total wood; brownish heartwood; compact, elongated fibers, bitter, resistant to decay, hard, elastic, resistant, homogeneous, takes good polish.

Table 36.—Continued

Scientific Name	Native Names	Density	Mechanical Properties
Andira jamaicensis (Wright) Urb.	angelin, angelin-palmiste, angelin à grappes, angelin grand-bois, angelin-tree, moca, bastard mahogany, cabbage bark, angelin-rivière, bois-olive, angelin-olive.	0.73	red or sometimes yellowish, long straight fibers, very fissile, medium hard, medium dense, resistant and semi-elastic.
Phoebe elongata (Vahl) Nees	bois-Chypre, cyp, laurier-Chypre.	0.70	brownish yellow, veined, silky: with numerous small compact spots; fissile, hard, medium shrinkage, very resistant, elastic,
Pithecolobium japunba (L.) Urb.	fougère, bâtard de fougère, bois ciceron, tamarin batard, tamarin bois, acacia de Saint-Domingue	0.70	light reddish or rose, with purple or violet rays, elongated fibers, medium hard, elastic, altered by humidity.
Inga laurina (Sw.) Willd.	pois doux blanc, guamá, sweet pea, pomshock	0.68	dark gray, hard, very fissile, shrinkage slight, few rays, not resistant to compression, elastic.

Anatomic Structure

Macroscopic examination indicates that the anatomic structure of mesophytic forest tree woods varies widely with the species. The form and distribution of vessels and the relative amount of heartwood and sapwood also varies. Among the most typical is the structure of Cedrela, Swietenia, Vitex and Andira. Cedrela mexicana Roem, from Guadeloupe, has the following characteristics: sapwood thin, reddish white color, very soft; heartwood reddish, porous, homogenous, very often silky, fine, straight fibers; thick vessels containing a brown resin, medullary rays numerous; when dry, wood has an agreeable cedar odor; wood light, soft, shrinkage slight, fissile, not much resistance to compression, easy to work, and not attacked by insects due to its bitterness.

Macroscopic examination of Swietenia mahagoni indicates that:

(a) In cross section - growth rings very marked, indicated by a difference in coloration, due to thickness of fibro-vascular bundles, numerous isolated or grouped in 2-4, radially, regularly distributed. Parenchyma in occasional bands or strips, thin; medullary rays numerous, rectilinear, compact.

(b) In tangential section - growth rings in unequally distributed vessels which are large, two to four-tenths of a millimeter, reddish, with abundant resin deposits. Parenchyma scarce, often invisible. Medullary rays thin, very small and very numerous, barely visible to the naked eye.

(c) In radial section - growth rings sharply indicated by vessels. Vessels appearing more rectilinear than in tangential section. Parenchyma invisible. Medullary rays three to four tenths of a millimeter, elongated radially, giving this section a brilliant aspect.

The wood of Vitex divaricata Sw. is decay resistant and very resistant to rupture. Fibers are compact, hard, and wood is very dense. Sapwood constitutes a more or less thick layer, varying with age of specimen. In a healthy normal specimen examined (45 cm. diameter) the sapwood was 12 centimeters thick. Heartwood pale gray even when recently sawn, turns grayer in the air, and dark and even completely black in water. Takes good polish. Good for making shingles. Resistant to bending, to shock and compression and does not swell.

Andira jamaicensis (Wright) Urban is a very common species in mesophytic forests which justifies its French name "Angelin-palmiste" because of its similarity in structure to palm. Bark is gray or reddish, spineless, or sometimes covered with small spines. Heartwood is reddish, and sapwood white. In the heartwood, concentric layers of parallel fibers of alternating red and rose color are seen in cross section. While the sapwood is often attacked by wood-eating insects, the heartwood is resistant, dense, hard and elastic, fibrous, and easy to work and polish.

It is evident, therefore, that broad structural variations exist in the woods of mesophytic forest trees, some similar to xerophytic trees, dense, with small compact vessels, fibrous, and marked growth rings, while others look more like hygrophytic forest tree wood.

Forest Physiognomy and Leaf Morphology

The physiognomy of mesophytic forests and the morphology of the leaves offer a homogeneity which contrasts sharply with the diversity of xerophytic forests. While the latter exhibits varied physiognomic aspects from the thorny bush to tall forests, the virgin mesophytic forest is always tall and deciduousness is only partial. Mesophyll leaves are dominant.

Physiognomic Aspect of Mesophytic Forests

This forest is partially deciduous, or semi-evergreen, although the writer believes that the latter name must be rejected because it is confusing, since it can be applied to angiosperm as well as gynmosperm forests.

Two physiognomic aspects are clearly distinguished in this forest, corresponding to two forest sub-types: the homogenous forest, having dominant species, and the heterogenous or mixed forest. Both subtypes exist in most of the more important islands of the Caribbean Archipelago.

The Homogenous Subtype.— This subtype contains some species which are definitely dominant over other vegetation, due to their abundance as well as to their greater size. It is pauci-specific, one to four species being dominant. Depending on the nature of the soil, drainage, amount of rainfall, topography, and physiologic drought, the dominant species may be: Simaruba amara Aubl., Calophyllum antillanum Britton, Inga vera Willd., Inga laurina (Sw.) Willd., Daphnopsis caribaea Griseb. or Amomis caryophyllata (Jacq.) Krug & Urb. Its aspect is that of a high forest, with much foliage, straight boles, with diameters as great as one to two meters in Cedrela and Mammea. The tallest trees sometimes reach 35 to 40 meters in height. On the other hand, Amomis is never higher than 14 to 18 meters, even in the tallest forest where it dominates, as at Rivière-Pilote (Martinique) and at Vieux-Fort (Guadeloupe). This homogenous forest does not form pure stands but the dominance of certain species is clearly evident, with a small proportion of numerous other species some of which are typically xerophytic, such as Tabebuia, Elaphrium, Homalium and Fagara and others belonging to hygrophytic forest and finally, even Clusia rosea (L) Jacq., a species of the Pterocarpus forest. However, none of these accompanying species are widely represented. The dominant species impart a homogenous aspect to this forest quite different from that of xerophytic forest or from the heterogenous subtype or from humid forests.

The Heterogenous Subtype.— This very mixed forest forms a belt between the littoral forest and the interior forest, and is similar to both types in physiognomy and composition. Even though there are sometimes dominants such as Andira and Lonchocarpus, their representation is not enough to impart a homogenous aspect. Boles of all sizes are observed, crown form varies, and deciduousness is partial.

In this subtype the less heterogenous "gallery forests" found along the rivers where certain species preferring humidity predominate can be distinguished from the essentially mixed aspect of the "transitional forest". This latter aspect exists in most islands. It constitutes the "transitional zone" in Dominica (22) containing Rhyticocos amara Becc. and on the slopes and mountains of Martinique and Guadeloupe. It is the forest described by Johnston in Margarita at 200 to 400 meters elevation, with Bursera, Brunfelsia, and Capparis on one side and Hymenaea, Clusia, and Inga on the other, with the following palms on both: Acroconia sclerocarpa Mart., Oreodoxa (Roystonea) and Bactris falcata Johnst.

Other equivalents are: "mesophytic forest" in Puerto Rico, (18) heterogenous vegetation with Elaphrium, Clusia, Amomis, Mammea, and Calophyllum. On the continent it is represented by Pittier's "selvas veraneras" specially those in the western side, with Cordia, Vitex, Hymenaea, Andira, such palms as Oreodoxa and Thrinax and other species found also on the Caribbean islands.

Seasonal Aspect, Deciduousness and Flowering

The alternating seasons previously described create different seasonal aspects in the mesophytic forests as in the xerophytic forests. Total deciduousness is exceptional and lasts only a short time. It is seen in Cedrela, Swietenia and Hymenaea but the shedding of all leaves occurs only during excessively dry periods and only on the drier sites. Partial deciduousness seems to be the rule. Leaves are replaced at the same time as they are shed so there is practically no interruption, and the deciduous aspect is not seen.

While most xerophytic species flower from January to May, flowering in mesophytic forest starts from May to July. Certain mesophytic species, such as Mammea and Andira, flower twice during the year, first from May to June and then from November to February. Some species, such as Daphnopsis, flower the year round with no interruption. On the contrary, some species have a brief flowering period, such as Hymenaea and the Myrtaceae. The flowering period for the former lasts 10 to 15 days in June or July, and the indehiscent brown pods hang from the branches for nearly a year.

Table 37.—Flowering Periods for Common Species in Mesophytic Forest

Scientific Name	Native Names	Flowering Period
Cedrela mexicana Roem.	acajou rouge, acajou amer, acajou senti, acajou à meuble, cedar, red cedar.	May-June
Simaruba amara Aubl.	bois blanc, acajou blanc, maruba.	May-June-July
Hymenaea courbaril L.	courbaril, courbaril jaune, courbaril rouge algarrobo, west indian locust.	June-July

Table 37.—Continued

Scientific Name	Native Names	Flowering Period
Amomis caryophyllata (Jacq.) Krug & Urb.	bois d'Inde, malagueta, ausu, bay-rum tree, wild cinnamon.	June-July
Calophyllum antillanum Britton	galba, galba odorant, calaba, maria, palo de maría	June-July
Inga laurina (Sw.) Willd.	pois, doux blanc, pois-douse, guamá, pomshock, sweat-pea	March-April
Inga vera Willd.	pois doux gris, pois doux poilu, guaba	August-September October
Sapindus saponaria L. forma inaequalis (DC)Randek.	savonette-montagne, savonier, bois mausseux, savonettier, jabuncillo, soap-berry, soap tree.	January-February
Mammea americana L.	abricotier-pays, mamey, mammee-apple.	May-June and November-December
Andira jamaicensis (Wright) Urb.	angelin, bois-olive, bastard mahogany, cabbage bark	May-June and December-January-February

Leaf Morphology and Size

Distinctive characters of leaf morphology in mesophytic forest are the nearly complete absence of spiny or very pubescent species, less coriaceous and less elastic appearance of the leaves, their darker color, and absence of extremely microphilous or macrophilous leaf types.

Leaves are green, glabrous or nearly so, sometimes pubescent but rarely setaceous nor covered with long protective hairs. Leaves of light demanding species such as Citharexylum turn yellowish or reddish before falling. Essential oils, alkaloids or resin products possessing special properties are found in numerous mesophytic species such as Clusia, Cedrela, Simaruba, and Sapindus.

Of the four aspects of dry forests, only the open littoral forest can be compared to this intermediate forest as far as leaf types is concerned. The micro-mesophyll character observed in the former is marked here and becomes clearly mesophyll in simple leaves and meso-macrophyll in compound leaves. Compound pinnate leaves are more abundant, giving a denser foliage aspect to mesophytic forests. Table 38 shows the leaf types for the most common species in mesophytic forests of the Caribbean area, and Table 39 those of the species in a typical mesophytic forest of Martinique.

Table 38.— Leaf Types of Common Species in Mesophytic Forest.

Species	Leaf Type	Number of Leaflets	Form and Size of	
			Leaves	Leaflets
Cedrela mexicana Roem.	pinnate	10 - 16	macrophyll elliptic	micro-mesophyll ovate-elliptic
Simaruba amara Aubl.	pinnate	6 - 14	macrophyll oblong-elliptic	micro-mesophyll oblong-lanceolate
Hymenaea courbaril L.	pinnate	2	meso-macrophyll ovate-suborbicular	micro-mesophyll, oblong-ovate
Amomis caryophyllata (Jacq.) Krug & Urb.	simple	-	micro-mesophyll oblong elliptic	--
Calophyllum antillanum Britton	simple	-	micro-mesophyll oblong-elliptic	--
Inga laurina (Sw.) Willd.	pinnate	2 - 4	macrophyll elliptic	micro-mesophyll, elliptic-oblong
Inga vera Willd.	pinnate	6 - 10	macrophyll elliptic	micro-mesophyll, elliptic
Sapindus saponaria L. forma inaequalis (DC.) Radlk.	pinnate	8 - 10	macrophyll elliptic	micro-mesophyll, oblong-lanceolate falcate
Mammea americana L.	simple	-	mesophyll elliptic	--

Table 38.—Continued

Species	Leaf Type	Number of Leaflets	Form and Size of Leaves	Form and Size of Leaflets
Andira jamaicensis (Wright) Urb.	pinnate	7-18	macrophyll elliptic	micro-mesophyll elliptic-lanceolate
Lonchocarpus latifolius (Willd.) H.B.K.	pinnate	4-8	macrophyll elliptic	micro-mesophyll elliptic
Daphnopsis caribaea Griseb.	simple	-	micro-mesophyll, oblongue	--

Table 39.—Leaf Types found in the Mesophytic Forest at St. Luce (Martinique)

Scientific Name	Native Names	Dominance	Leaf Types
Simaruba amara Aubl.	bois blanc	25%	macrophyll, oblong elliptic; 6-14 leaflets
Inga laurina (Sw.)Willd.	pois doux blanc	8%	macrophyll, elliptic; 2-4 leaflets.
Eugenia monticola DC. and sp. pl. aff.	petites feuilles, bois créoles	5%	microphyll, elliptic, simple
Nectandra patens (Sw.)	laurier grandes feuilles, laurier Isabelle	4%	mesophyll, elliptic to ovate, simple.
Tabebuia pallida Miers. subspec. pentaphylla (Juss.) Bureau et Schum.	poirier blanc	3%	macrophyll, 1-3-5 oblong to ovate leaflets
Ocotea martinicensis Mez	laurier bord-de-mer	2%	mesophyll, obovate, simple
Amomis cariophyllata (Jacq.) Krug & Urb.	bois d'Inde	2%	micro-mesophyll oblong-elliptic, simple
Byrsonima spicata (Cav.) DC.	bois tan	2%	micro-mesophyll, elliptic, lanceolate, simple.

Table 39.—Continued

Scientific Name	Native Names	Dominance	Leaf Types
Eugenia lambertiana DC.	mérisier-jaune mérisier petites feuilles	communal in groups	microphyll, ovate simple
Eugenia floribunda West	coco-carette	rare scattered	microphyll, lanceolate, simple
Elaphrium simaruba (L.) Rose	gommier rouge	scattered	mesophyll: 6-18 leaflets, ovate-oblong
Fagara caribaea (Lam.)	lépineux blanc	very rare scattered	mesophyll: 12-14 leaflets, elliptic
Ficus laevigata Vahl. var lentiginosa (Vahl.) Urb.	figuier maudit, aralie	very rare scattered	micro-mesophyll ovate-elliptic simple
Acacia muricata(L) Willd.	tendre à cailloux	very rare scattered	mésophyll, 20-32 leaflets oblong
Calliandra tergemina Benth.	bois patate, mirette.	communal in group (West)	micro-mesophyll, bipinnate, 2-4 leaflets, ovate
Lonchocarpus Benthamianus Pittier	savonnette	scattered	mesophyll, 6-8 leaflets, ovate
Lonchocarpus latifolius (Willd.) H.B.K.	savonnette rivière	very common (near river)	macrophyll 4-8 leaflets, elliptic
Inga vera Willd.	pois doux gris	scattered	macrophyll, 6-10 leaflets, elliptic
Mammea americana L.	abricotier	rare	mesophyll, elliptic, simple
Cedrela mexicana Roem.	acajou rouge	very rare scattered	macrophyll, 10-16 leaflets, ovate-elliptic
Hymenaea courbaril L.	courbaril	scattered	meso-macrophyll 2 leaflets oblong-ovate.

Table 39.— Continued

Scientific Name	Native Names	Dominance	Leaf Types
Phoebe elongata (Vahl)Nees	laurier-chypre, cyp.	widely distributed	mesophyll, elliptic to ovate, simple
Ficus urbaniana Warb.	figuier blanc, figuier grandes feuilles.	rare (near river)	macrophyll, obovate to elliptic simple
Daphnopsis caribaea Griseb	mahot-piment	communal, in groups	micro-mesophyll oblong, simple
Swietenia mahagoni Jacq.	mahogany-pays mahogany-petites-feuilles	rare scattered	macrophyll, 4-10 leaflets, ovate or ovate lanceolate
Swietenia macrophylla King	Honduras mahogany	poles on 5 ha.	macrophyll, 1-10 leaflets ovate.
Ceiba pentandra (L.) Gaertn. var. caribaea(DC) Bakhuizen	fromager	scattered (near river)	macrophyll, palmate 5-7 leaflets oblong
Miconia laevigata (L.) DC.	cré-cré, bois cendre.	scattered very rare	micro-mesophyll oblong to elliptic
Casuarina equisetifolia Forst	filao	subpontaneous	microphyll, needles
Aniba bracteata (Nees) Mez	bois jaune	rare, scattered	meso-macrophyll, oblanceolate to elliptic, simple
Protium attenuatum (Rose) Urban	gommier, bois l'encens	very rare	macrophyll, 3-7 leaflets elliptic
Tapura antillana Gleason	bois-côtes	very rare	mesophyll, obovate, simple
Sapium caribaeum Urb.	bois-la-glue	scattered (near river)	mesophyll, elliptic, simple

Table 39.—Continued

Scientific Name	Native Names	Dominance	Leaf Types
Chymarris cymosa Jacq. var. genuina Urb.	bois-rivière	very rare (river)	macrophyll, ovate or elliptic, simple.
Sterculia caribaea R. Br. et Benn.	mahot-cochon	very common (river)	macrophyll, 1-5 lobes, or simple
Cecropia peltata L.	bois canon	scattered	macrophyll, palmate, suborbicular.
Jambosa vulgaris DC.	pommier rose	communal (naturalized)	micro-mesophyll elliptic-lanceolate simple

Both Tables 38 and 39 show that pinnate leaves are more numerous than simple leaves and that the macrophyll type is also most common. Leaflets are numerous, varying from 2 to 18 in each leaf. They are generally entire and simple.

A Typical Mesophytic Forest:
Montravail Forest at St. Luce, Martinique

This forest, which was once private, became a public forest in 1924. Its area is approximately 80 hectares, elevation 120 to 200 meters, and it is located in the so-called dry region in Southern Martinique on soil derived from volcanic parent rocks. It is on a 40 percent slope, exposed to the west wind but sheltered by the Debat Morne in the east and the Desmarinieres Morne in the Northeast. Trees here have very straight boles reaching 35 meters in height and 1 meter in diameter. Deciduous species (Tabebuia, Swietenia, and Cedrela) are rare and total shedding of leaves is seen only during excessively dry periods. This forest was intensely exploited in 1942 and 1943. A selective cutting is contemplated for 1944 in order to improve the remaining stand (See Fig. 14).

Table 39 shows the composition of this forest. Simaruba forms 25 percent and Inga more than 33 percent of the forest. These, plus the other first six species of Table 39 comprise most of the stand. Several other species are observed but are rare and scattered. Some of these are communal (Eugenia, Calliandra, Daphnopsis) but the groups they form are few.

Among the species found scattered in Montravail forest one finds a few xerophytic species, indicated also in Table 39, below first horizontal broken line. Other mesophytic species appear in the third part in Table 39.

Some hygrophytic species are also found. These are the 8 species listed from Aniba bracteata (Nees) Mez to Jambosa vulgaris DC. Aniba, Protium, Tapura and Chymarris are found in the center of the forest. They are the least sciophilous of hygrophytic species, and due to their adaptation to drier and more sunny places than humid forests, their original habitat, they serve in regenerating degraded hygrophytic forests and even its extension into mesophytic forests.

Sterculia and Sapium are less shade tolerant, but demand moist soils. They are, therefore, found preferably along river margins, on alluvial sands or on heavy and impermeable soils. Cecropia is found in openings where humus accumulates after cutting and is scattered here and there in the forest.

This particularly interesting forest may be classified because of the 25 percent dominance of Simaruba under the homogenous subtype but contains also in smaller proportions, most of the species of the heterogenous subtype (those mentioned in part 3 of Table 39).

Dominant Species in the Homogenous Forest

The differentiation between the homogenous and heterogenous subtypes in mesophytic forests lies essentially in the representation of species, and in their degree of dominance. The most homogenous mesophytic forests studied in Martinique are those of Prefontaine at Rivière-Pilote on lateritic soil, with Daphnopsis-Calophyllum; Baudelle at Rivière Pilote on volcanic but not laterized soil, with Inga-Simaruba; and that of Plateau Larcher, Anse d'Arlet on calcareous soil, with Amomis caryophyllata (Jacq.) Krug & Urb. The composition of these forests, is as follows:

1. Daphnopsis Calophyllum forest at Prefontaine. This forest, containing 21 hectares, is on a 25 percent slope and exposed to wind in the east. Trees average 10 meters in height and 0.80 meters in diameter. Its composition is as shown in Table 40. The largest trees are Calophyllum and Inga which have buttresses and reach 25 meters in height, with an abundant, dense, evergreen foliage.

Table 40.—Composition of the Daphnopsis-Calophyllum Forest of Prefontaine (Southern Martinique).

Scientific Name	Representation
	%
Daphnopsis caribaea Griseb.	45
Calophyllum antillanum Britton	15
Inga laurina (Sw.) Willd.	15
Eugenia sp. pl.	5
Simaruba amara Aubl.	5
Nectandra and Ocotea	2
Miconia sp. pl.	1
Numerous other species	10

2. Inga forest at Baudelle. This forest comprises 7 hectares. The mean height of its trees is approximately 20 meters and they average 0.30 meters in diameter. Trees of some species reach 30 meters in height and 1 meter in diameter. There are almost no deciduous species. The composition is as shown in Table 41.

Table 41.— Composition of the Inga Forest at Baudelle (Southern Martinique)

Scientific Name	Representation %
Inga laurina (Sw.) Willd.	20
Simaruba amara Aubl.	15
Ocotea and Nectandra	15
Daphnopsis caribaea Griseb.	5
Inga vera Willd.	3
Cordia sp. pl.	2
Various scattered species	40

3. Amomis forest at Anses d'Arlet and Vieux-Fort.- Sometimes Amomis forms pure dense stands, from 10 to 15 meters in average height. These are very homogenous. They are generally located on pure or lenticular calcareous soils. Amomis makes up generally from 50 to 100 percent of the stand and the common species found are: Simaruba, Inga, Daphnopsis, the Myrtaceae and Lauraceae previously mentioned, and sometimes Cornutia pyramidata L. and various smaller species, such as Chiococca.

Floristic Composition and Stratigraphy

Dominant Families

The species in mesophytic forests belong to diverse families. Leguminous species, especially Papilionaceae and Mimoseae, are prominent, represented by Lonchocarpus, Andira, Hymenaea, Calliandra, and Inga. The same pinnately-compound, paripinnate, and pinnate leaf types are found in the representatives of other arborescent families such as Meliaceae (Cedrela, Swietenia), Simarubaceae (Simaruba) and Sapindaceae (Sapindus). Among the species with simple, entire leaves, the most common are of the Clusiaceae (Mammea, Calophyllum and Clusia), the Moraceae (Ficus) Lauraceae (Phoebe, Nectandra and Ocotea) all of mesophyll size, and the Myrtaceae (Amomis and Eugenia) of the micro-mesophyll size.

Facies in the Homogeneous Subtypes

The distinction of different facies by edaphic characters, permits the recognition of certain selectivity among plant groups, in relation to structure, age, and degradation of the soil. In the Lesser French Antilles it is possible to recognize a volcanic facies with Simaruba, a clay facies (Inga, and Daphnopsis-Calophyllum), and a calcareous facies (Amomis-Cornutia), all having a somewhat different and variable floristic composition.

Facies on Volcanic Soil with Simaruba

This facies is found in Montravail Forest, Martinique. The common species appear in Table 39. Simaruba amara Aubl. represents 25 percent of the total stand. The parent rock is volcanic and its composition is similar to the andesite described by Giraud and presented in Table 25. Erosion has resulted in a soil with a high proportion of fine and coarse sand but poor in calcium. Red mercuric outcrops appear in certain basins but generally in the forest a humus layer covers sandy and clayish elements.

The undergrowth present beneath the dominant Simaruba trees forms four different strata: understory layer, lianas, herbaceous layer and epiphytes. Their constituents appear in Table 42.

Table 42.—Floristic Composition and Stratigraphy of the Mesophytic forest at Montravail Wood, Martinique.

Stratum	Scientific Name	Native Names
(1) Understory	Odontonema nitidum (Jacq.)Kuntze	bois genou, bois indien
	Cordia martinicensis R.& S.	mahot noir
	Palicourea crocea (Sw.) R. & S.	bois de l'encre
	Mimosa ceratonia L.	croc-chien
	Piper medium Jacq.	malimbé, queue à rat
	Cephaelis Swartzii DC.	ipecah bâtard, graines bleues
(2) Liana	Heteropteris platyptera DC. var martinicensis (Ndz.)Macbr.	ailes à ravet
	Lasiascis divaricata (L.)Hitchc.	calumet-bois
	Batocydia unguis (L.) Mart.	griffe-chatte
	Paullinia Plumierii (Triana) Planch.	liane-persil
	Securidaca diversifolia (L.) Blake	liane bleue
(3) Herbaceous	Polygala paniculata L. forma leucoptera Blake	aster fragile
	Althernanthera sessilis (L.) R. Br.	magloire
	Desmodium triflorum (Sw.) DC.	petit trèfle
	Gayodes crispum (L.)	guimauve
	Sida carpinifolia L.f. var. Hochreutineri Stehlé	balais dix-heures
	Blechnum pyramidatum (Lam.) Urb.	herbe genou
	Dicliptera martinicensis (Jacq.) Juss.	petite violette

Table 42.- Continued

Stratum	Scientific Name	Native Names
(3) Herbaceous (Cont.)	Scutellaria purpurascens Sw.	soulier zombi
	Pharus latifolius L.	collant
	Olyra latifolia L.	calumet
	Oplismenus hirtellus (L.) Beauv. forma foliaceous (Speng.)comb.nov.	herbe à barbe
	Scleria latifolia Sw.	herbe couteau, herbe coupante
	Adianthum tetraphyllum H. & B.	capillaire
	Spiranthes quinquelobata (Poir.) Urb.	petite Orchidée
	Spiranthes apiculata Lindl.	petite Orchidée
	Ponthieva petiolata Lindl.	Orchidée
	Prescottia oligantha (Sw.)Lindl.	Orchidée, queue à rat
	Liparis elata Lindl.	petite Orchidée
(4) Epiphytes	Epidendrum ciliare L. var. cuspidatum (Lodd.) Lindl.	orchidée
	Epidendrum difforme Jacq.	orchidée, roi de l'arbre
	Polystachya minuta (Aubl.)Britton	orchidée, l'envers male
	Polypodium astrolepis Liebm.	fougère couresse
	Polypodium lycopodioides L.	fougère couresse
	Polypodium piloselloides L.	fougère couresse
	Polypodium jubaeforme Kaulf.	petite fougère
	Octoblepharum albidum Hedw.	mousse blanche
	Pilotrichum crypheoides Schimp.	mousse verte

Within this Simaruba forest are numerous differences in soil composition, soil drainage, presence of volcanic parent rock or of humus, and microclimatic variations such as insolation, relative humidity, and penetration of the water down to the lower strata and to the soil cover.

These variations serve to explain the presence of certain xerophytic species such as Mimosa ceratonia L. and Piper medium Jacq. and shade-loving species such as terrestrial orchids and cortical epiphytes belonging to genera Spiranthes, Ponthieva, Prescottia, Liparis, Epidendrum, and Polystachya, and Cephaelis swarzii DC, Polypodium jubaeforme Kaulf., and Pilotrichum crypheoides Schimp. The last three species, growing upon the bark of larger trees (Simaruba and other species) have been collected only from the center of this forest, in very shaded, humid places similar to hygrophytic environment. This remnant of mesophytic forest, nevertheless, is located in southern Martinique, where the environment is generally xerophytic.

Even though stratification is not complex and strata are discontinuous and not dense, the presence of orchids, ferns and epiphytic mosses, grasses with large leaves, and small humiferous orchids are characters which distinguish this mesophytic forest from xerophytic forest. It is different from the humid shady forests in that stratification in the latter is much better developed, and there is a high specific and generic heterogeneity, and epiphytes are common on trees and shrubs of all sizes and even on herbs and petioles, covering all with a dense green layer.

Clay Facies with Inga and Daphnopsis-Calophyllum

High forests of Inga sometimes develop on clays of varied origin, composition and coloration in the Caribbean islands. These trees have round crowns, and dense foliage. Sometimes a Daphnopsis-Calophyllum association is formed, with shorter trees and less foliage. Their dominants are indicated in Tables 40 and 41. Stratification is similar to the previous facies and the same species are found in the understories. The difference between the two facies lies essentially in the absence here of the species requiring humid, shady conditions, particularly Cephaelis, Prescottia, Pilotrichum, and Polypodium jubaeforme Kaulf. Certain species such as Scleria, Palicourea, Gonzalaguina, Smilax and Lasiascis are more prominent here in the understory, forming dense masses and sometimes spiny. Among the mosses found upon the bark of Inga and other large trees are Calymperes richardii C.M. and Macromitrium sp. as well as a terrestrial moss found also in the preceding facies: Isopterygium tenerum (Sw.) Mitt.

Although the Ingas found in the forests of Prefontaine and Baudelle make up only 15 to 25 percent of the stand, their hemispheric crowns give the forest a dense, homogenous aspect.

Facies on Calcareous Soil, with Amomis

Amomis caryophyllata (Jacq.) Krug & Urb. may form pure or nearly pure stands. It develops most rapidly and in association in the humous calcareous facies sheltered from the winds. In this forest its ascending branches form an angle of 45 degrees with the trunk giving it an aspect similar to that of European Populus. This narrow type of crown permits trees to grow very close. This aspect, however, is not found in isolated trees or groups exposed to the wind. In stands the trees reach 25 to 28 meters in height, but the mean height is 15 to 20 meters. Diameters are always small, generally not over 0.80 meter.

On lenticular clays, which include volcanic tuff, as found in southern Martinique and at Pointe de Vieux-Fort, Guadeloupe, this species does not occur in pure stands but in homogenous communities with Cornutia. The "bois coral" Cornutia pyramidata L. is a shorter, co-dominant species.

Among the common species on calcareous soil are: Brunfelsia fallax Duchass., Picramnia pentandra Sw., Malpighia glabra L., Chiococca alba L. and at lower altitudes certain species of xerophytic forests are also found such as Krugiodendron, Forestiera, and Eugenia.

The understory varies with the region, with erosion and dissolution of certain mineral elements, and also with elevation, precipitation, and insolation. The less shade-loving species of the subordinate, herbaceous and liana layers presented in Table 42 are found also here, but epiphytes are rare.

Facies on Clayey, Humous Conglomerate Soil, with Cedrela-Chlorophora

In Barbados several relicts of primitive forests exist, which upon careful study are found to be mesophytic. The facies is related to the soil, which is a dark gray, clayey, humiferous sand. These remnants are found in Turner's Hall Wood and to a lesser extent in Forster Hall. Hardy (20) states correctly that Turner's Hall Wood "is the most typical representative of the mesophytic forest association" and that due to topography, humidity, soil and exposure it differs considerably from other tropical forests. The difference between this forest, containing only 20 to 25 tree species, and the heterogenous hygrophytic forests of the French Antilles containing approximately 200 species, or with the tropical rain forests of Dominica, which according to Hardy contain at least 176 tree species, is indeed great. But Hardy apparently never visited the Simaruba, Inga, Daphnopsis-Calophyllum, Amomis, or Cedrela forests of southern Martinique which resemble those of Barbados in physiognomy and even in composition, and stratigraphy. They all are very different from humid forests.

The writer visited Turner's Hall Wood in 1937 and found the 17 species mentioned by Hardy and some others which were not included in his list, and certain herbaceous species and shrubs. Lack of time did not permit the determination of the percentage composition of each species.

This forest is found between 250 and 350 meters above sea-level and is about half a mile in length and about 300 yards in width. It is on the island's most ancient geologic formation, dating from the Lower and Middle Eocene presenting abrupt topographic features, contrasting with the undulated round bluffs of the rest of the island's Pleistocene reef-limestones or coral rocks. The soil is composed of oceanic gray sediments traversed by greenish or rose-colored clays with abundant red or brown ferruginous nodules produced by decalcification. An abundant permeable and well-drained humus layer covers the soil. Average annual rainfall during the dry season is 16.35 inches while in the rainy season it is approximately 44.95 inches. Humidity is rather low, and strong, saline, northeast winds sweep the island nearly throughout the year.

Seasonal variations mentioned for other facies of the mesophytic forests are also found here. During the dry season when the writer observed it, the following trees in Turner's Hall Wood were partially out of leaf: Hymenaea courbaril L., Ceiba pentandra Gaertn, Lonchocarpus benthamianus Pittier, and Elaphrium simaruba L. Rose. The following had thin crown and are probably evergreen: Dipholis salicifolia (L) A.DC., Sapium hippomane G.F.W. Meyer and Hernandia sonora L. The largest trees do not exceed 60 feet in height nor 3 feet in diameter. Table 43 shows the layers formed by the most common species.

Table 43.—Composition and Stratigraphy of Turner's Hall Wood, Barbados

Layer	Scientific Name	Native Names
1. Dominant trees (Higher than 35 feet)	Cedrela mexicana Roem.	West Indian Cedar
	Chlorophora tinctoria (L.) Gaud	Fustic
	Hymenaea courbaril L.	Locust tree
	Lonchocarpus benthamianus Pittier	Spanish ash
	Hernandia sonora L.	Jack-in-a-box
	Elaphrium simaruba (L.)Rose	Birch gum
	Ceiba pentandra Gaertn. var. caribaea (DC)Bakhuisen	Silk cotton tree
	Hura crepitans L.	Sandbox tree
	Cecropia peltata L.	Trumpet tree
2. Dominated trees (18 to 35 feet)	Sapium hippomane G.F.W. Meyer	Poison tree or Milktree
	Dipholis salicifolia (L.) A.DC.	Bully tree
	Aiphanes minima Burs.	Macaw palm
	Roystonea regia (H.B.K.) Cook	Cabbage palm
	Fagara caribaea (Lam.) Krug & Urb.	White Hercules or Harkis
	Cordia glabra L.	Clammy cherry
	Citharexylum spinosum L.	Fiddle wood
	Coccoloba grandifolia Jacq.	Leather-Coat tree
3. Shrubs (6 to 18 feet)	Piper Mac Intoshii Trel. nov. spec.	Elder bush
	Piper Eggersii C.DC.	Rock bush
	Schoepfia Schreberi Gmelin	Olax tree
	Ardisia humilis Vahl	
	Cestrum latifolium Lam.	Wild jasmine
	Faramea occidentalis L. A. Rich.	Wild coffee
	Clusia Pluckenettii Urb.	Balsam tree
4. Herbaceous Shrubs (6 to 18 feet)	Odontonema nitidum (Jacq.) Kuntze	
	Psychotria undata Jacq.	Wild coffee
	Wedelia calycina L. Cl. Rich	Daisy-like
5. Herbs	Adianthum latifolium Lam.	Maiden-hair fern
	Pityrogramma calomelana (Link) Maxon	Golden Fern

Table 43.—Continued

Layer	Scientific Name	Native Names
	Salvia occidentalis Sw.	Blue salvia
	Anthurium Willdenowii Kunth	Anthurium
6. Lianas	Securidaca diversifolia (L.) Blake	Blue flowers
	Batocydia unguis (L.) Mart.	Cat's claw
	Lasiascis divaricata (L.) Hitchc.	Cane-grass
	Stigmatophyllon ciliatum (Lam.) A. Juss.	
7. Epiphytes	Wittmackia lingulata (L.) Mez	Wild pine
	Polypodium phyllitidis L.	Creeping-fern
	Polypodium piloselloides L.	Creeping-fern

This forest is essentially homogeneous, pauci-specific, and similar to the facies observed in southern Martinique. Hardy (20) states that the undergrowth is not as luxuriant and varied as that of other tropical forests due probably to the nature of the soil, low humus content and low atmospheric humidity. These are the typical differences separating mesophytic from humid forests. He also states that epiphytes like Tillandsia sp. and epiphytic ferns and orchids are never observed in Barbados and the only undergrowth he mentions for Turner's Hall is Odontonema (Thyrsacanthus), Piper, Psychotria, and Faramea. Lianas were considered absent by him. The lianas and epiphytes in Table 43, nevertheless, were collected there. Epiphytism and lianas are indeed limited but they are not absent.

Other mesophytic remnants are found in Barbados but generally in different edaphic substrata, such as calcareous cliffs whose crevices are filled with humus, or on very old coral cliffs. Their formation is somewhat different from Turner's Hall, and is generally less forest-like.

In a recent Paper "Provisional list of trees and shrubs of the Lesser Antilles" Beard gives a list of approximately half of the tree and shrub species known to the Lesser Antilles, from Anguilla to Grenada. He points out that, "Barbados is not shown at all, owing to the almost total destruction of the native tree flora". Hardy states that "In very few places only are the relicts of the ancient forest of Barbados to be seen at present. The best impression of their botanical characteristics is furnished by Turner's Hall Wood." The writer shares this opinion and believes that even though the characteristics of the original forests cannot be re-established with absolute certainty, study of relicts do provide much information of value. The writer has studied the island and early documents and collections from Ligon 1657 & Hughes (1750) up to Symbolae Antillanae (Urban). This has provided information as to which are the endemic species and their geographic affinities. (Caribbean Forester, 5:2:48-67, January, 1944). It is believed that there were originally three native forest types in Barbados:

1. Mangrove, occuring on saline coastal swamps, now found only in Greame Hall Estate and margins of the Careenage River, but which must have occupied the estuaries of rivers in the south and west and on low shores.

2. Xerophytic forests, with diverse facies on sands, calcareous, and volcanic sediments from the volcanoes of the southern Caribbean chain, with Coccolobis, Tabebuia, etc.

3. Mesophytic forests, with facies on marine sediments (Scotland District) and on calcareous cliffs of which only limited and degraded relicts now exist. The composition of Turner's Hall Wood does not show the original, typical vegetation of that section of the island. It lacks, undoubtedly, certain other tree species now not present. It is curious that fustic, (Chlorophora tinctoria (L.) Gaud.) is abundant there while it has completely disappeared since the end of the 19th century from similar forests of the French Lesser Antilles where it occurred abundantly. This is the fate of valuable species where forest protection is negligeable, and serves to explain why certain interesting species have disappeared. On the other hand, other less demanding, rapid growing species have invaded the degraded forest of Turner's Hall Wood and Montravail Wood, Martinique. The Elaphrium simaruba (L.) Rose, Ceiba pentandra (L.) Gaertn., Hura crepitans L. and Cecropia peltata L. are among them.

The Facies of the Heterogenous, Mixed Subtype

There are two facies in the heterogenous subtype in the French Antilles, the riparian woodland or gallery forest and the transitional forest.

Riparian woodland or gallery forests, with Lonchocarpus-Calliandra.— This facies corresponds to Warming's "galeriewald", called "forêt riveraine" by Swiss botanists, and "selvas de galería" by Pittier and Latin-American foresters. In the Lesser Antilles the forest is not as common as in South America. In Brazil, the Guianas, and Paraguay it is found along rivers, penetrating even to steppes or savannas. In southern Martinique it is found throughout river courses and even in plains and on dry shores on Grande Terre and on the leeward side of St. Lucia and Dominica. The presence nearby, throughout its range, of hygrophytic forest first, then other mesophytic, xerophytic and finally mangrove forests, modifies its composition, but the common factor of nearness to the river gives it a definite physiognomy. The river sediments create an excellent site for the establishment of a forest. It is found along even torrential rivers, such as Lezarde, Capote, Lorrain, Macouba, in Martinique; Plaines, Guadeloupe; Pegoria, Castle Bruce, Roseau, Layon, Coulibaut in Dominica; Buckley's Ravine, Wingfield River and Godwin Ghaut in St. Kitts. Evidently the general flora and endemism of each of the islands dictates the composition of the facies. The most salient character of this facies is the presence of long, high lianas reaching almost to the tree tops, a development resulting from the prevailing humid atmosphere.

In Martinique an examination of the forests bordering the rivers that flow into the southern coasts at Trois Ilets, Riviere Pilote, Case Pilote, etc. discloses a Lonchocarpus sericeus-Calliandra latifolia association. Table 44 shows the various strata observed in such a riparian forest in Martinique.

Table 44.—Composition, and Stratigraphy of Gallery Forest Facies at Rivière de la Pagerie, Trois-Ilets, Martinique.

Stratum	Scientific Name	Native Names
1. Arborescent species	Lonchocarpus sericeus H.B.K.	Savonnette rivière
	Calliandra latifolia Griseb.	Poix-doux-rivière
	Lonchocarpus domingensis (Pers.)DC.	Savonette-bois
	Cordia glabra L.	Ti-bonbon
	Cordia sulcata DC	Mahot rivière
	Acacia Westiana DC	Amourette rivière
	Genipa americana L.	Genipa
	Erythrina glauca Willd.	Bois immortel
	Ocotea cernua Mez	Laurier
	Ficus laevigata Vahl var. lentiginosa (Vahl) Urb.	Figuier maudit
2. Undergrowth	Piper dilatatum L.C. Rich.	Malimbé
	Aegyphila martinicensis Jacq.	Bois cabri
	Cestrum alternifolium (Jacq.) O.E. Schultz	Galant de nuit
	Cordia cylindrostachya R. & P.	Mahot noir
	Miconia striata Cogn.	Cré-cré
	Mimosa asperata L.	Amourette rivière
	Miconia cinnamomifolia Triana	Cré-cré rivière
	Myrcia berberis P. DC.	Bois-ti-feuilles
3. Lianas	Dalbergia monetaria L.f.	Lianas à barriques
	Heteropteryx platyptera DC. var. martinicensis (Ndz.) Macbr.	Aile à ravet
	Tetrapteris citrifolia (Sw.) Pers	Liane mibi
	Stigmatophyllum convolvulifolium (Cav.) A. Juss.	Liane mibi
	Paullinia pinnata L.	Bonbon les filles
	Cissampelos Pariera L.	Liane molle, liane amère
	Trichostigma octandrum (L.) Walt.	Liane murette

Table 44.— Continued

Stratum	Scientific Name	Native Names
	Centrosema Plumieri Benth.	Pois-pois rivière
	Entada scandens Benth.	Liane oua-oua
	Mucuna urens (L.) DC.	Yeux bourrique
	Stizolobium pruritum (Wight) Piper	Pois-gratter
4. Herbaceous layer	Desmodium axillare DC.	Cousin trèfle rivière
	Justicia pectoralis Jacq.	Herbe à charpentier
	Pilea microphylla (L.) Liebm.	Petite teigne
	Pilea nummulariaefolia (Sw.) Wedd.	Petite teigne ronde
	Tradescantia elongata G.F.W. Meyer	Herbe grasse rivière
	Tradescantia geniculata Jacq. var. pilosa nov.	Herbe grasse poilue
	Callisia repens L.	Petite herbe grasse
	Pitcairmia angustifolia (Sw.)	Citronnelle rivière
	Phragmites communis Trin.	Roseau
	Eragrostis hypnoides (Lam.) B.S.P.	Herbe à chapeau
	Axonopus compressus (Sw.) Beauv.	Herbe gazon
	Dryopteris patens (Sw.) Kuntze	Fougère
	Dryopteris subtetragona (Link) Maxon	Fougère
	Tectaria heracleifolia (Willd.) Under-w.	Fougère
	Adiantum latifolium Lam.	Cheveu de Vénus
	Tectoria incisa Cav.	
5. Epiphytes	Psilotum nudum (Sw.) Griseb.	Barbe à l'arbre
	Paltonium lanceolatum (L.) Presl.	Barbe à l'arbre
	Polypodium polypodioides (L.) Watt	Fougère courante
	Polypodium aureum L.	Grande fougère
	Polypodium pectinatum L.	Grande fougère
	Oncidium cebolleta (Jacq.) Sw.	Orchidée
	Oncidium guttatum (L.) Rchb. f.	Orchidée
	Peperomia conulifera Trel.	Malimbé

Transitional forests.— The largest islands of the archipelago, such as Guadeloupe, Dominica, St. Lucia, Martinique, and St. Vincent have a transitional mesophytic forest occuring between the xerophytic and the hygrophytic forests. Its altitude is generally between 600 and 1300 feet above sea level. It is similar in some aspects to the riparian facies and to a lesser extent to the homogenous facies.

This facies is greener than xerophytic forests. Tree species are more numerous, both evergreens and deciduous, and stratification although diffuse and not absolutely clear, is evident. It differs from hygrophytic forests in having a less humid atmosphere, a more rocky and less humous soil, paucity of bryophytic vegetation, reduction in cortical epiphytism and total absence of epiphilism or membranous ferns, and differences in the form of buttresses. The presence of certain palms, Rhyticoccos amara (Jacq.) Becc. in Dominica and Martinique, Euterpe oleracea in Trinidad, Bactris falcata Johnst. in Margarita and Aiphanes minima Burns in Barbados is a peculiarity of this facies.

In northern and central Martinique this transitional forest is of scattered occurrence. The most remarkable examples are at Grande Riviere, two or three kilometers away from the river and at the foot of Chaine des Pitons, at an elevation between 600 and 1050 feet. The composition of this forest appears in Table 45. It may well be classified as an Andira-Lonchocarpus association.

Table 45.—Composition and Stratigraphy of Transitional Forest. Bois de Varvotte, Ceron and Grand Rivière, Martinique.

Layer	Scientific Name	Native Name
1. Tree layer	Andira jamaicensis (Wright) Urb.	Angelin ou Bois olive
	Lonchocarpus latifolius (Willd.) H.B.K.	Savonnette grand bois
	Hymenaea courbaril L.	Courbaril
	Ormosia dasycarpa Jacks.	Angelin palmiste
	Drypetes Dussii Krug et Urb.	Bois moussara
	Linociera caribaea (Jacq.) Knobl.	Bois de fer
	Ceiba pentandra (L.) Gaertn. var. caribaea (DC.) Bakhuizen	Fromager
	Ficus crassinervia Desf.	Figuier maudit
	Calophyllum antillanum Britton	Galba
	Erythroxylum squamatum Vahl	Bois piquette
	Ruyschia clusiaefolia Jacq.	Bois josé
	Rhyticoccos amara (Jacq.)Becc.	Coco-nain
2. Understory tree layer	Exostema caribaeum (Jacq.) Retz	Quinquina piton
	Palicourea crocea DC.	Bois cabri
	Phyllanthus mimosoides L.	Batard de fougère
	Piper Nottirbanum Trel.	Queue de rat
	Pothomorphe Dussii Trel.	Bois anisette
	Solanum triste Jacq.	Bois caca
	Chiococca alba (L.) Hitch.	Jasmin-bois, liane cainca
3. Liana layer	Mucuna altissima DC.	Oeil bourrique
	Amphilophium paniculatum H.B.K.	Liane à canot
	Tanaecium crucigerum Seem.	Liane à barriques
	Paullinia vespertilio L.	Liane persil
	Gonzalaguina hirsuta Schum.	Liane foufou

Table 45.—Continued

Layer	Scientific Name	Native Name
	Stigmatophyllum puberum Juss.	Liane ravet
	Anthurium scandens L.	Liane siguine
	Lasiascis sloanei (Griseb.) Hitchc.	Calumet-bois
	Lasiascis divaricata (L.) Hitchc.	Calumet-bois
4. Herbaceous layer	Pharus latifolius L.	Collant
	Ichnanthus pallens (Sw.) Munro	Avoir bâtard
	Callisia repens L.	Petite herbe grasse
	Episcia melittiflora Mart.	Herbe à miel
	Pilea semi-dentata (Juss.) Wedd.	Ortie bois
	Peperomia Broadwayi C. DC.	Queue de lézard
	Asplenium formosum Willd.	Fougère
	Adiantum tenerum Sw.	Cheveu de Vénus
	Adiantum fragile Sw.	Cheveu de Vénus
	Dryopteris subtetragona (Link) Maxon	Fougère
	Pteris grandifolia L.	Fougère
	Blechnum unilaterale Sw.	Fougère
	Asplenium cristatum Lam.	Fougère
5. Epiphytic layer	Peperomia conulifera Trel. var. Stehleae Trel.	Queue de lézard
	Peperomia conulifera Trel. var. acutifolia Trel.	Queue de lézard
	Peperomia palpebrata Trel.	Queue de lézard
	Peperomia rotundifolia Kunth var. nummularifolia (Kunth) Stehlé	Queue de lézard
	Peperomia trifolia Dictr.	Queue de lézard
	Tillandsia utriculata L.	Ananas bois
	Tillandsia recurvata L.	Ananas bois
	Guzmania lingulata Mez	Ananas bois
	Epidendrum difforme Jacq.	Orchidée, roi de l'arbre
	Epidendrum ramosum Jacq.	Orchidée, roi de l'arbre
	Oncidium tetrapetalum Willd.	Orchidée, roi de l'arbre
	Leucobryum antillanum Hampe	Mousse blanche
	Octoblepharum albidum (L.) Hedw.	Mousse blanche

As one approaches the humid forest in this transition belt, diversity of epiphytic flora increases. Only those epiphytes typical of mesophytic forests appear in Table 45. The various Piperaceae of genus Peperomia, Bromeliaceae, and Orchidaceae mentioned are not found in hygrophytic forests.

Varied insular aspects of the Caribbean mesophytic forest.— In these descriptions of the mesophytic forests the writer has considered only the environmental conditions and stratigraphy observed in the French islands he knows well, and certain British West Indian islands. Since these islands are the highest and largest of them all and also ecologically the richest, diverse facies studied are more numerous there than in the smaller islands.

The mesophytic forests present many different insular aspects in the northern and southern islands of the Caribbean region.

(To be concluded in a future issue)

Fig. 1 is the folded map at the end of this number.

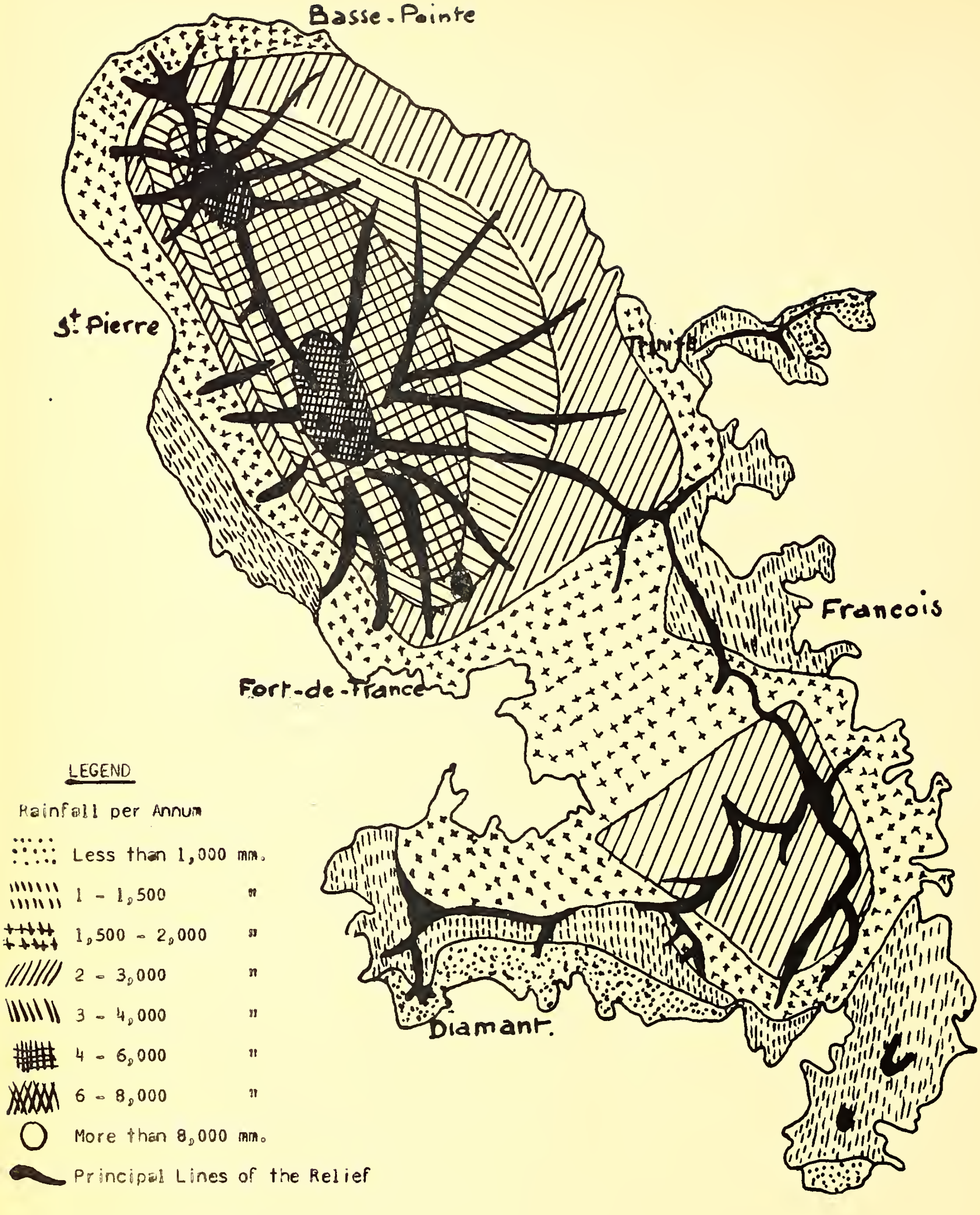


Fig. 2- Map of Rainfall Distribution in Martinique.
E. Revert

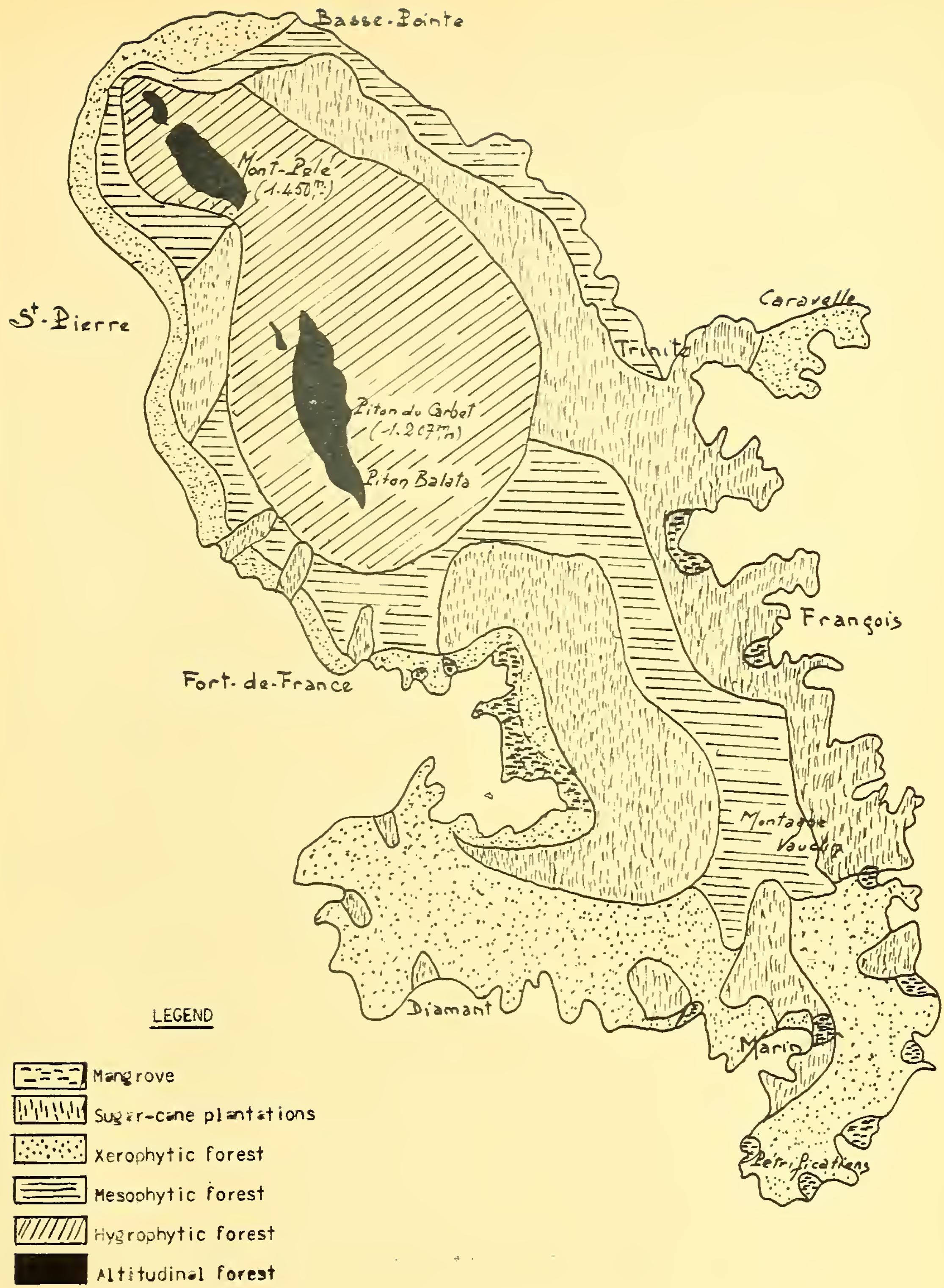


Fig. 3- Vegetation Distribution in Martinique. H. Stehlé.

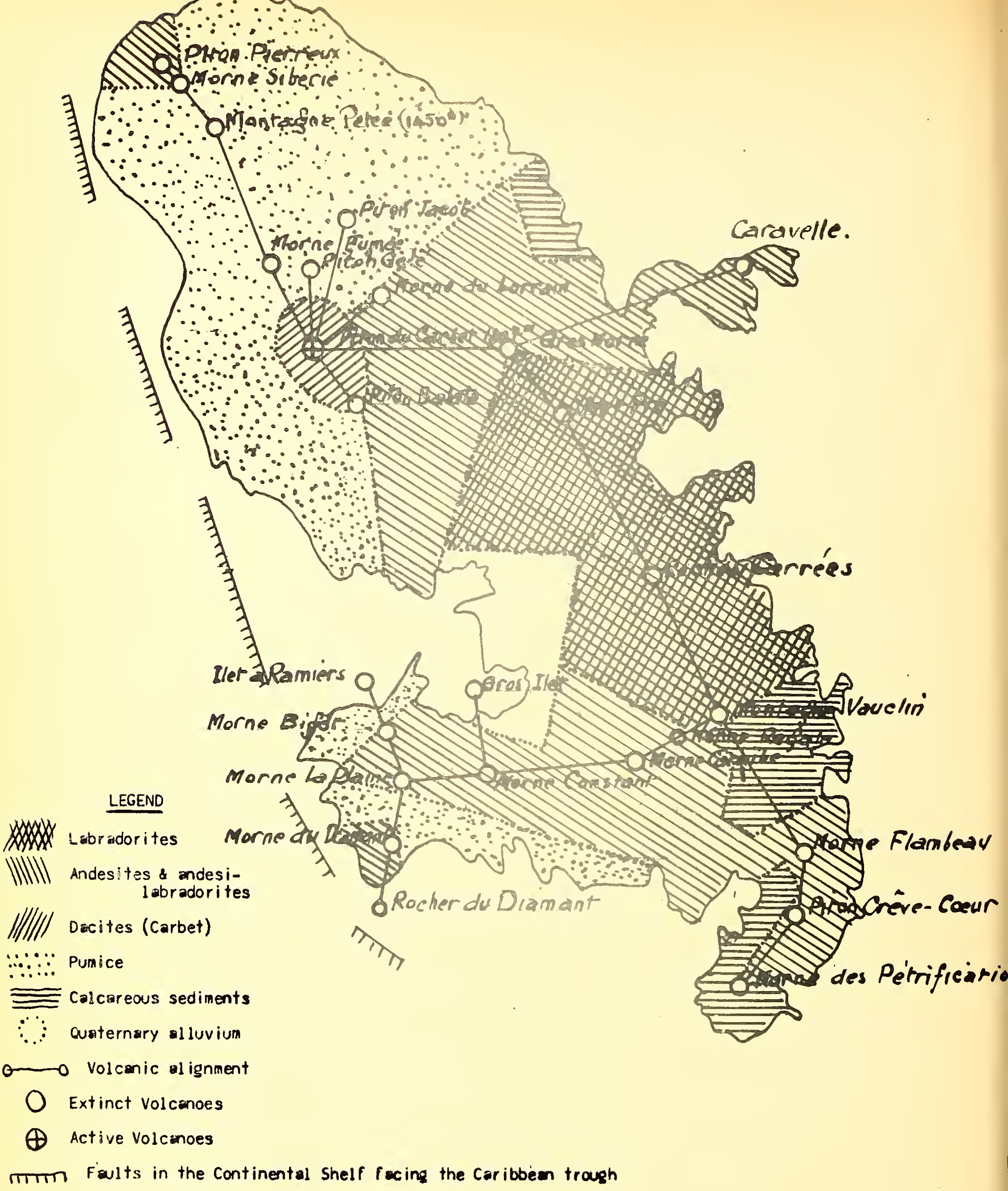


Fig. 4- Simplified Geological Map. (after Giraud) and Volcanic Alignment (after Revert).

Fig. 5.—Hythergraphes Comparatifs des Secteurs de Forêt Xerophytique (I) et de Forêt Hygrophytique (II), au Littoral Sous-le-Vent, Martinique. (Hythergraphs in the Xerophytic (I) and Hygrophytic Forests (II) at the Leeward Coast, (Martinique) (Hiterógrafos del Bosque Xerofítico (I) y del Higrofítico (II) en la Costa Sotavento, Martinica)

(I) Fort-de-France, Alt. 82 m.
(II) Morne des Cadets Alt. 510 m.

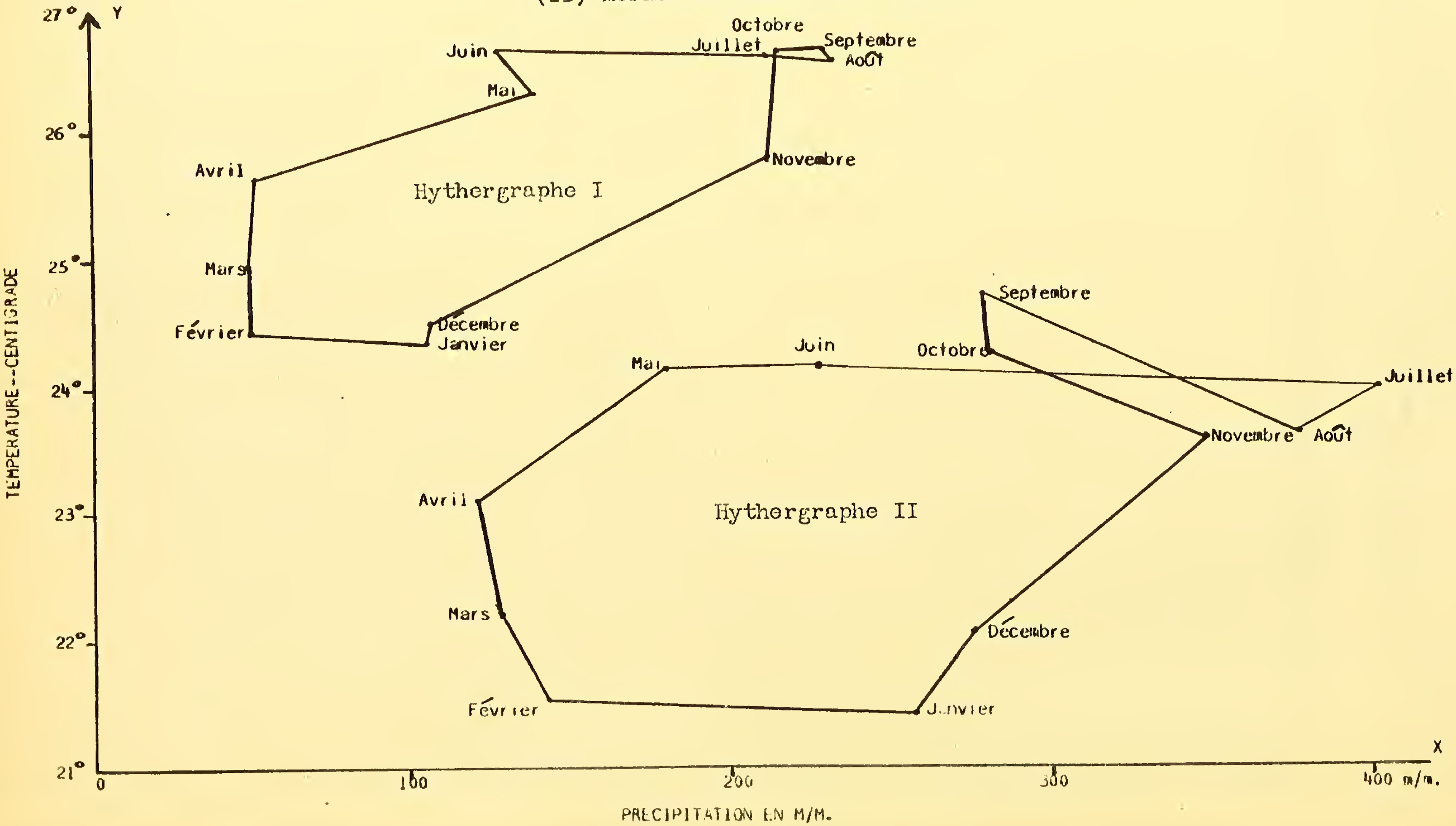
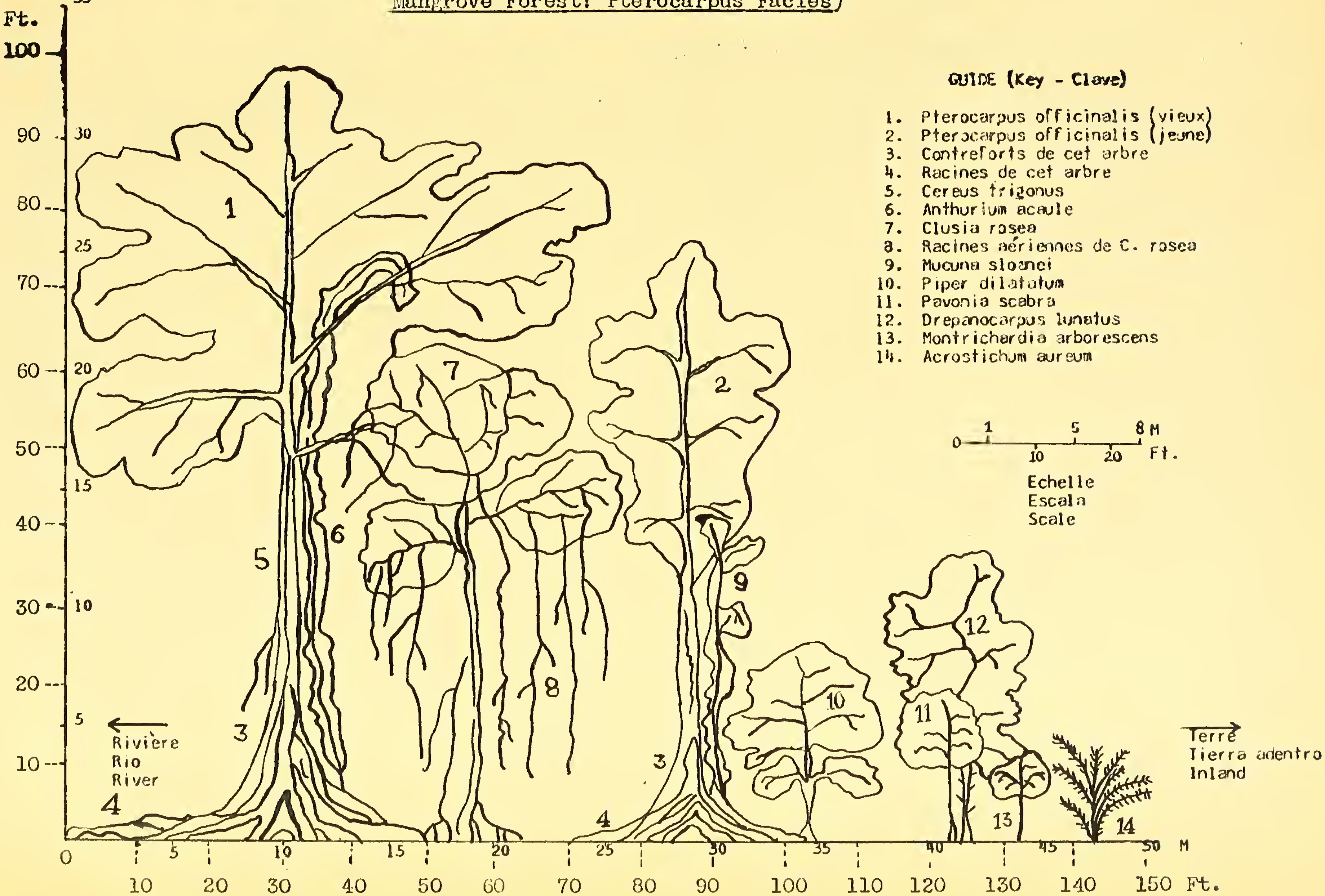


Fig. 6- Profil-diagramme de la Forêt Type de Mangrove Caraïbe. Faciès à Rhizophora (Profile in the Caribbean Forest Mangrove, Rhizophora Facies) (Croquis del Perfil del Manglar, Facie de Rhizophora)

LEGENDE
(Key)
(Clave)

1. Rhizophora Mangle
2. Avicennia nitida
3. Conocarpus erecta
4. Laguncularia racemosa
5. Pavonia scabra
6. Drepanocarpus lunatus
7. Brachypteris ovata
8. Cydista aequinoctialis
9. Rabdadenia biflora
10. Acrostichum aureum
11. Racines aeriennes du Rhizophora
12. Pneumatophores de l'Avicennia
13. Plantules vivipares du Rhizophora

Fig. 7.—Profil-diagramme de la Forêt-Type de Mangrove Caraïbe: Faciès à Pterocarpus. (Croquis del Perfil Típico del Manglar Caribe: Facie de Pterocarpus) (A Typical Profile in the Caribbean Mangrove Forest: Pterocarpus Facies)



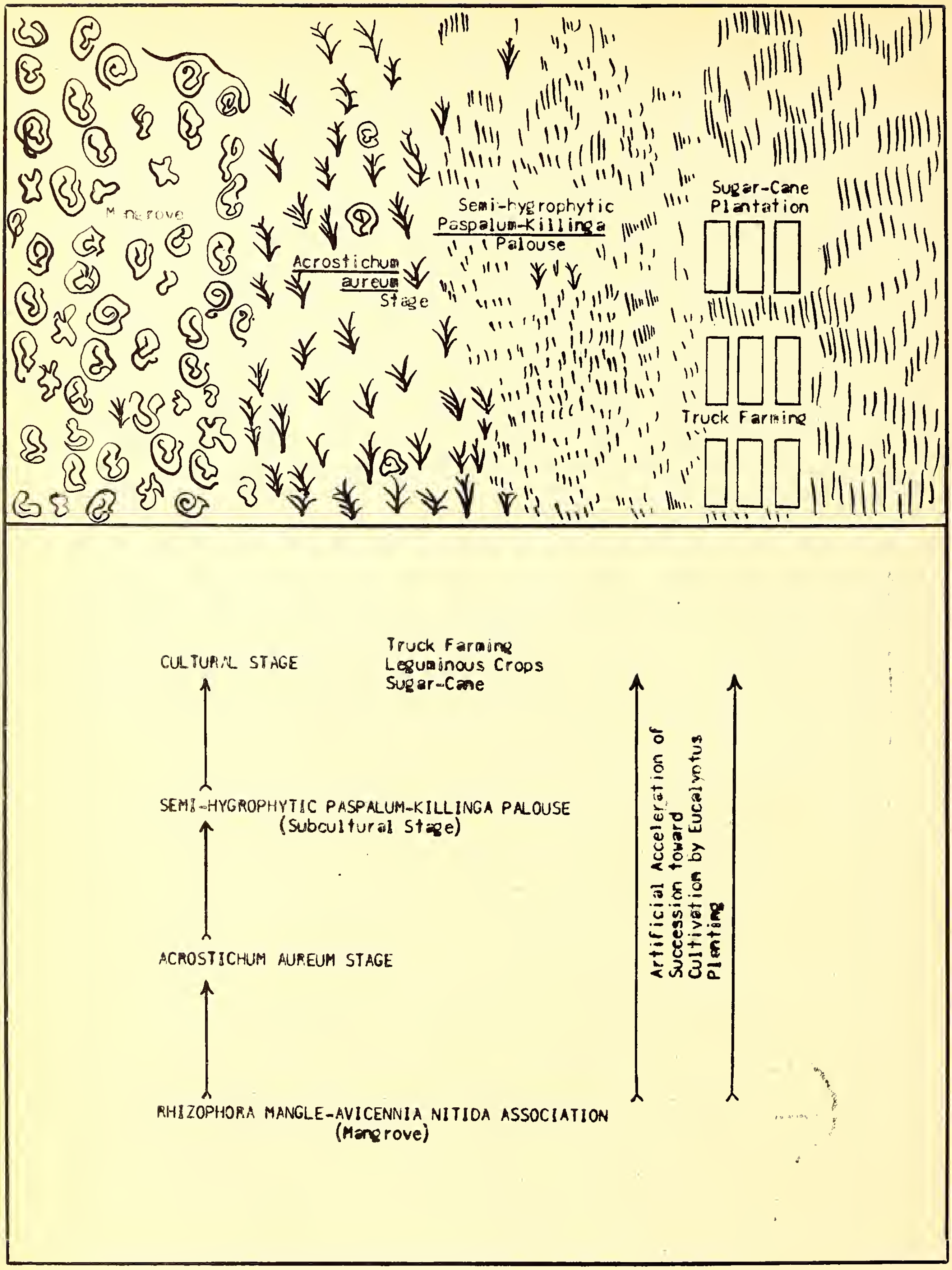


Fig. 8- Diagram of Succession from Mangrove to the Highest Economic Use.

Fig. 9- Courbes Representatives des Variations d'Evaporation (I) et Insolation (II) Moyennes en Secteur de Forêt Xerophytique. (Curves Showing Monthly Variations in Mean Evaporation (I), and Insolation (II) in Xerophytic Forests). (Curvas Representativas de las Variaciones en Evaporación Media (I) e Insolación Media (II) en el Bosque Xerofítico)

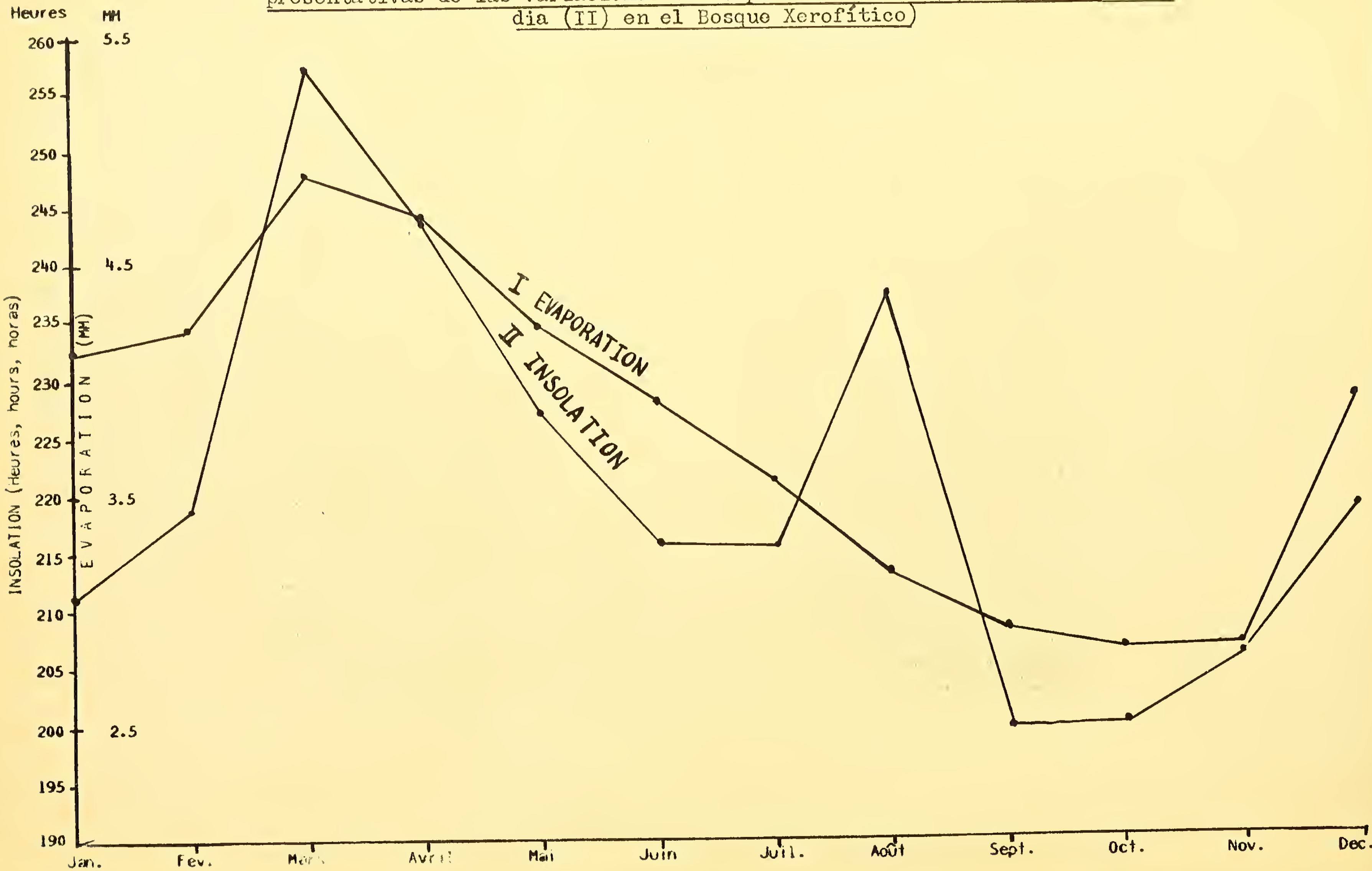


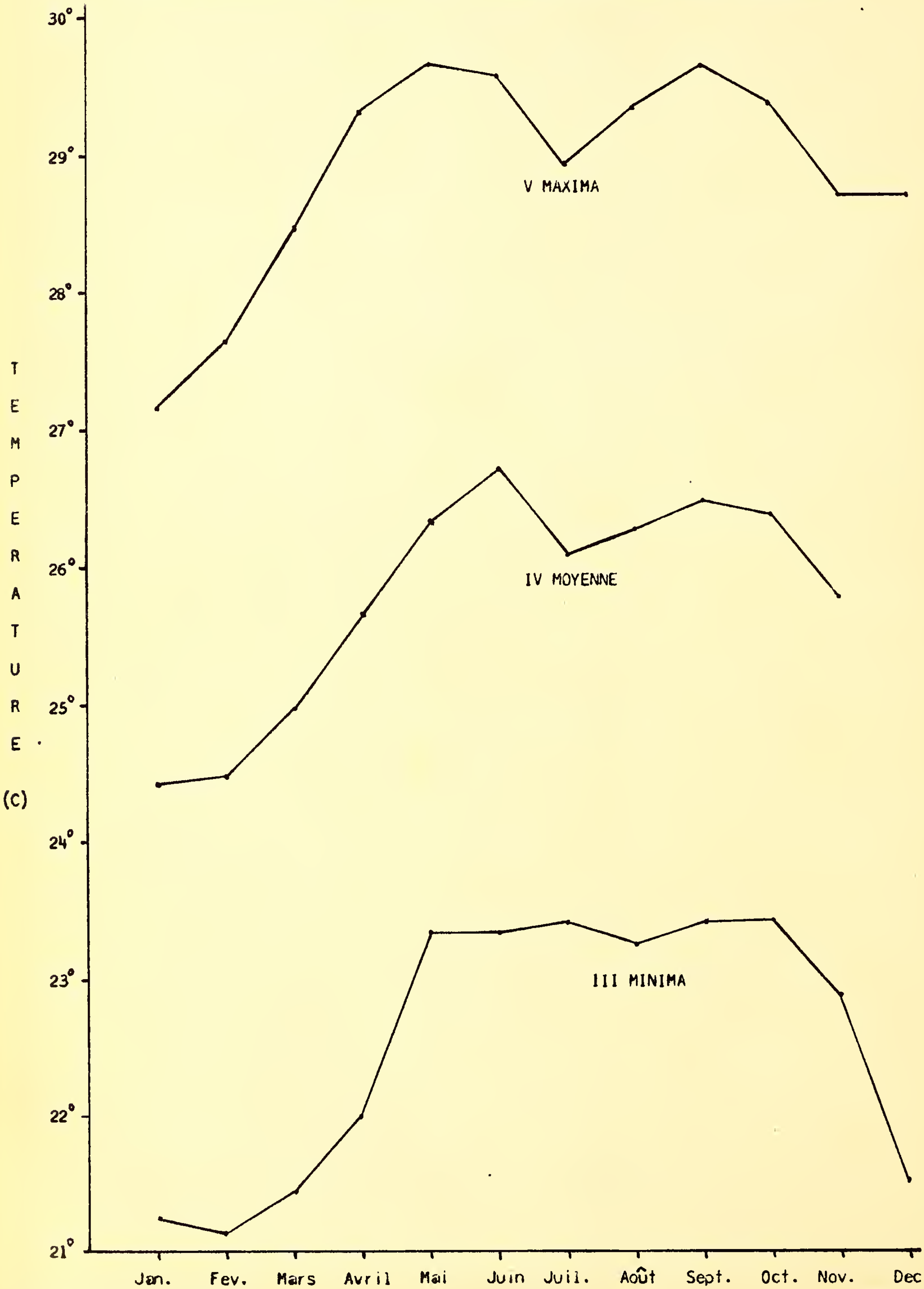
Fig. 11- Profil-Diagramme de la Forêt Xérophytique à *Tabebuia* - *Drypetes*
(Croquis del Perfil del Bosque Xerofítico de *Tabebuia* - *Drypetes*
(Profile in the *Tabebuia*-*Drypetes* Association)
Marie Galante, Bois de Folle Anse

LEGENDE

Symboles	Noms Scientifiques	Symboles	Noms Scientifiques
1	*Tabebuia pallida* Miers subsp. *pentaphylla* (Juss.) Bur. et Schum.	13	*Xylosma buxifolium* A. Gray
		14	*Ficus laevigata* Vahl var. *lentiginosa* (Vahl) Urb.
2	*Tabebuia pallida* Miers subsp. *pentaphylla* (Juss.) Bur. et Schum., stade juvenile	15	*Fagara flava* (Vahl)Kr. et Urb.
		16	*Dipholis salicifolia* (L.) DC.
		17	*Coccoloba grandifolia* Jacq.
3	*Hippomane mancinella* L.	18	*Maytenus elliptica* (Lam.) Kr. et Urb.
4	*Drypetes serrata* Krug et Urb.		
5	*Drypetes alba* Poit.	19	*Rhacoma crossopetalon* L. forma *tipica* Urb.
6	*Eugenia axillaris* (Sw.) Willd.		
7	*Anamomis fragrans* (Sw.) Griseb. var. *brachyrhiza* (Kr. et Urb.) Stehlé	20	*Erythalis fruticosa* L.
		21	*Acrodiclidium salicifolium* (Sw.) Griseb.
8	*Ixora ferrea* Benth	22	*Neurolaena lobata* (L.) R. Br.
9	*Exostema sanctae-luciae* (Kentish) Britten	23	*Gonzalaguina hirsuta* (Jacq) Schum.
10	*Ardisia guadelupensis* Duchass.	24	*Peperomia conulifera* Trel. var. *Stehleae* Trel.
11	*Ximenia americana* L.		
12	*Clusia rosea* L.	25	*Wittmackia lingulata* Mez

Fig. 11.—Profil-Diagramme de la Foret Xérophytique à Tabebuia - Drypetes
(Croquis del Perfil del Bosque Xerofítico de Tabebuia - Drypetes)
(Profile in the Tabebuia-Drypetes Association)
Marie Galante, Bois de Folle Anse

Fig. 10.—Courbes des Variations de Températures Minima, Moyenne et Maxima en Secteur de Forêt Xérophytique. (Variations in Minima, Maxima and Mean Temperatures in Xerophytic Forests) (Variaciones en la Temperaturas Máximas, Mínimas y Medias en el Bosque Xerofítico).



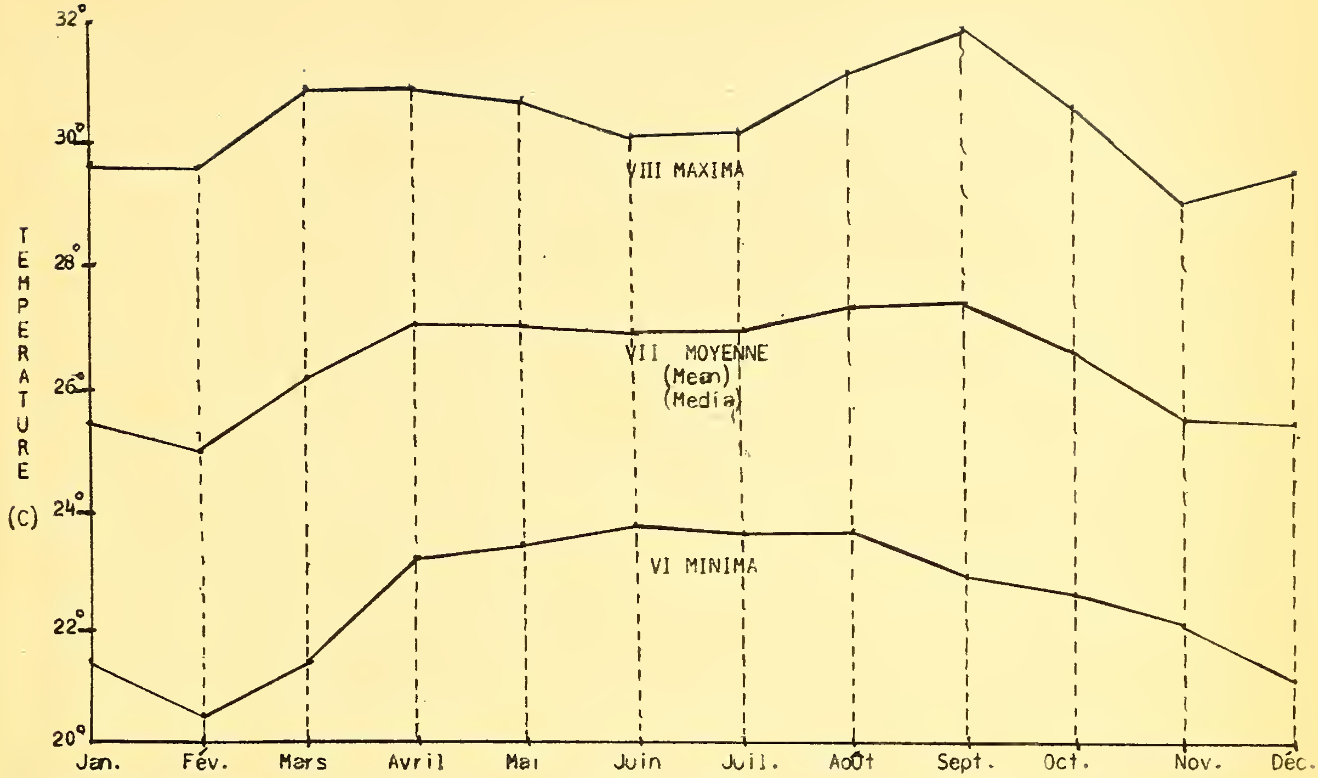


Fig. 12.- Courbes des Variations de Temperatures Minima, Moyenne et Maxima, en Forêt Mesophytique. (Variations in Maxima, Minima and Mean Temperatures in Mesophytic Forests) (Variaciones en las Temperaturas Máxima, Mínima y media, en el Bosque Mesofítico)

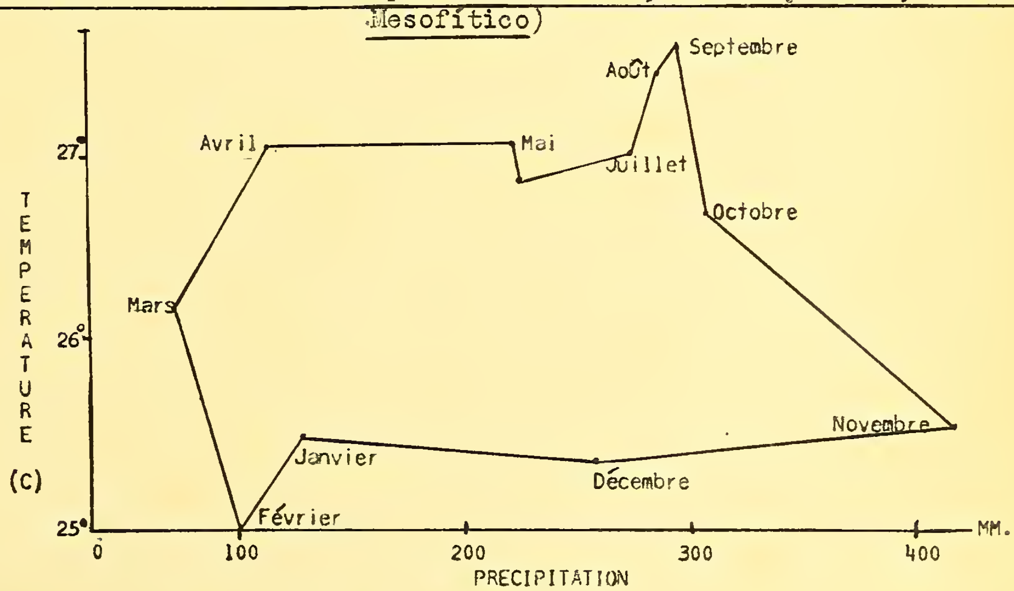
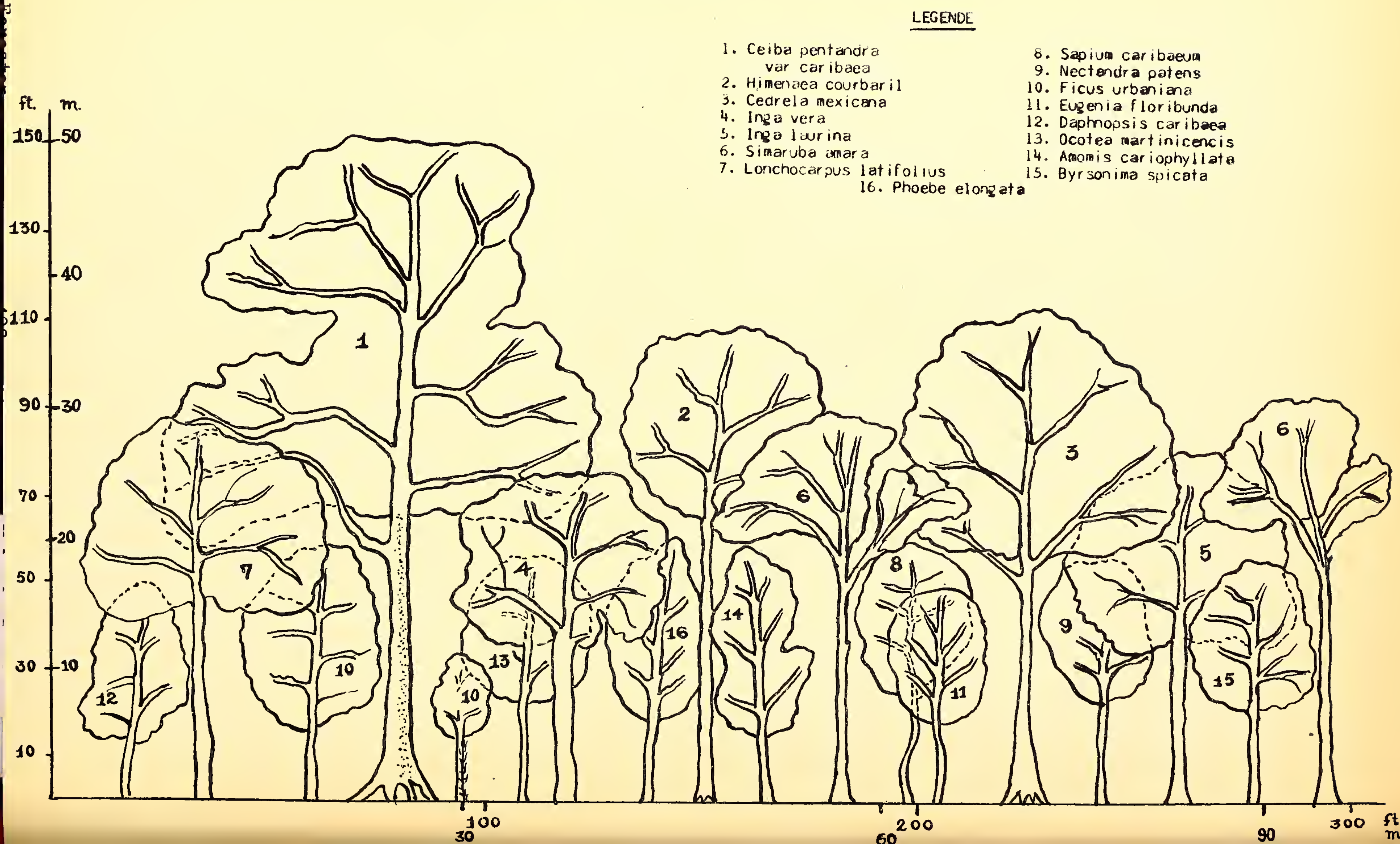


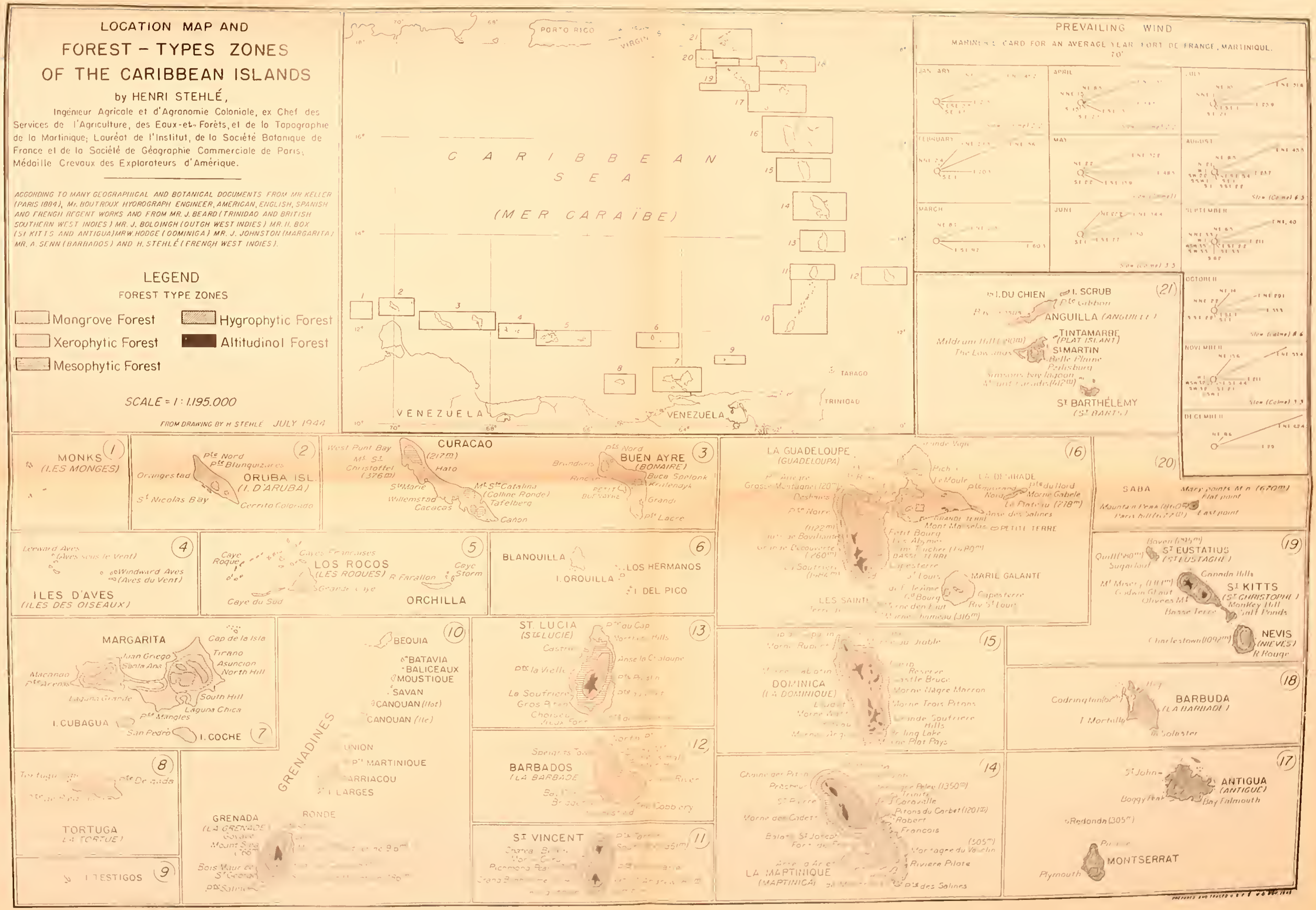
Fig.13- Hythergraphe du Secteur de Forêt Mesophytique (Hythergraph of the Mesophytic Forest) (Hiterógrafo del Bosque Mesofítico). Jardin de la Tracée (Gros Morne) Alt. 250 m.

Fig. 14- Profil-Diagramme de la Forêt Type Mesophytique Caraïbe-Faciès à Simaruba. (Profile in the Mesophytic Forest, Simaruba Facies). (Croquis de un Perfil del Bosque Mesofítico, Facie de Simaruba).

Forêt de Montravail, Sainte-Luce, Martinique



INDEX TO
VOLUME 5 AND 6 OF THE CARIBBEAN FORESTER
OCTOBER 1944 TO JULY 1945


LOCATION MAP AND
FOREST - TYPES ZONES
OF THE CARIBBEAN ISLANDS
by HENRI STEHLÉ,
Ingénieur Agricole et d'Agronomie Coloniale, ex Chef des Services de l'Agriculture, des Eaux-et-Forêts, et de la Topographie de la Martinique; Lauréat de l'Institut, de la Société Botanique de France et de la Société de Géographie Commerciale de Paris; Médaille Crevaux des Explorateurs d'Amérique.
ACCORDING TO MANY GEOGRAPHICAL AND BOTANICAL DOCUMENTS FROM MR KELLER (PARIS 1884), Mr. BOUTROUX HYDROGRAPH ENGINEER, AMERICAN, ENGLISH, SPANISH AND FRENCH RECENT WORKS AND FROM MR. J. BEARD (TRINIDAD AND BRITISH SOUTHERN WEST INDIES) MR. J. BOLOINGH (DUTCH WEST INDIES) MR. H. BOX (ST KITTS AND ANTIGUA) MR W. HODGE (DOMINICA) MR. J. JOHNSTON (MARGARITA) MR. A. SENN (BARBADOS) AND H. STEHLÉ (FRENCH WEST INDIES).
LEGEND
FOREST TYPE ZONES
Mangrove Forest
Hygrophytic Forest
Xerophytic Forest
Altitudinal Forest
Mesophytic Forest
SCALE = 1 : 1.195.000
FROM DRAWING BY H STEHLE JULY 1944
PORTO RICO
VIRGIN IS
CARIBBEAN SEA
(MER CARAÏBE)
VENEZUELA
TOBAGO
TRINIDAD
PREVAILING WIND
MARINER'S CARD FOR AN AVERAGE YEAR FORT DE FRANCE, MARTINIQUE.
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
MONKS (1) (LES MONGES)
ORUBA ISL. (2) (I. D'ARUBA)
Pte Nord
Pte Blanquizares
Oranjestad
St Nicolas Bay
Cerrito Colorado
CURACAO
West Punt Bay
Mt. St. Christoffel (376m)
Hato
St Marie
Willemstad
Cacacas
Mt. St. Catalina (Colline Ronde)
Tafelberg
BUEN AYRE (3) (BONAIRE)
Pte Nord
Buca Spelonk
Kralendyk
Grandi
Pte Lacre
ILES D'AVES (4) (ILES DES OISEAUX)
Leeward Aves (Aves sous le Vent)
Windward Aves (Aves du Vent)
LOS ROCOS (5) (LES ROQUES)
Caye Roque
Cayes Françaises
R. Farallon
Caye Storm
Caye du Sud
ORCHILLA
BLANQUILLA (6)
LOS HERMANOS
I. ORQUILLA
I. DEL PICO
MARGARITA (7)
Cap de la Isla
Juan Griego
Santa Ana
Tirano
Asuncion
North Hill
Macanao
Pte Arenas
Laguna Grande
South Hill
Laguna Chica
Pte Mangles
San Pedro
I. CUBAGUA
I. COCHE
TORTUGA (8) (LA TORTUE)
TESTIGOS (9)
BEQUIA (10)
BATAVIA
BALICEAUX
MOUSTIQUE
SAVAN
CANOUAN (Ilot)
CANOUAN (Ile)
GRENADINES
UNION
Pt MARTINIQUE
CARRIACOU
LARGES
RONDE
GRENADA (LA GRENADE)
ST. LUCIA (13) (STE LUCIE)
Castries
Pte la Vielle
La Soufrière
Gros Piton
Choiseul
BARBADOS (12) (LA BARBADE)
ST VINCENT (11)
LA GUADELOUPE (16) (GUADELOUPA)
LA DESIRADE
Le Moule
Pte du Nord
Morne Gabele
La Plateau (278m)
Pte Noire
GRANDE TERRE
Petit Bourg
Mont Maréselas
PETITE TERRE
BASSE TERRE
Capesterre
LES SAINTES
MARIE GALANTE
Capesterre
Morne Jumeau (316m)
DOMINICA (15) (LA DOMINIQUE)
LA MARTINIQUE (14) (MARTINICA)
Montagne Pelée (1350m)
Pitons du Carbet (1207m)
Robert
François
Rivière Pilote
Pte des Salines
ANGUILLA (21) (ANGUILLE)
I. DU CHIEN
I. SCRUB
TINTAMARRE (PLAT ISLANT)
ST MARTIN
ST BARTHÉLEMY (ST BARTS)
SABA (20)
ST EUSTATIUS (19) (ST EUSTACHE)
ST KITTS (ST CHRISTOPHE)
Canada Hills
Basse Terre
Salt Ponds
NEVIS (NIEVES)
Charlestown (1092m)
BARBUDA (18) (LA BARBADE)
Codrington
ANTIGUA (17) (ANTIGUE)
St John
Boggy Peak
Falmouth
Redonda (305m)
MONTSERRAT
Plymouth

THE CARIBBEAN FORESTER

El "Caribbean Forester", que se comenzó a publicar en julio de 1938 por el Servicio Forestal del Departamento de Agricultura de los Estados Unidos, es una revista trimestral gratuita dedicada a encauzar el mejor aprovechamiento de los recursos forestales de la región del Caribe. Su propósito es estrechar las relaciones que existen entre los científicos interesados en la Dasonomía y ciencias afines exponiéndoles los problemas confrontados, las políticas forestales vigentes, y el trabajo realizado hacia la culminación de ese objetivo técnico.

Se solicitan contribuciones de no más de 20 páginas escritas en maquinilla. Deben ser sometidas en el lenguaje vernáculo del autor, con el título o posición que éste ocupa. Es imprescindible también incluir un resumen corto del estudio efectuado. Los artículos deben dirigirse al "Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, P. R."

The Caribbean Forester, published since July 1938 by the Forest Service, U. S. Department of Agriculture, is a free quarterly journal devoted to the encouragement of improved management of the forest resources of the Caribbean region by keeping students of forestry and allied sciences in touch with the specific problems faced, the policies in effect, and the work being done toward this end throughout the region.

Contributions of not more than 20 typewritten pages in length are solicited. They should be submitted in the author's native tongue, and should include the author's title or position and a short summary. Papers should be sent to the Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, Puerto Rico.

Le "Caribbean Forester", qui a été publié depuis Juillet 1938 par le Service Forestier du Département de l'Agriculture des Etats-Unis, est un journal trimestrel de distribution gratuite dedié à l'encouragement du ménagement rationnel des forêts de la région caraïbe. Son but est entretenir des relations scientifiques de ceux qui s'intéressent aux Sciences Forestières, ses problèmes et systèmes mis à jour, avec les travaux faits pour réaliser cet objectif d'amélioration technique.

On sollicite des collaborations de pas plus de 20 pages écrites à machine. Elles doivent être écrites dans la langue maternelle de l'auteur en comprennant son titre ou position professionnel et un résumé de l'étude. Les articles doivent être adressés au "Director of Tropical Forestry, Tropical Forest Experiment Station, Rio Piedras, Puerto Rico".


UNITED STATES
ATLANTIC
OCEAN
GULF OF
MEXICO
MEXICO
BAHAMA
ISLANDS
CUBA
JAMAICA
HAITI
DOMINICAN
REPUBLIC
PUERTO
RICO
GUADELOUPE
DOMINICA
MARTINIQUE
STA LUCIA
TRINIDAD
BRITISH
HONDURAS
CARIBBEAN SEA
HONDURAS
GUATEMALA
SALVADOR
NICARAGUA
COSTA
RICA
PANAMA
PACIFIC
OCEAN
VENEZUELA
BR.
GUIANA
COLOMBIA

U.S.F.S.,WO-1944