Micropholis chrysophylloides Pierre Caimitillo

Sapotaceae Sapodilla family

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Micropholis chrysophylloides Pierre, commonly known as caimitillo in Puerto Rico, yellow oliver in Trinidad, and by more than 23 other common names elsewhere in the Caribbean Basin, may be identified by its straight trunk and narrow, dense crown of dark-green, thick, leathery foliage *(16)*. The leaves, which appear bronze on the undersurface, are borne alternately on bronze, hairy petioles. When cut, trunks, stems, and leaves produce a small amount of milky sap. Mature trees in Puerto Rico are 10 to 20 m tall and up to 60 cm in d.b.h. (fig. 1).

HABITAT

Native Range

Caimitillo grows between 12° and 18° 30′ N. latitudes in the Caribbean Islands, including Puerto Rico and the Lesser Antilles from St. Kitts to Grenada *(2, 16)* (fig. 2). It was erroneously reported growing in Hispaniola *(15)*. The Hispaniolan species was later identified as *M. polita* (Griseb.) Pierre, which was previously considered endemic to the Oriente region of Cuba *(13)*.

At the time of Puerto Rico's discovery, caimitillo was relatively common in the montane forests of the Luquillo Mountains and the Cordillera Central *(21)*, growing at elevations that range from 200 to 950 m. Today, the species is still common in the Luquillo Mountains between these elevations. In the Cordillera Central, it grows at higher elevations, both in montane forests where it is relatively common *(3)* and in abandoned coffee shade forests where it is uncommon *(4, 24, 32)*.

Climate

Caimitillo grows in the mountainous interiors of the Caribbean Islands where rainfall, cloud cover, and relative humidity are higher and solar insolation, temperature, and evapotranspiration are less than in coastal areas *(2, 31)*.

Rainfall in Puerto Rico's mountainous interior varies from 2500 to over 4000 mm/yr *(6)*. January, February, and March are slightly drier than other months, but there is no lack of moisture in any month. Mean annual temperatures range from 20 °C at the highest elevations to 23 °C at the lowest. Temperature differences between the warmest and coolest months are slight *(6)*. No frost occurs within the natural range of caimitillo.

Annual rainfall and temperature of montane forests elsewhere in the Caribbean Islands parallel those of Puerto Rico. In his summary of natural vegetation in the Caribbean Islands, Beard *(2)* characterizes the climate found in montane forests as follows: rainfall in excess of 2550 mm/yr; sufficient rains during the relatively dry months to maintain an excess of supply over evaporation so that drought does not occur; typically cloudy and overcast skies with little sunshine; temperatures averaging 22 °C, with monthly means between 19 and 24 °C; and relative humidities frequently close to saturation, declining to 70 percent during sunny periods.

In Puerto Rico, caimitillo grows in four life zones *(10, 12)*: the subtropical wet and subtropical rain forests and the

Figure 1. — Micropholis chrysophylloides *Pierre (caimitillo) at a 750-m elevation in Puerto Rico's Luquillo Mountains.*

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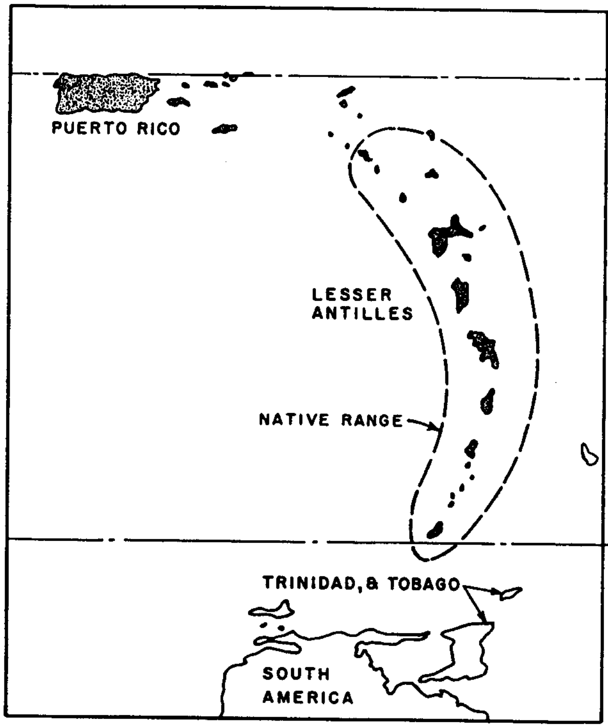

Figure 2. — *Native range of* Micropholis chrysophylloides *Pierre (caimitillo) in the Caribbean Islands: Puerto Rico and Lesser Antilles (from Nevis to Grenada).*

lower montane wet and lower montane rain forests. A sampling of 350 caimitillo trees greater than 4 cm in diameter at breast height (d.b.h.) on 75 plots in the lower montane life zones of the Luquillo Mountains showed that 95 percent of the trees were situated in wet forest located to the leeward of the mountains and only 5 percent in rain forest located to the windward *(30)*. This distribution pattern indicates caimitillo's preference for the drier of the two montane life zones found in the Luquillo Mountains.

Soils and Topography

The soils at higher elevations in the Luquillo Mountains are mainly leached, acidic clays and silty clay loams classified principally as Ultisols and Inceptisols. They contain large amounts of organic matter and remain saturated most of the year *(22,25)*.

The mean amount of soil organic matter in the top 50 cm of the aforementioned 75 plots in the lower montane life zones were 9.6 percent, or 33.8 kg/m^2 *(30)*. Mean organic matter contents were greater in the rain forest (37.7 kg/m^2) than in the wet forest (30.0 kg/m^2).

Stratification of the same 75 plots into three groups of 25 according to topography (that is, 25 plots apiece on ridges, slopes, and ravines) showed that 56 percent of the caimitillo grew on ridges, 35 percent on slopes, and only 9 percent in valleys *(30)*. Caimitillo, therefore, appears to favor the better drained sites within the same life zone.

In an earlier sampling of ridge topography between 600 and 800 m in the Luquillo Forest, caimitillo averaged from 7 to 10 percent of the stand basal area *(35)*. In a riparian palm forest on valley topography at a 750-m elevation, caimitillo comprised 13 percent of the stems but only 0.02 percent of the basal area for all trees greater than or equal to 1 cm in d.b.h. *(11)*. Given caimitillo's preference for better drained sites, few of these smaller trees would be likely to survive to maturity.

Associated Forest Cover

Caimitillo has numerous tree associates in the species-rich montane forests of the Caribbean (table 1). The most important forest types containing caimitillo are the lower montane rain forest and the montane rain forest, or montane thicket, according to Beard's *(2)* classification system.

In the Luquillo Mountains, 4-ha inventories of all stems greater than or equal to 10 cm in d.b.h. were tallied in both the lower montane rain forest (locally known as the tabonuco forest) and the montane rain forest (locally known as the colorado forest). The lower tabonuco forest sample contained 3,140 trees and 65 species, of which caimitillo comprised 0.8 percent *(22)*. In contrast, the higher elevation colorado rain forest sample contained 3,376 trees and 57 species, 8.8 percent of which were caimitillo.

Other studies of species composition within the Luquillo Mountains also indicate caimitillo's relative abundance. For six plots totaling 2.1 ha in the tabonuco forest, the 98 sampled caimitillo trees ranked eighth in stem density and third in both basal area and volume *(5)*. For 75 plots totaling 3.75 ha in the colorado forest, the 350 caimitillo trees tallied represented about 8 percent of the stems and nearly 7 percent of the basal area *(31)*. Caimitillo was concentrated at elevations between 600 and 800 m to the leeward of the summits (fig. 3).

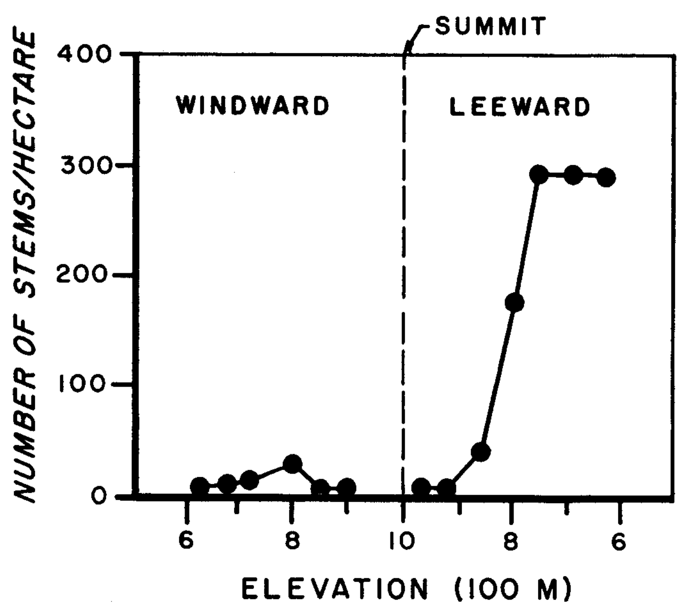

Figure 3. — *Elevational distribution for* Micropholis chrysophylloides *Pierre (caimitillo) in the montane colorado forest of Puerto Rico's Luquillo Mountains for all stems greater than 4 cm. The gradients are from 600 to 900 m to the windward and from 970 to 600 m to the leeward.*

Table 1.—*Associated forest cover or major tree species found with* Micropholis chrysophylloides

Forest cover or major associated species*	Location	Source†
Micropholis garciniaefolia, Dacryodes excelsa	Upper leeward slopes of Luquillo Mountains, Puerto Rico	*9*
Prestoea montana, Cecropia peltata, Cyathea arborea	Upper montane and palm forests in Toro Negro, Cordillera Central, Puerto Rico	*3*
Coffee shade forests more than 30 years after abandonment	Central mountain areas, Puerto Rico	*32*
Prestoea montana, Croton poecilanthus, Micropholis garciniaefolia	Floodplain forests at 750 m elevation in the Luquillo Mountains, Puerto Rico	*11*
Magnolia portoricensis, Calycogonium squamulosum, Clusia krugiana	Upper montane forests in Luquillo Mountains and Cordillera Central, Puerto Rico	*21*
Cyrilla racemiflora, Calycogonium squamulosum, Micropholis garciniaefolia	Upper montane forests in Luquillo Mountains, Puerto Rico	*22*
Dacryodes excelsa, Euterpe globosa Sloanea truncata	Rain forests between 425 and 550 m in elevation, Nevis	*2*
Sloanea spp., Lauraceae (three species), *Simarouba amara*	Secondary rain forests between 480 and 550 m in elevation, Montserrat	*2*
Dacryodes excelsa, Sloanea caribaea, S. truncata, Tapura antillana	*Sloanea* association in rain forests between 275 and 425 m in elevation, Dominica	*2*
Amanoa caribaea, Licania ternatenis Dacryodes excelsa	*Licania—Oxythece* association between 275 and 425 m in elevation, Dominica	*2*
Dacryodes excelsa, Sloanea caribaea, Sterculia caribaea	*Dacryodes—Sloanea* rain forests as midcanopy species, St. Lucia	*2*
Euterpe globosa, Licania ternatensis, Oxythece pallida	*Licania—Oxythece* lower montane rain forests, St. Lucia	*2*
Euterpe globosa, Tovomita plumeriera, Licania aligantha	Montane thicket at 650 m. St. Lucia	*2*
Euterpe sp., *Dacryodes excelsa,* Lauraceae spp.	*Dacryodes—Sloanea* rain forests between 300 and 500 m in elevation, St. Vincent	*2*
Euterpe globosa, Euterpe sp., *Freziera hirsuta*	Palm brake above 500 m in elevation, St. Vincent	*2*
Dacryodes excelsa, Licania ternatensis, Euterpe sp.; *Sloanea caribaea*	Subtropical and lower montane rain forests *(Dacryodes—Licania* forest together) at 425 m in elevation, Grenada	*2*
Guatteria caribaea, Maytenus granadensis		
Myrtaceae spp., *Licania ternatensis, Euterpe globosa*	Montane thickets, Grenada	*2*
Podocarpus cariaceus, Oxythece pallida, Ilex spp.	Montane thickets, Martinique	*2*

*Only a few associated species have been listed for each type of forest; most species lists from cited references are extensive.
†Reference to literature cited section.

A 1980 inventory of secondary forests in Puerto Rico's mountainous interior indicated that caimitillo was a relatively uncommon component of secondary stands, where it comprises only 0.3 percent of the stems, 0.6 percent of the basal area, and 0.9 percent of the sawtimber volume *(4)*. A separate inventory of *Eucalyptus robusta* J.E. Smith plantations in the Toro Negro Forest at high elevations in the Cordillera Central revealed that caimitillo constituted 3.6 percent of the trees, 3.8 percent of the basal area, and 2.8 percent of the volume.

LIFE HISTORY

Reproduction and Early Growth

Flowering and Fruiting.—Caimitillo's inconspicuous flowers are bronze and greenish, cup-shaped, about 0.6 cm long, and broad *(16)*. They have five bronze, hairy sepals that are 0.2 cm long and a yellowish-green corolla with five rounded lobes about 0.6 cm wide. Five small stamens are located on the corolla tube, and the pistil has a hairy five-celled ovary. The flowers are borne laterally and are attached to twigs by bronze, hairy stalks about 0.6 cm long. The fruits are fleshy, and each fruit contains one large, elliptic, brown seed. Flowering and fruiting occur throughout the year.

Seed Production and Dissemination.—The seeds, comparatively large for canopy tree species in the colorado forest *(30)*, are disseminated by gravity or animals such as bats and rodents. A 2.2-kg sample of fruits collected in Puerto Rico was used to determine the weight of fruits and seeds. Fruits averaged 875 per kilogram, whereas seeds averaged 2,370 per kilogram. The moisture content of a 98-g sample of seeds was 38 percent. Seed viability was tested by placement in water: those that floated were not viable; 93 percent of those that sank were viable *(18)*.

Seedling Development.—The natural regeneration of 20 tree species that reach the canopy in the colorado forest of the Luquillo Mountains was sampled on the 75 subplots totaling 0.15 ha. Caimitillo seedlings were found on one-third of the subplots and averaged 3,720 per hectare, or 8 percent of the total number of seedlings in the entire sample *(30)*.

In December of 1944, 400 wildlings averaging 0.6 m tall were planted under shade in Puerto Rico's Toto Negro Forest.[1] Half were planted with a ball of earth, and the remainder were bare-root planted. Survival was poor with both planting techniques.

Vegetative Reproduction.—Root sprouts were not observed during field observations of caimitillo. Epicormic branching, however, was common on tree trunks exposed to direct sunlight less than 2 years after Hurricane Hugo damaged much of Puerto Rico's colorado forest.

[1]Weaver, Peter T. [n.d.] Unpublished notes on file with: International Institute of Tropical Forestry, U.S. Department of Agriculture, Forest Service, Río Piedras, PR 00928-2500. [Number of pages unknown]

Sapling and Pole Stage to Maturity

Growth and Yield.—Caimitillo growth data are available for a few permanent plots established in Puerto Rican forests (table 2). The mean d.b.h. growth rate for 327 trees that survived a 35-year period in the Luquillo Forest was 0.12 cm/yr. Growth rates ranged between 0.05 and 0.29 cm/yr according to crown class (table 2). The most rapid growth rates were attained by trees exposed to light. Similar growth rates were reported for other forests on Puerto Rico *(26)*.

Given the numerous observations of growth rates in natural forests, a simple arithmetic technique may be used to approximate tree age by stem diameter. First, mean d.b.h. growth rates are calculated by diameter class (fig. 4). Each diameter class is then divided by its mean growth rate to determine the number of years needed for the average tree to grow through each class. Finally, the years are summed from the smallest through the largest diameter class to yield an estimate of age for the average tree.

Use of this technique showed that it would take a caimitillo with a 4-cm d.b.h. about 65 years to reach 10 cm in d.b.h., 125 years to reach 20 cm, 190 years to reach 30 cm, 285 years to reach 40 cm, and about 380 years to reach 50 cm. Mean d.b.h. growth rates are most rapid for tree diameters between 15 and 30 cm, with slower growth rates characterizing smaller trees and those approaching senescence (fig. 4). The unknowns in this technique (for example, the amount of time spent between germination and the minimum d.b.h. class of 4 cm, as well as the probability that only the fastest growing individuals will survive in any class) make the age estimates tenuous at best. Actual age for most surviving mature trees may be considerably less.

A survey of crown diameter (CD) to bole diameter (BD) ratios in Puerto Rico's Maricao Forest showed a highly significant decline from 29.3 for caimitillo trees averaging about 10 cm in diameter to 20.5 for trees averaging 30 cm in diameter *(34)*:

$$CD = 1.32 + 16.1\,BD \quad (n = 14,\ r^2 = 0.885)$$

where both CD and BD are in meters.

When BD = 10 cm = 0.1 m

then

$$CD = 1.32 + 16.1(0.1) = 2.93$$

and

$$CD/BD = 2.93/0.1 = 29.3$$

When BD = 30 cm = 0.3 m

then

$$CD = 1.32 + 16.1(0.3) = 6.15$$

and

$$CD/BD = 6.15/0.3 = 20.5$$

Diameter growth for trees was positively correlated with several tree parameters in the Maricao Forest, including crown diameter, crown area, bole diameter, tree height, and crown depth *(34)*.

Table 2.—*Growth information for* Micropholis chrysophylloides *from reported sources in Puerto Rico*

Locality	Elevation	Rainfall	Duration	Mean d.b.h. growth	Comments	Source*
	Meters	*mm/yr*	*Years*	*cm/yr*		
Luquillo Mountains	700	3500–4000	5	0.15	Short-term study of 144 trees in a colorado forest	*20, 23*
Luquillo Mountains	650	~3500	33	0.11	Trees in a thinned tabonuco stand	*28*
				0.13	Trees in an undisturbed tabonuco forest	
					Long-term study in a colorado forest	
Luquillo Mountains	650–850	3500–4000	35	0.20	For 33 dominant trees	*29*
				0.18	For 56 codominant trees	
				0.12	For 130 intermediate trees	
				0.05	For 108 suppressed trees	
				0.11	For 327 trees combined	
Luquillo Mountains	670	3500	30	0.10	For seven trees in a thinned colorado forest	*28*
Maricao Forest	670	2590	24	0.11	Long-term study of 17 trees ranging from 5 to 25 cm in d.b.h.	*26*
Toro Negro Forest	930	2560	25	0.14	Long-term study of 76 trees ranging from 5 to 23 cm in d.b.h.	*26*
Carite Forest	725	2500	28	0.29	Long-term study of 27 trees ranging from 4 to 39 cm in d.b.h. in a previously thinned colorado stand.	*27*

*Reference to literature cited section.

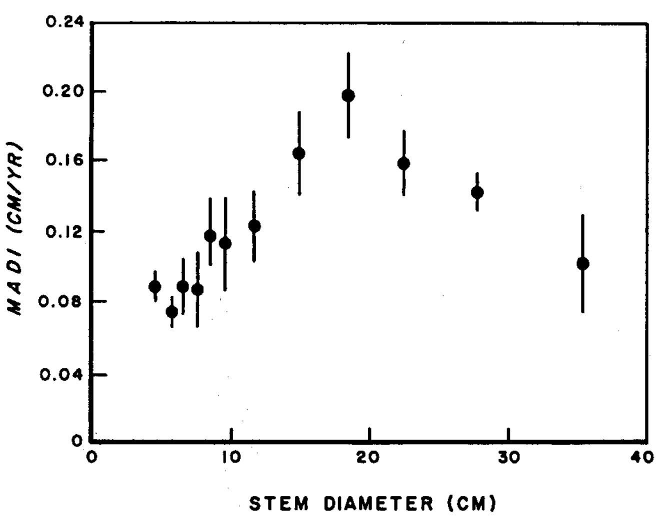

Figure 4. — *Mean annual diameter increment (MADI) by diameter class for* Micropholis chrysophylloides *(Pierre (caimitillo) in the montane (colorado) forests of Puerto Rico's Luquillo Mountains. Lines above and below points represent standard errors.*

Rooting Habit.—Several uprooted caimitillo seedlings between 20 and 30 cm in height had strong taproots. The tree does not form buttresses.

Reaction to Competition.—Caimitillo was tentatively classified as a shade-tolerant climax species requiring gaps to mature *(30)*. This designation was derived by comparing the relative densities of seedlings and understory stems, seed size, and wood density *(19)* with 19 other tree species that reach canopy size in some parts of the colorado forest. Other available information supports this classification. Measurements of forest recovery from 1946 to 1981 on seven plots totaling 2.8 ha within the Luquillo Mountains revealed that caimitillo increased in dominance after the 1932 hurricane, San Cipriano *(31)*. Caimitillo demonstrated a reversed J-shaped distribution of diameter classes in 1946 and in 1981 (fig. 5). Moreover, the proportion of caimitillo stems and basal area on the plots increased from 7.2 to 8.9 percent in 1946 and from 4.9 to 8.3 percent in 1981. Although the number of caimitillo trees tallied in 1946 declined by about 20 percent, ingrowth raised the number of stems recorded in 1981 by 25 percent over the 1946 population (fig. 6). Basal area of the 1981 residual caimitillo trees had increased by nearly 30 percent of the 1946 basal area, and when ingrowth was added, the 1981 basal area was 50 percent greater than that recorded in 1946 (fig. 6).

Thinning data for caimitillo are not easily interpreted because treatments were implemented without controls in similar stands. Thinned stands were successional in nature and contained smaller, mostly younger stems than the undisturbed stands for which comparative d.b.h. growth data are available. Basal areas in undisturbed tabonuco and colorado forests average about 40 m^2/ha *(28)*. Caimitillo in secondary tabonuco forests with average basal areas between 20 and 25 m^2/ha (a little more than half of that found in undisturbed tabonuco forest) grew in d.b.h. about 15 percent more rapidly than in undisturbed forests (0.13 vs. 0.11 cm/yr) during a 33-year period (table 2). Thinnings in Carite's colorado forest, characterized by smaller and younger stems and a basal area of only 11 m²/ha, were more dramatic. Diameter increment averaged 0.29 cm/yr over a 28-year period, compared to rates between 0.11 and 0.14 cm/yr for all stems in undisturbed stands in the Luquillo, Maricao, and Toro Negro Forests (table 2) *(26, 28)*.

The notable differences in d.b.h. growth rates among crown classes and the favorable long-term growth effects due to thinning indicate that caimitillo is capable of responding to better light conditions, particularly in secondary stands (table 2). A recurrent thinning regime, possibly on a 10-year cycle and maintaining stand basal areas between 15 and 20 m²/ha, is suggested for timber production.

Caimitillo trees have also been included in ecological studies in the Luquillo Mountains. Thirty caimitillo leaves sampled in the colorado forest yielded the following structural estimates: mean dry weight, 0.46 ± 0.02 g; mean leaf area, 27.2 ± 0.9 cm²; and mean specific leaf area, 59.1 cm²/g *(33)*. Moreover, three trees with diameters of 10.0, 12.5, and 36.7 cm were harvested in the colorado forest to determine plant biomass. The respective total dry weights for the trees sampled were: leafy biomass, 3.5, 12.4, and 43.9 kg and total aboveground woody biomass, 50.7, 79.3, and 882.9 kg *(30)*. In addition, one study of a floodplain forest dominated by a palm, *Prestoea montana* (R. Grah.) Nichols, revealed phosphorus concentrations of 0.431, 0.485, and 0.040 mg/g for caimitillo leaves, branches, and trunks, respectively *(11)*. These values tended to be among the lowest recorded for the 23 tree species sampled from this floodplain forest.

Damaging Agents.—The heartwood of caimitillo is moderately resistant to white-rot fungi and very resistant to brown-rot fungi *(7)*. Field tests have shown, however, that the wood has little resistance to marine borers *(17)*. Caimitillo is also rated as susceptible to attack by the West Indian dry-wood termite, *Cryptotermis brevis* Walker *(36)*.

During the inventory of Puerto Rico's secondary forests, slightly more than half of caimitillo's basal area was classed as damaged, with the greatest amount occurring in the poletimber class *(1)*. Form damage (crook or sweep) was the most prevalent damage type noted in all size classes, with diseases accounting for slightly more than 20 percent of the sawtimber damage.

Caimitillo fenceposts were found receptive to preservative treatments in Puerto Rico. In field trials, cold soaking of posts for 5 days in 5-percent pentacholorophenol dissolved in diesel fuel yielded an average service life of 13.7 years in the Cambalache Forest *(8)*. Hot-and-cold bath treatments with the same components at Cambalache extended the average service life to 15.3 years. The same cold soaking treatment using 10-percent pentacholorophenol dissolved in diesel fuel showed an estimated service life of 30.8 years in the Toro Negro Forest. Treatments using double diffusion salts at Cambalache gave average service lives of between 10.3 and 13.0 years *(8)*.

Observations of standing herbivory of leaves on 237 live caimitillo trees revealed that 2.7 percent of the leaf surfaces had been consumed by insects *(33)*. A 90-day study of the herbivory rate for 39 caimitillo leaves showed that an estimated 0.4 percent would be consumed annually *(33)*. Numerous seeds collected during experimental work in the 1940's were noted as being infested with an unidentified insect larva.

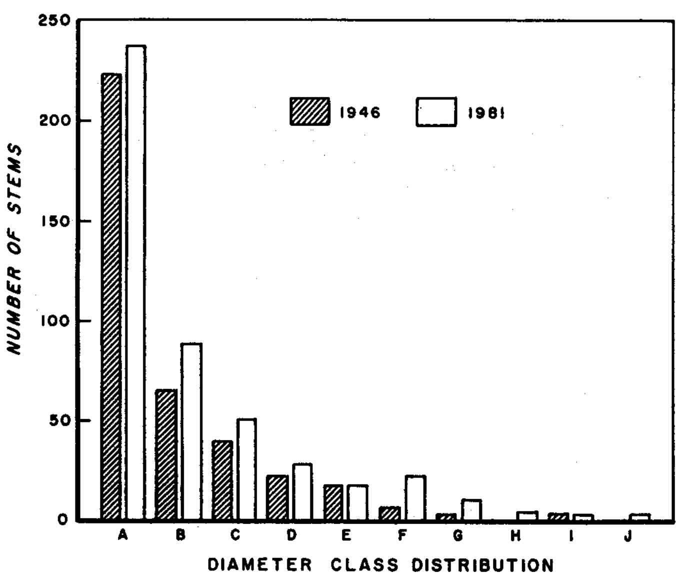

Figure 5. — *Diameter class distribution in 1946 and 1981 for* Micropholis chrysophylloides *Pierre (caimitillo) on 3.75 ha of montane (colorado) forest between elevations of 600 and 970 m in Puerto Rico's Luquillo Mountains. Class A, 4.1 to 9.9 cm; class B, 10.0 to 14.9 cm; classes C through I, in 5-cm increments; and class J, 50.0 to 54.9 cm.*

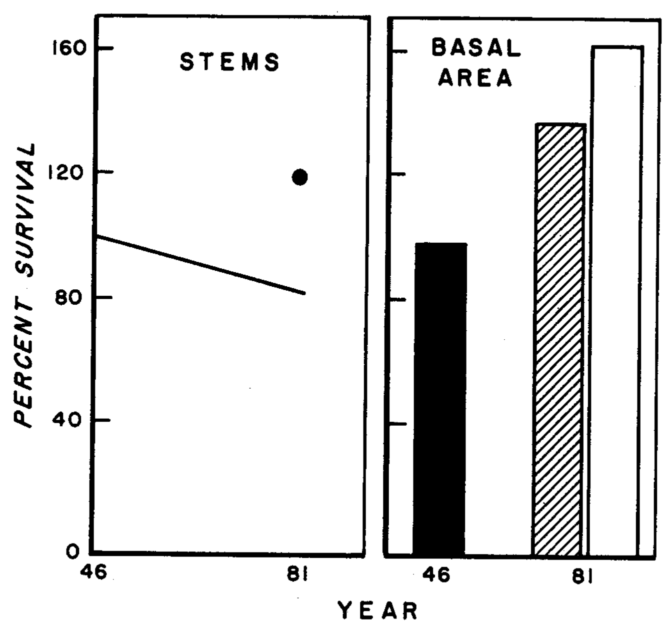

Figure 6. — *Survival and increase in stems and basal area of* Micropholis chrysophylloides *Pierre (caimitillo) in the montane (colorado) forest from 1946 to 1981. The line indicates the percent survival of the original tree. The dot is the 1981 population of trees (survivors of the 1946 stand plus ingrowth). The bars indicate the percent survival of basal area—black bar—1946 basal area, white bar—1981 basal area of stems surviving from 1946; and obliquely lined bar—1981 total basal area or growth of basal area surviving 1946 trees plus basal area ingrowth on new stems.*

SPECIAL USES

Caimitillo's heartwood is a uniform light yellowish brown without pronounced figure and is not readily distinguished from the lighter colored sapwood *(17)*. The wood is hard, strong, and tough and has a uniformly fine texture, straight grain, and medium luster. Caimitillo air-dries rapidly with only minor degrade in the form of a light bow. No surface or end checking, casehardening, or other defects occur during drying.

The specific gravity of caimitillo is 0.68 g/cm^3. Shrinkage is moderate and uniform. The silica content of the wood *(14)* causes a rapid dulling of saws and woodworking machinery. Planing, turning, and mortising are good; shaping and boring are excellent; and sanding and resistance to screw splitting are fair *(16)*. The wood takes a high polish.

The wood is suitable for furniture, cabinetwork, interior trim, flooring, boat paddles, farm implements, tool handles, veneer, plywood general carpentry, and construction *(7, 16)*.

GENETICS

No genetic information for caimitillo was found in the literature. Botanical synonyms for the species include *M. curvata* (Pierre) Urban, *M. portoricensis* Pierre var. *curvata* Pierre, and *Pouteria cyrosophylliodes* (Pierre) Stehlé.

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