Ormosia krugii Urban — Palo de matos

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Leguminosae — Legume family
Lotoideae — Pea subfamily

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Ormosia krugii Urban, called palo de matos in Puerto Rico, peronia in the Dominican Republic, bois nan-non in Haiti, angelin batard in Martinique and Guadeloupe, and malcaconier in Dominica, is a medium-sized evergreen tree that reaches 20 m or more in height and 60 to 90 cm in d.b.h. at maturity (fig. 1). The large, pinnately compound leaves, bearing leaflets with prominent lateral veins, serve as useful characteristics for field identification.

Figure 1.– *Palo de matos (*Ormosia krugii *Urban) shown growing in the Luquillo Mountains of Puerto Rico.*

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HABITAT

Native Range

Palo de matos is endemic to the Caribbean Islands (fig. 2). It grows naturally in Hispaniola (*1, 26*), Puerto Rico (*21*), Guadeloupe (*18*), Martinique (*20*), and Dominica (*2*). It is notably absent from the smaller islands of the Lesser Antilles situated between Puerto Rico and Dominica.

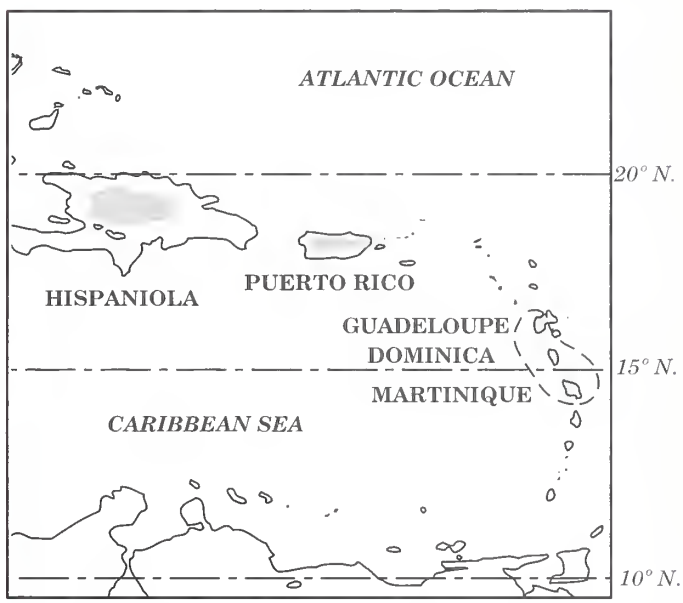

Figure 2.– *Shaded areas and dashed line represent the native range of palo de matos (*Ormosia krugii *Urban) in the Caribbean: Hispaniola, Puerto Rico, Guadeloupe, Dominica, and Martinique.*

Climate

In Puerto Rico, palo de matos grows in the following life zones sensu Holdridge (*19*): the subtropical moist forest, the subtropical wet forest, the subtropical rain forest, and the subtropical lower montane wet forest (*17*). Rainfall in these forest types ranges from 1500 to 4000 mm/yr with mean annual temperatures fluctuating between 20 and 24 °C (*6*). Rainfall throughout the range of palo de matos is similar to that of Puerto Rico. Frosts do not occur within its range.

Soils and Topography

In the best sample of Dominica's lower montane rain forest in the Layou Valley, palo de matos grows in "yellow earth" soils on well-sheltered, gently undulating terrain (*2*). In the Luquillo Experimental Forest (LEF) of northeastern Puerto

Rico, palo de matos grows mainly on acid clay soils classified as Ultisols and Inceptisols. Although the species grows on all topographic positions, it is most common on slopes and ridges (*11*).

Associated Forest Cover

In Puerto Rico, palo de matos grows in humid to wet montane forests. A 4-ha sample of 3,140 trees measured in the LEF during 1946 contained 127 palo de matos stems greater than 4 cm in d.b.h., or 4.0 percent of the total (*5*). Among the 30 most common species recorded, palo de matos ranked 12th in stem density and 4th in both basal area and volume. For trees larger than 25 cm in d.b.h., however, palo de matos was less common (*28, 36*).

An inventory of areas with commercial forestry potential in Puerto Rico, now covered mainly by secondary forests, showed that palo de matos comprised less than 1.0 percent in each of three categories: sampled trees, total basal area, and total volume (*4*). A separate inventory in the Toro Negro Forest showed that palo de matos, with 0.3 percent of all trees, contained 1.2 percent of the basal area and 2.1 percent of the volume (*3*).

The major tree associates for palo de matos in Puerto Rico and Dominica are given in table 1. Palo de matos grows in association with species found in primary and secondary forests.

LIFE HISTORY

Reproduction and Early Growth

Flowering and Fruiting.— Palo de matos flowers have a short stalk and are borne on panicles measuring from 15 to 30 cm in length (*21*). The brown, hairy, bell-shaped calyx, about 1.0 cm long, contains unequally pointed teeth. The petals are dark violet and each is about 1.6 cm long. They have a broad, rounded standard that is spotted with white or yellow, two wings, and two keel petals. The pistil, about 1.6 cm long, has a flattened, brown, hairy one-celled ovary and a slender, curved style. There are 10 separate and unequal stamens. Palo de matos flowers from September through December in the LEF (*16, 21*).

Fruits are borne during many months (*16*), particularly from May to November (*21*). The brown pods are 1.6 to 2.0 cm wide, slightly keeled, and long and pointed at the ends; they include the calyx at the base (*21*).

Seed Production and Dissemination.— Each palo de matos pod contains from one to five seeds that are rounded but slightly flattened. The seeds, red with one or more black spots, fall below the parent tree and are useful for species identification.

In the late 1940's, several studies were initiated in Puerto Rico with palo de matos seeds (*23*). Seeds averaged 1,365 per kilogram, with 24-percent moisture content. Recent work confirmed earlier results: the mean weight for 180 air-dried seeds sampled was 0.72 ± 0.01 g per seed, or 1,390 seeds per kilogram.

Seedling Development.— Seed germination is hypogeal (*13, 14*). The first pair of leaves produced by palo de matos is simple and opposite; alternate, compound leaves develop later. Both seedling leaves (*13*) and mature leaves (*32*) are illustrated in dichotomous keys used for the identification of tabonuco forest plants.

Palo de matos has a hard seedcoat, which delays germination. In Puerto Rico's earliest tests, a sample of 200 palo de matos seeds yielded 11-percent germination after an average lapse of 60 days (*23*). During the late 1960's, five additional comparative germination tests were conducted (*14*).

Table 1.— *Major tree species growing with palo de matos* (Ormosia krugii *Urban*)

Country	Location	Elevation	Rainfall	Principal associated species	Source
		- Meters -	*mm/yr*		
Dominica	Upper Layou Valley	275-425	~4000	*Dacryodes excelsa* *Sloanea truncata* *Sterculia caribaea* *Tapura antillana*	*(2)*
Puerto Rico	Cutover tabonuco	450	~3300	*Guettarda valenzuelana* *Miconia tetrandra* *Tabebuia heterophylla*	*(39)*
	Tabonuco slope	570	~3000	*D. excelsa* *M. prasina* *Prestoea montana*	*(39)*
	Rio Grande	420-600	3300	*Cecropia peltata* *D. excelsa* *Sloanea berteriana*	*(11, 12)*
	Sabana 8	180-360	2300	*Alchornea latifolia* *Didymopanax morototoni* *T. heterophylla*	*(11, 12)*

Chlorox-sterilized[1] seeds treated with *Rhizobium* bacteria and planted in sterile moss gave the best results, with a 36-percent rate of seedling production after 1 month. Investigators concluded that biochemical digestion of the hard seedcoats by *Rhizobium* greatly aided water uptake and sprouting. Another test conducted with untreated seeds in 1992 showed that the first seed germinated within 20 days, and 30 percent of the seeds germinated within 60 days.[2]

Direct seeding of palo de matos was tested near St. Just, Puerto Rico, using 4 seeds per spot in a total of 60 spots.[3] Germination and early growth, first observed after 6 months, occurred in 22 percent of the 60 spots. All seedlings were less than 8 cm high. The results were considered poor, and direct seeding of palo de matos was not recommended as a method for planting.

In another study, 50 seedlings of palo de matos were planted at St. Just.[4] After 3.5 years, the saplings averaged about 2 m in height. After 7 years, they were about 6 m high and 5 to 8 cm in d.b.h. After 10 years, the trees averaged 9 m in height and 8 cm in d.b.h. The results demonstrate that at St. Just, at least through the first 10 years, palo de matos did not appear to be a fast-growing species. In comparison, a recent study of seedlings in a Río Piedras nursery gave slightly better results. Numerous seedlings averaged 10 to 15 cm in height within 50 days.[2] After 4 months, however, none of the seedlings exceeded 18 cm.

Palo de matos seedlings have been the subject of several ecological studies. In one experiment, a comparison was made between normal seedlings and those with excised drip tips after saturating both with water. Seedlings with normal drip tips lost less calcium, magnesium, and zinc in leaching experiments than those with excised drip tips (*13*). In another study, the photosynthetic rate of 30 seedlings was found to be midway between that of *Sloanea berteriana* Choisy, a tree species considered to be primary, and *Cecropia peltata* L., a rapid-growing, early secondary species (*13*).

Photosynthesis experiments showed that palo de matos seedlings placed in low light intensities did not grow past the 2-leaf stage in more than 8 months, whereas those placed in higher light intensities grew as many as 12 leaves (*13*). These results suggest that the seedlings may benefit from previously disturbed, or "successional" habitats, but that they are also capable of surviving in deep shade for long periods.

Vegetative Reproduction.— Palo de matos sprouts vigorously in secondary forests (*21*). Vigorous sprouting was also observed for trees that were either snapped or uprooted during Hurricane Hugo (*38*).

Sapling and Pole Stage to Maturity

Growth and Yield.— Data on tree growth are available from several permanent plots in the tabonuco forest of the LEF. Measurements spanning 5 years on 47 dominant and codominant trees showed an average d.b.h. increment of 0.68 cm/yr (table 2). Measurements spanning 18 to 30 years showed that the mean annual d.b.h. growth for all trees sampled was concentrated between 0.37 and 0.51 cm/yr (table 2). These data were collected during a period when the tabonuco forest was recovering from Hurricane San Cipriano (*10*). Both the short- and long-term growth rates for palo de matos are more rapid than for most other tree species in the tabonuco forest (*39*).

Rooting Habit.— The root tips of mature palo de matos

Table 2.— *Comparative growth data for palo de matos (*Ormosia krugii *Urban) in Puerto Rico*

Plots	Elevation	Trees sampled	Duration	D.b.h. growth	Source
	- Meters -	*No.*	*Years*	*cm/yr*	
Cutover tabonuco	450	6	30	0.10 *	(*39*)
Rio Grande	420-600	18	18	0.38 †	(*12*)
Sabana 8	180-360	59	18	0.51 †	(*12*)
Tabonuco slope	570	21	30	0.37 *	(*39*)
Several	300-600	47	5	0.68 ‡	(*35*)

* All trees greater than 4 cm in d.b.h.

† Trees greater than 10 cm in d.b.h.

‡ Codominant and intermediate trees combined from several plots in size classes greater than 4 cm in d.b.h.

[1]The use of trade or firm names in this publiction is for reader information and does not imply endorsement by the U. S. Department of Agriculture of any product or service.

[2]Parrotta, John. Research Forester, International Institute of Tropical Forestry, P.O. Box 25000, Río Piedras, PR 00928-2500.

[3]IITF management file 784, June 15, 1945; information available from the International Institute of Tropical Forestry, P.O. Box 25000, Río Piedras, PR 00928-2500.

[4]IITF management file 1293, August 15, 1944; address as in footnote 3.

trees in the LEF exhibit both well-defined ectotrophic mycorrhizae and bacterial nodules (*14, 15*). Given that palo de matos is a legume, it is suspected that the bacteria fix nitrogen.

Reaction to Competition.– Palo de matos has been described as common in secondary forests (*21*). Results from autecological studies have indicated, however, that palo de matos has several of the attributes of a primary species (*14, 33*). The tentative classification as primary was derived by comparing the survival of palo de matos seedlings and understory trees in a closed forest, its seed size, and the specific gravity of its wood with the same characteristics of other species that reach the canopy in a tabonuco forest. The composite score for palo de matos, based on the mean of its scores for all factors, ranked it as the 7th most primary of the 29 species tested. The scale ranged from 1 (most primary) to 29 (most secondary) for the 29 species studied (*33*).

The size-class distribution of palo de matos trees in Puerto Rico's tabonuco forest followed a reverse J-shaped curve: 73 trees between 4 and 10 cm in d.b.h., 38 between 10 and 20 cm, 13 between 20 and 30 cm, and 1 tree each in the 30- to 40-, 40- to 50-, and greater than 50-cm d.b.h. classes (*5*). Another independent survey of trees and saplings in the same forest near the El Verde Field Station confirmed the results of the above study (*14*). Reversed J-shaped distribution patterns are associated with primary tree species.

Data from two permanent plots in the tabonuco forest may provide insights into palo de matos' reaction to competition. In 1946, 14 years after the passage of Hurricane San Cipriano, palo de matos accounted for 1.8 percent of the stems and 3.6 percent of the basal area in both stands combined (*29*). By 1976, the palo de matos' proportion of stems and basal area had changed to 1.7 and 4.3 percent, respectively. About 75 percent of the stems originally tallied in 1946 survived to 1976. Moreover, ingrowth into the smallest d.b.h. class averaged six stems per hectare. This indicates a capacity not only to persist, but also reproduce, in a forest recovering from past hurricane disturbance.

Ecological studies have also been conducted with palo de matos trees. A comparison of leaf stomata showed that palo de matos contained a low number of stomata compared to other species in the tabonuco forest (*9*). Pore size, however, was at the median for the species sampled. The biomass and chemical content of palo de matos fruits, leaves, branches, wood, and bark have been reported in two separate studies (*29, 31*). Other investigators conducted in situ determinations of root respiration rates (*27*); carbon values in seedling leaves, stems, and roots (*25*); and the effect of gamma radiation from a cesium source on palo de matos seedlings (*14*).

Damaging Agents.– The wood of palo de matos is very susceptible to attack by dry-wood termites (*40*) and is probably susceptible to marine borers (*22*). Moreover, *Megalopyge krugii* cocoons were reported as being abundant on palo de matos tree trunks (*24*). It was presumed that the caterpillars fed on the foliage.

After the passage of Hurricane Hugo in September 1989, field observations of palo de matos at El Verde to the leeward of the storm trajectory in the LEF showed that 50 percent of the trees surveyed had been defoliated (*38*). Moreover, 33 percent of the trees suffered branch damage, 20 percent had snapped trunks, 11 percent had uprooted stems, and 7 percent died (38). After the storm, palo de matos was one of the slowest tree species to refoliate.

During the testing of arboricides, a 5-percent solution of 2,4,5-T[5] mixed with a low volatile ester in diesel oil was applied to girdled trees of several species in the LEF (*34*). Mortality ranged from 61 to 100 percent. All 14 of the palo de matos in the study were killed, indicating that the species is susceptible to arboricide treatment.

SPECIAL USES

Palo de matos, with a specific gravity of 0.50 g/cm,[3] is a medium weight, somewhat coarse-textured wood (*22*). Its yellowish sapwood is not distinct from the salmon-colored heartwood, which contains occasional dark streaks.

The air-drying of palo de matos is slow with a moderate amount of degrade: moderate bow; slight cup and twist; and very slight crook, surface checking, and end splitting (*22*). Its wood works easily in machining operations. Planing, shaping, and sanding are considered good; turning, boring, and mortising, however, are only fair because of a tendency for the wood to crush and tear. Palo de matos has good resistance to screw splitting and probably takes and holds nails well. The species finishes and polishes satisfactorily but requires considerable sanding before varnish is applied.

During the formulation of the earliest management plans for the LEF, palo de matos was selected as a potential timber species (*37*). Historically, however, the wood has been used chiefly for fuel. Given its attractive appearance after finishing, palo de matos should be suitable for furniture, millwork, interior and exterior construction, crates, general carpentry, and possibly utility veneer (*22*).

Preservative treatments using a cold soak in pentachlorophenal[5] mixed with diesel oil for 5 days were used to test the durability of treated palo de matos fenceposts against untreated controls. Solutions in 5- and 10-percent pentachlorophenol increased the average life of fenceposts by 6 and 14 years, respectively (*8*).

GENETICS

Palo de matos is the northern-most species of the genus *Ormosia*, which is widespread in South America, especially in the Amazon Basin (*14*). *Ormosia dasycarpa* Bello, non Jacks is a reported synonym (*18*). Both the nuclear volume of shoot apices (*20*) and DNA in leaves (*7*) have been reported for palo de matos in the LEF.

[5]No longer manufactured or sold in the United States.

LITERATURE CITED

1. Barker, Henry D.; Dardeau, William S. 1930. Flore D'Haiti. Port-Au-Prince, Haiti: La Direction du Service Technique du Departement de L'Agriculture et de L'Enseignement Professionnel. 455 p.

2. Beard, J.S. 1949. The natural vegetation of the Windward and Leeward Islands. Oxford Forestry Memoirs 21. Oxford, England: Clarendon Press. 192 p.
3. Birdsey, Richard A.; Jimenez, Diego. 1985. The forests of Toro Negro. Res. Pap. S0-222. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 29 p.
4. Birdsey, Richard A.; Weaver, Peter L. 1982. The forest resources of Puerto Rico. Resour. Bull. S0-85. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 59 p.
5. Briscoe, C.B.; Wadsworth, F.H. 1970. Stand structure and yield in the tabonuco forest of Puerto Rico. In: Odum, Howard T.; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 79-89. Chapter B-6.
6. Calvesbert, Robert J. 1970. Climate of Puerto Rico and the U.S. Virgin Islands. Climatography of the United States 60-52. Silver Spring, MD: U.S. Department of Commerce, Environmental Science Administration, Environmental Data Service. 29 p.
7. Canoy, Michael J. 1970. Deoxyribonucleic acid in rain forest leaves. In: Odum, Howard T.; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 69-70. Chapter G-6.
8. Chudnoff, M.; Boone, R.S.; Goytia, E. 1969. Preservative treatments and service life of fence posts in Puerto Rico. Res. Pap. 10. Río Piedras, PR: U. S. Department of Agriculture, Forest Service, Institute of Tropical Forestry. 30 p.
9. Cintron, Gilberto. 1970. Variation in size and frequency of stomata with altitude in the Luquillo Mountains. In: Odum, Howard T.; Pigeon, Robert F. eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 133-135. Chapter H-9.
10. Crow, Thomas R. 1980. A rain forest chronicle: a thirty year record of change in structure and composition at El Verde, Puerto Rico. Biotropica. 12: 42-55.
11. Crow, Thomas R.; Grigal, David F. 1979. A numerical analysis of arborescent communities in the rain forest of the Luquillo Mountains, Puerto Rico. Vegetatio. 40(3): 135-146.
12. Crow, Thomas R.; Weaver, Peter L. 1977. Tree growth in a tropical moist forest of Puerto Rico. Res. Pap. ITF-22. Río Piedras, PR: U.S. Department of Agriculture, Forest Service, Institute of Tropical Forestry. 17 p.
13. Duke, James A. 1970. Keys for the identification of seedlings of some prominent woody species in eight forest types in Puerto Rico. In: Odum, Howard T.; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 239-274. Chapter B-15.
14. Edmisten, Joe. 1970a. Some autecological studies of *Ormosia krugii*. In: Odum, Howard T.; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 291-298. Chapter B-17.
15. Edmisten, Joe. 1970b. Survey of mycorrhiza and nodules in the El Verde forest. In: Odum, Howard T.; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 15-20. Chapter F-2.
16. Estrada Pinto, Alejo. 1970. Phenological studies of trees at El Verde. In: Odum, Howard T.; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 237-269. Chapter D-14.
17. Ewel, John J.; Whitmore, Jacob L. 1973. The ecological life zones of Puerto Rico and the U.S. Virgin Islands. Res. Pap. ITF-18. Río Piedras, PR: U.S. Department of Agriculture, Forest Service, Institute of Tropical Forestry. 72 p.
18. Fournet, Jacques. 1978. Flore illustree des phanerogames de Guadeloupe et de Martinique. Paris, France: Institut National de la Recherche Agronomique. 1654 p.
19. Holdridge, L.R. 1967. Life zone ecology. San Jose, Costa Rica: Tropical Science Center. 206 p.
20. Koo, F.K.S.; de Irizarry, Edith R. 1970. Nuclear volume and radiosensitivity of plant species at El Verde. In: Odum, Howard T; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 15-20. Chapter G-1.
21. Little, Elbert L., Jr.; Wadsworth, Frank H. 1964. Common trees of Puerto Rico and the Virgin Islands. Agric. Handb. 249. Washington, DC: U.S. Department of Agriculture. 548 p.
22. Longwood, Franklin R. 1961. Puerto Rican woods: their machining, seasoning and related characteristics. Agric. Handb. 205. Washington, DC: U.S. Department of Agriculture. 98 p.
23. Marrero, Jose. 1949. Tree seed data from Puerto Rico. Caribbean Forester. 10 (1): 11-30.
24. Martorell, Luis F. 1975. Annotated food plant catalog of the insects of Puerto Rico. Río Piedras, PR: Agricultural Experiment Station, University of Puerto Rico. 303 p.
25. Medina, E.; Sternberg, L.; Cuevas, E. 1991. Vertical stratification of delta 13C values in closed natural and plantation forests in the Luquillo Mountains, Puerto Rico. Oecologia. 86(3): 369-372.
26. Moscoso, R.M. 1943. Catalogus florae Domingensis (Catalogo de la flora Dominicana). Parte 1: Spermatophyta. New York: L & S Printing Company, Inc. 732 p.
27. Odum, H.T.; Lugo, A.; Cintron, G.; Jordan, C.F. 1970. Metabolism and evapotranspiration of some rain forest plants and soil. In: Odum, Howard T.; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 103-164. Chapter I-8.
28. Odum, Howard T. 1970. Summary: an emerging view of the ecological system at El Verde. In: Odum, Howard T.; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 191-289. Chapter I-10.
29. Ovington, J.D.; Olson, J.S. 1970. Biomass and chemical content of El Verde lower-montane rain forest plants. In: Odum, Howard T.; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 53-77. Chapter H-2.

30. Poupon, Joesph; Chauvin, Gerard. 1983. Les arbres de la Martinique. Martinique: Office National des Forets. Direction Regionale pour la Martinique. 256 p.
31. Scatena, F.N.; Silver, W.; Siccama, T.; Sanchez, M.J. 1993. Biomass and nutrient content of the Bisley experimental watersheds, Luquillo Experimental Forest, Puerto Rico, before and after Hurricane Hugo, 1989. Biotropica. 25(1):15-27.
32. Smith, Robert Ford. 1970a. Preliminary illustrated leaf key to the woody plants of the Luquillo Mountains. In: Odum, Howard T.; Pigeon, Robert F. eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 275-290. Chapter B-16.
33. Smith, Robert Ford. 1970b. The vegetation structure of a Puerto Rican rain forest before and after short-term gamma radiation. In: Odum, Howard T.; Pigeon, Robert F., eds. A tropical rain forest. Springfield, VA: U.S. Department of Commerce: 103-140. Chapter D-3.
34. Sposta, Joseph W. 1960. Chemical removal of inferior tropical tree species. Tropical Forest Notes. 4. Río Piedras, PR: Tropical Forest Research Center. 2 p.
35. Tropical Forest Experiment Station. 1953. Thirteenth Annual Report. Caribbean Forester. 14(1): 1-33.
36. Wadsworth, Frank H. 1951. Forest management in the Luquillo Mountains. Caribbean Forester. 12(3): 93-114.
37. Wadsworth, Frank H. 1952. Forest management in the Luquillo Mountains. III. Selection of products and silvicultural policies. Caribbean Forester. 13(3): 93-119.
38. Walker, Lawrence R. 1991. Tree damage and recovery from Hurricane Hugo in Luquillo Experimental Forest, Puerto Rico. Biotropica. 23 (4a): 379-385.
39. Weaver, Peter L. 1983. Tree growth and stand changes in the subtropical life zones of the Luquillo Mountains of Puerto Rico. Res. Pap. SO-190. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 24 p.
40. Wolcott, George N. 1957. Inherent natural resistance of woods to the attack of the West Indies dry-wood termite *Cryptotermes brevis* Walker. Journal of Agriculture of the University of Puerto Rico. 41: 259-311.

NOTE

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