Prestoea montana (R. Graham) Nichols. Sierra palm

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Palmaceae Palm family

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Prestoea montana (R. Graham) Nichols., commonly known as sierra palm, mountain palm (English), palma de sierra, manacla, palma boba (Spanish), and palmiste-montagne (French) (*14,16*), is a small- to medium-sized palm (fig. 1) found in the mountains of the Antilles where there is heavy rainfall. This palm can attain high importance values in Caribbean forests (table 1). Sierra palm is a principal species in critical watersheds on several Caribbean islands and is an abundant producer of fruit that is important to a number of wildlife species. It grows at elevations ranging from 60 to 1,000 m (*18*).

Figure 1.—*A sierra palm* (Prestoea montana) *that had been planted as an ornamental in a high rainfall area of Puerto Rico.*

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HABITAT

Native Range

The native range of sierra palm extends from eastern Cuba through Hispaniola, Puerto Rico, and the Lesser Antilles, including Saba, St. Martin, St. Kitts, Nevis, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, Grenada (*14,17*), and Tobago (*16*) (fig. 2). There have been no reports of the species being planted outside its native range.

Climate

Sierra palm grows in four of the Holdridge (*13*) subtropical life zones: moist forest, wet forest, lower montane wet forest, and lower montane rain forest. The palm is also found in the transition from subtropical lower montane to subtropical rain forest life zones (*18*). These life zones have an annual rainfall of between 2000 to 6000 mm. Rainfall in the Caribbean is seasonal, with drier months between January and April and wetter months the rest of the year. Peak rainfall is in May at low elevations and in October at high elevations. Although rain can be highly variable from month to month, on an average, no month receives less than 100 mm (*5*). Where the palm grows at lower elevations in the subtropical moist forest life zone, annual rainfall is more than 2200 mm. At these low elevations, mean monthly temperatures range from 23 to 27 °C. It is more common to find sierra palms above a 350-m elevation where mean annual rainfall exceeds 3000 mm and mean monthly temperatures range from 21 to 23 °C. The mean monthly temperature range is from 19 to 22 °C at a 700-m elevation and from 17 to 19.5 °C at 1,000 m (*5*).

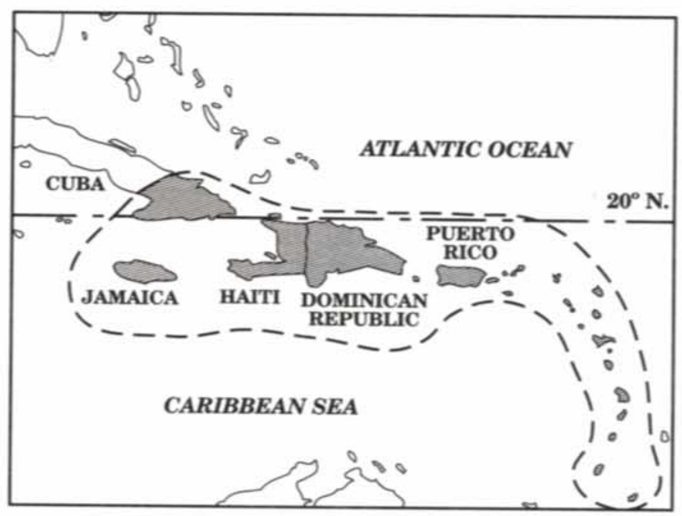

Figure 2.—*Native range of sierra palm* (Prestoea montana) *in the Caribbean indicated by shaded areas.*

Table 1.— *Density, basal area, and dominance of* Prestoea (Euterpe) *palms in eastern Caribbean islands and Puerto Rico; data are mostly from Beard (2); table modified from Lugo and others (18)**

Forest type and location	Forest				Palms			
	Area sampled	Species	Density	Basal area	Density	Basal area	Importance value	Diameter of dominant class
	ha	*Number*	*Stems / ha*	*m²/ha*	*Stems / ha*	*m²/ha*	*Percent*	*cm*
Rain forest formation								
Dacryodes-Sloanea								
Dominica	4.047	60	381	49.5	3	0.1	0.5 †	‡
St. Lucia	4.047	41	299	26.0	89	1.5	18.0 †	‡
St. Vincent	4.047	39	308	34.5	59	3.1	14.0 §	38.8-48.5
Puerto Rico *(28)*	4.047	‡	776	28.2	251	3.4	22.0	‡
Puerto Rico *(25)*	1.570	54	870	‡	99	‡	11.0	‡
Dacryodes-Licania								
Grenada	4.047	23	422	50.8	49	2.3	8.5 ¶	‡
Climax forest								
St. Kitts	0.405	18	578	64.5	183	8.4	23.0	19.4-29.1
Nevis	0.405	19	496	40.6	245	11.4	39.0	19.4-29.1
Nevis	0.405	18	476	31.1	234	10.8	42.0	‡
Ruinate forest								
St. Kitts	0.405	19	790	75.2	430	19.7	41.0	19.4-29.1
Lower montane rain forest formation								
Amanoa-Licania-Oxythece								
Dominica	4.047	56	523	47.0	16	0.6	2.0 †	‡
Licania-Oxythece								
St. Lucia	4.047	37	297	237.3	51	0.9	10.0	‡
Montane thicket formation								
Amanoa								
Dominica	4.047	31	646	29.2	44	1.4	4.0	‡
Richeria-Podocarpus								
Dominica	0.405	25	820	32.6	44	0.8	4.0 †	‡
Mixed species								
St. Lucia	0.405	21	714	20.3	284	4.8	32.0	9.7-19.4
Nevis	0.405	12	526	19.9	296	13.6	63.0	‡
Grenada	0.405	16	462	28.4	49	1.0	7.0 **	‡
Puerto Rico *(28)*	4.047	‡	834	31.6	219	2.9	18.0	‡
Puerto Rico *(9)*	0.253	27	3059	42.4	1206	19.9	37.5	‡
Palm brake								
St. Vincent	0.405	17	620	24.6	444	9.6	56.0 ††	9.7-19.4
Puerto Rico 1946 *(31)*	0.400	33	1772	31.9	1016	20.0	60.0	‡
Puerto Rico 1975 *(31)*	0.400	34	1470	31.8	866	17.0	56.0	‡
Puerto Rico ††	804.000	35	2206 (1484)	34.5 (21.7)	710	20.6	46.0	5-10
Puerto Rico at 400 m *(3)*	0.100	9	400	17.6	250	7.6	53.0	10-20
Puerto Rico at 700 m *(3)*	0.100	8	870	23.8	680	13.9	68.0	10-20
Puerto Rico at 1000 m *(3)*	0.100	8	1700	43.2	1300	39.4	84.0	10-20

* Importance value (dominance) is based on the sum of relative density and relative basal area, minimum tree diameter is 10 cm, and unless indicated otherwise, the species is *P. montana (E. globosa)*; data on the forest and size of dominant palms (when available) are also given for comparison.

† Mostly *E. dominicana.*

‡ Data were not available.

§ Mostly an unidentified *Euterpe.*

¶ Mostly *E. hagleyi.*

** An unidentified *Euterpe* also found.

†† Birdsey and Jimenez (*4*) include all trees >5 cm in d.b.h.; values for trees >10 cm in d.b.h. in parenthesis.

Soils and Topography

Sierra palm is most frequently found on steep slopes, on margins of small streams, and on mountain floodplains with unstable soils. It is also present on gentle terrain, sometimes concentrated in drainage confluences. The optimal elevation for palm forests appears to be about 700 m (*3, 9, 18*). Soils are variable in texture, with or without gravel and boulders, very humid to wet, frequently anoxic, and sometimes waterlogged. Table 2 illustrates the variability of soil chemical and physical properties for six forests dominated by sierra palm in the Luquillo Mountains of Puerto Rico.

Associated Forest Cover

In the Luquillo Mountains of Puerto Rico, sierra palm attains dominance in the palm forests or palm brakes (subtropical lower montane wet forest and subtropical lower montane rain forest and its transition to subtropical rain forest). When sierra palm is reported growing in other forest types such as the colorado (*Cyrilla racemiflora* L.), tabonuco, or cloud forests, the palm is invariably growing along water courses, drainages, or microsites with depressions and/or waterlogged soils.

In a 700-m elevation floodplain, the main associates of sierra palm are (in order of importance) *Micropholis chrysophylloides* Pierre, *Croton poecilanthus* Urban, *Eugenia eggersii* Kiaersk., *Calycogonium squamulosum* Cogn., and *M. garciniaefolia* Pierre (*9*). On steep-slope palm brakes at the same elevation, the main associates of sierra palm, in addition to the species previously listed, are *Cecropia schreberiana* Miq. and *Drypetes glauca* Vahl (*18*). In the colorado forest (subtropical lower montane wet forest), sierra palm is also associated with *Calycogonium squamulosum, Croton poecilanthus, Cyrilla racemiflora, M. chrysophylloides, M. garciniaefolia*, and *Ocotea moschata* (Meisn.) Mez (*29*). This forest type occurs in valleys and gradual slopes above a 600-m elevation. In tabonuco forests (subtropical wet forest), sierra palm is associated with *Cecropia schreberiana*, tabonuco (*Dacryodes excelsa* Vahl), *Inga laurina* (Sw.) Willd., *Miconia tetrandra* (Sw.) D. Don, *Micropholis garciniaefolia, Ormosia krugii* Urban, and *Sloanea berteriana* Choisy (*29, 31*). This forest type is found on foothills and slopes below a 600-m elevation (*16*). Palms in this forest can grow tall in open areas along drainages, but growth is suppressed below the taller forest canopy. In the cloud elfin forest, sierra palm trees are stunted and are found only along drainages.

In other Caribbean islands additional species have been recorded as associates of the sierra palm. In the mature secondary forests of St. Vincent, *C. schreberiana, Eugenia sintenisii* Kiaersk., *Ficus citrifolia* Mill., *I. vera* Willd., and tabonuco (*32*) have been listed. Beard (*2*) described a primary forest stand in Grenada consisting of *D. excelsa, Licania ternatensis* Hook. f., *M. chrysophylloides, Maytenus grenadensis* Urban, *S. caribaea* Krug & Urban, sierra palm, and a number of less abundant species. Table 1 contains a summary of quantitative information for stands in the Caribbean where the sierra palm has been recorded.

A large number of vascular and nonvascular epiphytes are associated with sierra palm (*22*). Some of these species tend to occur only with the palm. These epiphytes grow in proportion to palm diameter and height, stem roughness, and the moisture-holding capacity of the organic mats formed on palm-stem surfaces by mosses and other epiphytic plants. The growth of these mats is influenced by the intensity of stemflow (*9*). This growth can result in the accumulation of large quantities of phosphorus-rich organic humus on the stem surfaces of sierra palm (*9*).

LIFE HISTORY

Reproduction and Early Growth

Flowering and Fruiting.—Only open-grown, dominant, and codominant sierra palms flower. These trees are usually 6 m or more in height and at least 50 years old. Flowering and fruiting proceeds nearly all year (*17, 19*) but reaches a peak at low elevations (300 to 500 m) between June and September (*1*). Above 700 m, peak fruit inflorescence occurred between August and February (*19*). These periods of floral and fruiting activity appear to vary from year to year (*19*). Fly, bee, and beetle pollination are considered the major means of pollination in this genus (*8*).

The species is monoecious (*1*). The white to magenta flowers are borne on single-branched clusters 32 to 100 cm long that grow from the trunk between leaf scars. One to several clusters may be blooming and fruiting at any one time. Floral sex ratio is variable among individuals in the Luquillo

Table 2.—*Characteristics of soils of palm-dominated forests in the Luquillo Experimental Forest, Puerto Rico (adapted from* 3, 9, 18*)*

Forest type	Elevation	Bulk density	Depth	Organic matter	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium
	m	*g/cm*^{3}	*m*	------ *Mg/ha* ------		------ *kg/ha* ------			
Palm brake	400	0.66	0.3	277	*	*	*	*	*
	700	0.74	0.3	339	*	*	*	*	*
	750	*	0.4-0.5	118-247	6.4-9.8	1.3-1.8	2.6-11.7	6.5-24.1	8-33
	750	*	0.3-0.8	184-486	9.2-16.8	0.6-2.7	15.7-30.2	11.0-27.2	48-94
	1000	0.31	0.2	281	*	*	*	*	*
Floodplain	750	*	1.0	272	*	0.7	*	*	*

* Data were not available.

Mountains. Some only produce a few female flowers (4 percent), whereas others produce as many as 30-percent female flowers; the average was 20 percent. The percentage of female flowers in sierra palms had an inverse relationship with the percentage of canopy cover.[1]

At maturity, the fruits are black, thin fleshed, and 10 to 13 mm in diameter and contain a seed about 9 to 10 mm in diameter (*14, 16*). The lag between flowering and fruit maturation is approximately 8 to 9 months (*1*). A sample of 50 trees produced an average of 2 inflorescences per year. Counts from 10 of those inflorescences indicated an average of 2,500 fruits per inflorescence (*1*). In another study in the Luquillo Mountains, sierra palms produced an average of 9,573 seeds over a period of 2.5 years. However, the results were variable; some individuals produced as few as 110 seeds and others as many as 29,577. Seed production in sierra palm was inversely correlated with the percentage of crown cover.[1]

Yearly fruit fall may reach 560 kg/ha in the productive floodplain palm stands (*19*). There is evidence of ample interannual variability in fruit production and the occurrence of mast years (*19*). On an area basis, there is greater palm fruit production in palm floodplain forests than in tabonuco forests (table 3), both in the mass of fruits and the number of fruits produced. Fruits are heavier and more abundant at higher elevations (table 3). As a result, there are more fruits on the forest floor at high-elevation sites than at low-elevation sites. Fruit weight changes on a temporal basis (*19*). In the low-elevation tabonuco forest, fruit weight varied over a 3-year period from less than 0.1 g to almost 0.8 g per fruit. In the high-elevation floodplain forest over the same time span, fruit weight varied from 0.1 g per fruit to 1.3 g per fruit (*19*). It is not clear if these differences are due to elevation or to intrinsic physiological differences of sierra palm in floodplains and tabonuco forests.

[1]F. Gregory and A. Sabat, personal communication with authors.

Seed Production and Dissemination.—Mean dry weight of sierra palm seeds is reported to be 0.60 g per seed (*7*). However, the large temporal variation in fruit weight (*19*) suggests that seed weight may also be variable. Bannister (*1*) reported a mean seed weight of 0.07 g. Lugo and Frangi (*19*) reported a variation in weight between damaged and green fruits (table 3). The density of fruits on the ground ranges widely (table 3), with higher values directly under palm trees.

Seedling Development.—A study in the Luquillo Mountains at a 350-m elevation resulted in 18-percent seed germination.[2] Canopy structure had no effect on germination. Seedling survival was 83 percent. Seedling growth, however, was strongly related to light intensity: the greater the canopy opening, the greater the growth. Seedling growth was also more variable at higher light intensities than under shade conditions. Bannister (*1*) estimated the half-life (the time in months required for half the seedlings to die) of the seedling population to be 17 months in the tabonuco forest. Frangi and Lugo estimated that 1,000 seeds produced 4.3 mature sierra palms in the tabonuco forest but only 1.6 in the floodplain forest. They attributed these differences to flooding and competition from other species.[3]

The oldest sierra palms in the Luquillo Experimental Forest were about 100 years old in 1982, but the dominant age class (over 50 percent of the individuals) was 52 to 68 years (*20*). These data suggest episodic regeneration following disturbances, such as hurricanes or landslides (*20*). Seedlings and suppressed palm trees (provided they are young) greatly accelerate growth rates when a disturbance opens

[2]A. Sabat, J. Morales, and D. Fernandez, personal communication with the authors.

[3]J.L. Frangi and A.E. Lugo, unpublished data on file at the International Institute of Tropical Forestry, P.O. Box 25000, Río Piedras, PR 00928-2500.

Table 3.— *Values for mass of fruits and seeds of* Prestoea montana *in the Luquillo Experimental Forest based on the summary of Lugo and Frangi (*19*).*

Fruit or seed parameter*	Value
Fruit weight	*g*
High-elevation floodplain	
Green	1.08
In litterfall	0.81 to 0.86
Damaged	0.59
Low-elevation tabonuco forest	0.52
Seed weight	
Low-elevation tabonuco forest	0.59
	0.07
Fruit density (on the ground)	*Per m²*
High-elevation floodplain	42
Low-elevation tabonuco forest	
Below palms	37 to 55
Whole forest	1.41
	0.06 to 4.3
Fruit fall (annual)	*kg /ha*
High-elevation floodplain	560
Low-elevation tabonuco forest	35

* High-elevation corresponds to 750 m and low-elevation to 300 to 500 m.

the canopy and increases available light intensity. Older suppressed individuals do not respond to increasing light intensity (*20*).

Vegetative Reproduction.—Sierra palms do not sprout and cannot be rooted by ordinary means. Propagation by tissue culture has not been reported.

Sapling and Pole Stage to Maturity

Growth and Yield.—The periodic formation of leaf scars on stems allows for the analysis of the growth rate of individual palm trees (table 4). Palm trees produce an average of four leaves per year, with an average internode distance of 4.2 cm. These values can vary significantly depending on the degree of light suppression to which the palm is subjected (*20*). Sierra palm maintains about 11 functional leaves, except after abnormal leaf fall due to hurricanes or other types of wind storms. This means that with a production of 4 leaves per year, turnover is 0.36 leaves per year or a leaf longevity of 2.75 years.

The mean height of palms is lower at the highest elevations of its range (11 m at 1,000 m) and averages about 19 m between 400- and 700-m elevations (*3*). Height-growth averages 0.14 m/yr, but it is faster when the palm is growing into a canopy gap. Values as high as 0.5 m/yr have been observed (*20*). Once the tree reaches the canopy, height-growth rate decreases. The period of fast height-growth rate usually occurs early in the life of the tree, and if it fails to occur, the individual remains as a suppressed member of the understory, even if the canopy opens at a later date (*20*).

The annual turnover of leaves results in the return of 2.8 Mg/ha of leaf mass to the forest floor (table 5). This mass return is equivalent to 14 percent of the stand's aboveground net primary productivity and is equivalent to 13 percent of the canopy leaf biomass. In terms of mass, the canopy residence time is 7.5 years. This value is higher than the one reported previously for individual leaves. The reason is that sierra palm leaves partially decompose before they fall, and thus litterfall measurements underestimate leaf biomass production. By correcting for aboveground decomposition, the residence time of leaf biomass is about 2 years, which is closer to the reported leaf duration (*9*). Decaying tissues had the following half-lives (in days) in the palm floodplain forest: palm leaves still attached to the parent tree, 188; dicotyledonous leaves, 306; palm leaves on the ground, 462; palm stems, 576 (*9*).

Sierra palm leaves retranslocate phosphorus very efficiently prior to leaf fall (*9*). However, the export of phosphorus (6.1 kg/ha·yr) and organic matter (table 5) from palm forests is high in spite of numerous phosphorus-conserving mechanisms (*9, 11*).

Frangi and Lugo reported equations for estimating sierra palm biomass from diameter and height data (table 6). Table 5 contains data on nutrient and biomass distribution in the sierra palms of a floodplain forest. Taking the mass of palm trees as 100 percent, leaves, stems, inflorescence, and roots account for 34, 52, 2, and 12 percent, respectively. For the same stand, taking the total accumulation of phosphorus in palm tissue as 100 percent, leaves, stems, inflorescence, and roots account for the following percentages: 43, 50, 3, and 3, respectively (totals do not add up to 100 due to rounding). These data show that proportional to the total stock, leaf tissue concentrates phosphorus, whereas root tissue does not.

Rooting Habit.—The root system of sierra palm is a complex of fine roots; stilt roots; and short, specialized, aerial roots. Root biomass is 12 percent of the total tree biomass in lower montane floodplain forests (*9*). The thick mat of surface and shallow subterranean roots is believed to contrib-

Table 4.—*Allometric and growth parameters of 32 individuals of the palm,* Prestoea montana, *in the Luquillo Experimental Forest* (*20*)*

Parameter	Mean value and unit†
Diameter at breast height	19.0 cm
Height	9.1 m
Stem volume	0.027 m^3
Crown volume	63.3 m^3
Functional leaves	11
Leaf scars	210
Internode distance	4.2 cm
Diameter growth	0.02 cm/yr
Basal area growth	0.58 cm^2/yr
Height growth	0.14 m/yr
Leaf production	4.0 leaves/yr

*Values from 1982.

† Lugo and Rivera Batlle (*20*) report the variation around these means.

Table 5.—*Growth and productivity parameters for* Prestoea montana *in a palm floodplain forest at 750-m elevation in the Luquillo Experimental Forest, Puerto Rico* (*9*)*

Parameter	Value and unit†
Biomass	*Mg/ha*
Leaves	20.9
Stems	31.9
Inflorescence	1.0
Aboveground	53.8
Roots	7.5
Total	61.3
Nutrient accumulation (N, P, K, Ca, Mg‡)	*kg/ha*
Leaves	275, 20.8, 178, 74, 48
Stems	266, 24.2, 331, 121, 67
Inflorescence	1.5 (P)
Aboveground	541, 47, 508, 195, 115
Roots	1.5 (P)
Total	48.7 (P)
Litterfall	*Mg/ha·yr*
Leaves	2.8
Aboveground net primary productivity	19.5 Mg/ha·yr
Export of organic matter	1.0 g/m^2·yr

* Data are for the sierra palms in the forest, and only the parameters for "aboveground net primary productivity" and "export" include species other than the sierra palm.

† Nutrient data are from Frangi and Lugo (*10*).

‡ N= nitrogen, P=phosphorous, K= potassium, Ca= calcium, and Mg= magnesium; values provided in this order.

ute to nutrient cycling and to reduce sheet erosion (*9, 12*). Stilt roots 1.0 to 1.5 cm in diameter, sometimes extending several meters over large boulders, anchor the palm. The aerial portion of stilt roots has pneumatorhizae that facilitate gas exchange in poorly aerated soils (*12*). These pneumatorhizae are anatomically and morphologically similar to those described for *Euterpe oleracea* Mart. found in the lowland wetlands of Guyana by De Granville (*6*).

Reaction to Competition.—Palm forests and palm trees exhibit the following gradients with increasing elevation: reduction of canopy gaps; increasing Holdridge complexity index (the product of basal area, tree density, and number of species in 0.1-ha plots divided by 1,000); and increasing importance value, basal area, and tree density of sierra palm. Sierra palm tolerates shade and is an excellent competitor. It can survive heavy shading at all ages, but young plants react by growing faster when sufficient light is available. Adult palms require at least overhead light to produce fruit. Leaf internode distances are larger, and the number of leaves produced annually is greater, when the tree grows under full light (*20*).

Sierra palm invades landslides and secondary forests when seed sources are nearby. This palm maintains almost pure stands on wet and unstable areas where other species have difficulty surviving wind storms, shallow soils, soil movement, or flooding. However, sierra palm does not tolerate stagnant water conditions (*18*). Its ability to resist hurricanes and strong winds is related to the thin stems, which offer low resistance to winds, and the capacity to shed leaves, thus avoiding the mechanical impact of winds (*10*).

As a result of all its adaptations, the palm can be present in mature forests and forests in stressed conditions and successional stages. However, because of its tolerance of adverse conditions and its longevity, Bannister (*1*) classified the sierra palm as a climax species. Beard (*2*) termed palm brakes as storm forests and considered the palm a successional species because of its colonization of disturbed areas such as landslides and sites damaged by hurricanes or volcanic eruptions. Lugo and others (*18*) suggested that sierra palm is a wetland species that can be present in both mature and young communities, depending on conditions. They concluded:

> ...depending on rainfall, soil saturation, topography, and frequency of disturbance, the steep slopes of the Caribbean can support a rich diversity of palm-dominated forests. Pure palm stands that persist over long time periods reflect the optimal conditions for palm dominance. These conditions that favor steady-state palm brakes are continuous soil saturation, absence of stagnant waters, periodic disturbance, and shallow soils. As the intensity of these factors abates, conditions for the invasion of dicotyledonous trees improve while those favoring palms decrease, and a variety of plant communities develop where palms become increasingly less dominant.

In support of this conclusion, Frangi and Lugo[4] noted the following gradient of sierra palm dominance (in percent) in Puerto Rico: tabonuco forest, 15; colorado forest, 17; floodplain forest, 43; palm brake, 57; and cloud elfin forest, 7.5.

[4]J.L. Frangi and A.E. Lugo, unpublished data on file at the International Institute of Tropical Forestry, P.O. Box 25000, Río Piedras, PR 00928-2500.

Table 6.—*Parameters for the linear regression equation* (y = ax + b) *of biomass of various palm components (y, in kilograms) and palm height* (x, *in meters*)*

y	*a*	*b*	r^2
		x = *total height*	
Aboveground	6.4	-10.0	0.96
Root	1.1	-1.1	0.83
Spike	0.1	-0.1	0.68
Leaflet	0.8	1.9	0.77
Rachis	0.3	1.1	0.53*
Total leaf	1.7	1.2	0.67
Butt	0.6	-0.4	0.80
Stem	5.1	-9.2	0.96
Stem and butt	4.7	-11.1	0.77
Inflorescence	0.2	-0.8	0.45
Total	8.4	-10.2	0.96
		x = *stem height*	
Aboveground	7.7	4.5	0.90
Root	1.4	-0.6	0.91
Spike	0.1	0.2	0.58
Leaflet	0.8	4.0	0.60
Total leaf	1.7	6.1	0.50
Butt	0.8	0.9	0.81
Stem	6.0	0.8	0.97
Stem and butt	5.9	-1.6	0.85
Inflorescence	0.3	-0.4	0.55
Total	9.7	6.8	0.94

* All data are significant at $p = 0.01$ except for rachis data, where p = 0.05.

They concluded that the length of the period of soil saturation could explain the difference in importance value of the sierra palm, the palm being favored by periodic soil saturation.

Mortality rates of sierra palms are variable from year to year (table 7). Peaks of mortality are associated with periodic disturbance of forests (*18*). More trees died in the Luquillo Mountains on a leeward site than on a windward site (table 7). This difference in mortality was attributed to a faster rate of succession on the leeward site, where competition from dicotyledonous trees was greater than on the wetter windward site. It is also possible that the fall of larger dicotyledonous trees caused secondary mortality in the shorter sierra palm trees. However, the palm retained dominance in both sites. Annual palm ingrowth rates were 4 trees per hectare in the windward palm forest, and 6 to 12 trees per hectare in the leeward palm forest (*18*).

Damaging Agents.—Sierra palm generally has few insect and disease problems. However, infestations of the Lepidopteran *Homaledra sabalella* (Chambers) have been noted (*21*). The termite *Nasutitermes costalis* (Holmgren) frequently builds trails ascending sierra palm trunks to feed on dead leaves, a process that is not harmful to the palms. *Cocotrypes carpophagus* Hornung (Coleoptera: Scolytidae) attacks sierra palm fruits and seeds after they fall to the forest floor (*22*). The attacks are more intense in wetter climates.

Strong winds and hurricanes are the main physical factors that damage palms. The sierra palm is relatively resistant to their effects. About 30 percent of the palms on a bottomland site in eastern Puerto Rico suffered some form of damage from Hurricane Hugo in 1989. However, defoliation accounted for most of the damage observed, and 98 percent were refoliating 9 months later (*10*). Respectively, 67 percent, 11 percent, and 1 percent of the sierra palms in an upland site in the same general area were defoliated, snapped, or thrown. Of these, only the snapped and thrown individuals died (*30*). Taller and apparently older palms sometimes have large accumulations of epiphytes and lianas (*9, 22*). This biomass loading increases the wind resistance of individual trees and increases the probability of windthrows.

SPECIAL USES

Probably the greatest single benefit from the sierra palm in modern times is that it is a principal species in the high-rainfall areas of the Antilles and thus protects watersheds that are critical to these high-population islands. In former times, and to a very small extent today, sierra palm leaves and leaf sheets were used to thatch houses and sheds. Narrow boards for sheathing and flooring were sawn or hewn from the outer stemwood of sierra palm trunks (*17*). The inner portion of the bud, called palm heart or cabbage, is occasionally eaten as a salad or a vegetable. Raw, it tastes like very bland cabbage; cooked, much like artichoke hearts. Half an hour of hard work is required to extract half a kilogram or so of tender material (authors, personal observation). Extracting the edible material kills the plant and may have resulted in the reduction of palm numbers in some areas.

The sierra palm is also very important to indigenous wildlife. Sierra palm fruits are the single most important food of the endangered Puerto Rican parrot, *Amazona vittata vittata* (Boddaert), accounting for 22 percent of the feeding records in one study (*26*). Other bird species, including the scaled pigeon, *Columba squamosa* Bonnaterre, the Puerto Rican woodpecker, *Melancropes portorricensis* (Daudin), and the gray kingbird, *Tyrannus dominicensis dominicensis* (Gmelin), also feed on sierra palm fruits (*33*). Sierra palm fruits are a very good quality food averaging (in percent): protein, 5; fat, 15; and carbohydrates, 39 (*19*). Twelve percent of the fruit is pericarp, and this constitutes the portion eaten by parrots. The spathes (structures that enclose the flower) usually fall to the ground cupped upward and soon fill with rain water. These natural basins probably provide drinking places for wildlife and breeding habitat for aquatic insects and frogs.

Table 7.— *Adult tree mortality parameters for the palm* Prestoea montana *in two palm brakes at the Luquillo Experimental Forest**

Time interval	Annual palm mortality: Density	Annual palm mortality: Basal area
	Trees/ha	*cm^2/ha*
Palm forest 1		
1946-1949	2.5	717
1949-1951	11.3	3005
1951-1982	2.9	703
1982-1986	7.5	1948
Palm forest 2		
1946-1951	14.5	2886
1951-1956	10.5	2368
1956-1976	7.4	1702
1976-1982	9.6	2103
1982-1986	14.4	3230

*Palm forest 1 was on a windward site and palm forest 2 was on a leeward site, both at elevations of approximately 700 to 750 m.

† Data from Lugo and others (*18*).

GENETICS

The flowers of the sierra palm are pollinated by honeybees and small flies. Both selfing and outcrossing appear to occur (*1*).

Sierra palm has been referred to in the literature by the synonym *Euterpe globosa* Gaertn. (*15*). Sierra palm is extremely variable and after further study may be divided into several subspecies. There are about 28 species in the genus *Prestoea* (*14*). Sierra palm probably conforms to the pattern of two other members of the genus that are known to have n=18 chromosomes (*24*). The genus *Prestoea* is closely related to the genus *Euterpe*; however, their distinctive characteristics have not been clearly defined (*27*).

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