

The Palm Communities of Two "Terra Firme" Forests in Peruvian Amazonia

FRANCIS KAHN AND KEMBER MEJIA

ORSTOM, Apartado postal 18-1209, Lima, Peru, and

IIAP, Apartado postal 784, Iquitos, Peru

ABSTRACT

Two palm surveys carried out in "terra firme" forests of the lower Ucayali River valley in Peruvian Amazonia report very high diversities with, respectively, 29 species in 16 genera on 0.71 ha and 34 species in 21 genera on 0.5 ha. In both cases, most species are small, understory palms, and more than 99% of the community is under 10 m in height. Several genera and species inventoried, which are not frequent in Peruvian Amazonia at low elevations and rather common on the Andean piedmont and on mountain slopes, point out the influence of the subandean palm flora on the western lowlands of the Amazon basin.

"Terra firme" forests, which cover the major part of the Amazon basin, are considered a species rich ecosystem (Black et al. 1950, Boom 1986, Gentry 1982, Gentry and Dodson 1987, Pires et al. 1953, Prance et al. 1976). Previous reports from French Guiana (Granville 1978, Sist 1985) and from Brazil (Kahn 1986, Kahn and Castro 1985) presented data on species richness and density of palms in eastern and central Amazonia, pointing out particularly the high diversity of the palm community in a "terra firme" forest of the central basin; but there were no quantitative data from western Amazonia. Trying to fill the gap, we present here two palm surveys carried out in "terra firme" forests in Peruvian Amazonia, including data on species richness, density, life forms and vertical distribution of the palm community.

Study Areas

Both forests are located in the lower Ucayali River valley, near Jenaro Herrera

(4°55'S; 73°40'W). The first site, called "Ferrocaño," is about 6 km north of the field station of the Research Institute for Peruvian Amazonia (IIAP); the second, called "Copal," is at km 15 on the only road. Both sites belong to the same geographic unit at an elevation of about 160 m above sea level.

Climate is humid tropical, with an average annual rainfall of 2.9 m and average annual temperature of 26° C.

Soils of both sites correspond to Acrisol in the FAO-UNESCO (1971) classification system. They are yellow and clayey in their upper part; brownish to dark brown at greater depth; the upper 4 meters are never waterlogged; the drainage is vertical. At the Copal site, the soil differs slightly, having a silty layer in the upper horizon at the lowest part of the slope, and a sandy clay texture, at some places on the plateau at the margin of the area surveyed, corresponding to a transition zone into an area of gleyic podzol which extends about 50 m beyond.

Methods

Palm surveys. All palms were counted on contiguous 0.01-ha plots. For multi-stemmed species, all axes were counted. Total areas of 0.71 ha and 0.5 ha were surveyed respectively at the Ferrocaño and Copal sites. Density of each species is given according to height classes (under 1 m, 1 to 10 m, above 10 m), and lumped on the whole area at each site.

Palm collection and identification. All species were collected. Some of them could

not be identified due to the lack of comparative material in the herbaria (AMAZ, BH, K, NY, USM). J. Dransfield contributed to the identification of many palms. Several names of *Bactris* are provisional; this genus badly needs a new taxonomic treatment. Voucher numbers and herbaria where plants are deposited are given in the following list: *Aiphanes ulei* Burret (Kahn & Mejia 1916, K); *Astrocaryum chambira* Burret (K & M 1768, USM); *A. macrocalyx* Burret (K & M 1782, USM); *Bactris acanthocarpoides* Barbosa Rodrigues (K & M 1760, K); *B. acanthospatha* Trail ex Drude (K & M 1737, K); *B. bifida* Martius (K & M 1789, K); *B. humilis* (Wallace) Trail (K & M 1758, K); *B. cf. hylophila* Spruce (K & M 1798, K); *B. mitis* Martius (K & M 1763, K); *B. piranga* Trail (K & M 1761, K); *B. simplicifrons* Martius (K & M 1781, USM); *B. sphaerocarpa* Trail (K & M 1813, K); *B. sp. aff. B. mitis* Martius (K & M 1799, K); *B. sp. 1* (K & M 1835, K); *B. sp. 2* (K & M 1749, K); *B. sp. 3*. (K & M 1905, USM); *B. sp. 4* (K & M 1904, K); *Chamaedorea integrifolia* (Trail) Dammer (K & M 1790, K); *Chelyocarpus repens* Kahn et Mejia (K & M 1974, NY); *Desmoncus cf. leptospadix* Martius (K & M 1921, K); *Euterpe precatória* Martius (K & M 1778, USM); *Geonoma acaulis* Martius (K & M 2001, USM); *G. camana* Trail (K & M 1765, K); *G. leptospadix* Trail (K & M 1709, K); *G. oligoclona* Trail (K & M 1910, K); *G. piscicauda* Dammer (K & M 1810, K); *G. poeppigiana* Martius (K & M 2020, BH); *G. pycnostachys* Martius (K & M 1698, K); *G. spixiana* Martius (K & M 1808, K); *G. cf. tamandua* Trail (K & M 1888, BH); *Hyospathe elegans* Martius (K & M 1917, K); *H. cf. weberbaueri* Dammer ex Burret (K & M 1815, K); *Iriarteia deltoidea* Ruiz et Pavon (K & M 1766, USM); *Iriartella stenocarpa* Burret (K & M 1718, NY); *Jessenia bataua* (Martius) Burret (K & M 1792, USM); *Lepidocaryum tessmannii* Burret (K &

M 1999, NY); *Maximiliana maripa* (Corryê de Serra) Drude (Mejia 780, USM); *Oenocarpus balickii* Kahn (K & M 1723, NY); *O. mapora* Karsten (K & M 1727, NY); *Orbignya polysticha* Burret (K & M 1724, NY); *Phytelephas macrocarpa* Ruiz et Pavon (K & M 1726, AAU); *Pholidostachys synanthera* (Martius) H. E. Moore (K & M 1890, BH); *Scheelea basleriana* Burret (K & M 1794, USM); *Socratea exorrhiza* (Martius) Wendland (K & M 1702, NY); *S. salazarii* H. E. Moore (K & M 2013, BH); *Wettinia augusta* Poeppig et Endlicher (K & M 1767, USM).

Results

At the Ferrocaño site, 29 species in 16 genera were encountered on 0.71 ha (Table 1). The genus *Bactris* is the most diversified, with 10 species. Palm diversity varies from 7 to 14 species and 5 to 10 genera per 0.01-ha plot. Palm density is very high (986 palms per 0.1 ha). While species richness and density are both remarkably high, the palm community is largely dominated by two small, multi-stemmed, understory species, *Lepidocaryum tessmannii* and *Bactris sphaerocarpa*, which represent, respectively, 54.3% and 17.7% of the community.

At the Copal site, 34 species in 21 genera were encountered on 0.5 ha surveyed (Table 2). *Geonoma* with 8 species is the most diverse genus. Palm diversity varies from 6 to 18 species and 5 to 13 genera per 0.01-ha plot. Of the 50 plots surveyed, 27 present 12 or more species, and 31 have 9 or more genera. Palm density is slightly lower than in the former site (768 palms per 0.1 ha). *Lepidocaryum tessmannii* represents only 7.4% of the community. *Astrocaryum macrocalyx* and *Phytelephas macrocarpa* were only found on the lowest part of the slope where the soil differs in having a silty layer in the upper horizon; both species are frequent on alluvial soils. The four adults of *Jes-*

Table 1. Palm species richness and density at Ferrocaño site on 0.71 ha. S, single-stemmed; M, multi-stemmed; Acs, acaulescent with small leaves; Acl, acaulescent with large leaves; L, lianescent; P, procumbent; LU, lower understory (adult height less than 6 m); UU, upper understory (adult height 6–10 m); AR, arborescent (adult height above 10 m); N, total number of palms.

Palm Species	Height Classes			N	Life Form
	<1 m	1–10 m	>10 m		
<i>Astrocaryum chambira</i>	0	1	0	1	S.AR
<i>Bactris acanthocarpoides</i>	2	2	0	4	M.LU
<i>Bactris humilis</i>	0	1	0	1	M.LU
<i>Bactris cf. hylophila</i>	3	11	0	14	M.LU
<i>Bactris mitis</i>	2	10	0	12	M.LU
<i>Bactris piranga</i>	0	1	0	1	M.LU
<i>Bactris simplicifrons</i>	1	2	0	3	M.LU
<i>Bactris sphaerocarpa</i>	339	898	0	1,237	M.LU
<i>Bactris</i> sp. aff. <i>B. mitis</i>	2	3	0	5	M.LU
<i>Bactris</i> sp. 1	9	14	0	23	M.LU
<i>Bactris</i> sp. 2	12	101	0	113	M.LU
<i>Chelyocarpus repens</i>	18	188	0	206	S.PLU
<i>Desmoncus cf. leptospadix</i>	1	1	0	2	M.L.UU
<i>Euterpe precatória</i>	28	8	0	36	S.AR
<i>Geonoma acaulis</i>	17	53	0	70	Acs.LU
<i>Geonoma leptospadix</i>	15	22	0	37	M.LU
<i>Geonoma piscicauda</i>	76	102	0	178	M.LU
<i>Geonoma poeppigiana</i>	22	80	0	102	S.LU
<i>Geonoma spixiana</i>	57	191	0	248	M.LU
<i>Hyospathe cf. weberbaueri</i>	5	15	0	20	M.LU
<i>Iriartella stenocarpa</i>	120	67	0	187	M.LU
<i>Jessenia bataua</i>	151	195	0	346	S.AR
<i>Lepidocaryum tessmannii</i>	455	3,346	0	3,801	M.LU
<i>Maximiliana maripa</i>	0	1	0	1	S.AR
<i>Oenocarpus balickii</i>	6	3	4	13	S.AR
<i>Orbignya polysticha</i>	8	182	0	190	Acl.LU
<i>Pholidostachys synanthera</i>	27	117	0	144	S.LU
<i>Socratea exorrhiza</i>	2	0	1	3	S.AR
<i>Wettinia augusta</i>	1	5	0	6	M.UU
	1,379	5,620	5	7,004	

senia bataua were located at the limit with a gleyic podzol, on which this species forms a dense population beyond the area surveyed.

At both sites, most of the species are small, understory palms (23/29 at Ferrocaño; 27/34 at Copal), and most of the palm community is distributed under 10 m in height (99.9% at Ferrocaño; 99.3% at Copal). The density of large palms (above 10 m in height) is higher at Copal, 25 on 0.5 ha, than at Ferrocaño, which had five individuals on 0.71 ha. The percentage of palms under 1 m in height is low at Ferro-

caño (19.7%) and high at Copal (62.4%). In the first site, the low value, due to the low density of most species, is accentuated by the high density reached by *Lepidocaryum tessmannii* and *Bactris sphaerocarpa* between 1 and 10 m. In the second site, the high value is due to the high density of seedlings of two arborescent species, *Iriartea deltoidea* and *Jessenia bataua*, and of juveniles of three small, understory species, *Hyospathe elegans*, *Chamaedorea integrifolia*, and *Geonoma piscicauda*, which are particularly abundant in the clearings.

Table 2. Palm species richness and density at Copal site on 0.5 ha. (Legend: see Table 1).

Palm Species	Height Classes			N	Life Form
	<1 m	1-10 m	>10 m		
<i>Aiphanes ulei</i>	2	5	0	7	Acs.LU
<i>Astrocaryum chambira</i>	14	21	2	37	S.AR
<i>Astrocaryum macrocalyx</i>	31	66	0	97	S.UU
<i>Bactris acanthospatha</i>	3	10	0	13	M.LU
<i>Bactris bifida</i>	7	13	0	20	M.LU
<i>Bactris piranga</i>	2	2	0	4	M.LU
<i>Bactris</i> sp. 3	8	17	0	25	M.LU
<i>Bactris</i> sp. 4	1	7	0	8	M.LU
<i>Chamaedorea integrifolia</i>	105	103	0	208	S.LU
<i>Chelyocarpus repens</i>	7	14	0	21	S.P.LU
<i>Desmoncus</i> cf. <i>leptospadix</i>	4	24	0	28	M.L.UU
<i>Euterpe preicatoria</i>	70	21	0	91	S.AR
<i>Geonoma acaulis</i>	46	53	0	99	Acs.LU
<i>Geonoma camana</i>	21	22	0	43	S.LU
<i>Geonoma oligoclona</i>	33	9	0	42	M.LU
<i>Geonoma piscicauda</i>	94	65	0	159	M.LU
<i>Geonoma poeppigiana</i>	32	42	0	74	S.LU
<i>Geonoma pycnostachys</i>	30	47	0	77	M.LU
<i>Geonoma spixiana</i>	32	52	0	84	M.LU
<i>Geonoma</i> cf. <i>tamandua</i>	4	9	0	13	Acs.LU
<i>Hyospathe elegans</i>	415	221	0	636	M.LU
<i>Iriartea deltoidea</i>	919	9	19	947	S.AR
<i>Iriartella stenocarpa</i>	28	17	0	45	M.LU
<i>Jessenia bataua</i>	260	161	4	425	S.AR
<i>Lepidocaryum tessmannii</i>	43	240	0	283	M.LU
<i>Maximiliana maripa</i>	34	27	0	61	S.AR
<i>Oenocarpus mapora</i>	0	5	0	5	M.UU
<i>Orbignya polysticha</i>	0	1	0	1	Acl.LU
<i>Pholidostachys synanthera</i>	31	51	0	82	S.LU
<i>Phytelephas macrocarpa</i>	0	18	0	18	M.LU
<i>Scheelea bassleriana</i>	18	13	0	31	S.AR
<i>Socratea exorrhiza</i>	14	8	0	22	S.AR
<i>Socratea salazarii</i>	81	36	0	117	S.UU
<i>Wettinia augusta</i>	7	8	0	15	M.UU
	2,396	1,417	25	3,838	

Discussion

Both palm communities are characterized by a very high diversity. Data from the Ferrocaño site were previously compared with those from central and eastern Amazonian forests (Kahn et al. 1988): 29 species in 16 genera on 0.71 ha in the lower Ucayali River valley; 26 species in 9 genera on 0.72 ha in the lower Rio Negro valley, near Manaus; and 12 species in 8 genera on 3.84 ha in the lower Tocantins valley, eastern Amazonia. The inventory

at Copal site brings a new record: 34 species in 21 genera on 0.5 ha—with up to 18 species on 0.01 ha, i.e., more species than on 3.84 ha surveyed in the lower Tocantins River valley. Three genera found in the area surveyed at the Copal site, *Aiphanes*, *Chamaedorea*, and *Iriartea*, are not frequent at low elevations (less than 200 m above sea level) in Peruvian Amazonia, while they are rather common in the forests of the Andean piedmont and on mountain slopes. A fourth genus, *Dicthyocaryum* (M & K 2010, USM), not

inventoried in the plots, occurs in the same forest near the area surveyed. This genus was previously known only from higher elevations (1,800–2,200 m) in Peru (Gentry 1986). The occurrence of these four genera, as well as that of certain species (*Socratea salazarii* and *Wettinia augusta*) which are frequent on the Andean piedmont, points out the influence of the subandean palm flora on the western lowlands of the Amazon basin. As a result, palm diversity is high in the Peruvian Amazonia.

Acknowledgment

This study was supported by the international agreement ORSTOM, France/IIAP, Peru. Soil descriptions were made by L. Veillon. We are indebted to K. and H. Clark for their helpful assistance on the English manuscript.

LITERATURE CITED

- BLACK, G. A., TH. DOBZHANSKY, AND C. PAVAN. 1950. Some attempts to estimate species diversity and population density of trees in Amazonian forests. *Bot. Gaz.* 111: 413–425.
- BOOM, B. M. 1986. A forest inventory in Amazonian Bolivia. *Biotropica* 18: 287–294.
- FAO-UNESCO. 1971. Soil map of the world. Vol. IV, South America. UNESCO, Paris.
- GENTRY, A. H. 1982. Patterns of neotropical plant species diversity. *Evol. Biol.* 15: 1–84.
- . 1986. Notes on Peruvian palms. *Ann. Missouri Bot. Gard.* 73: 158–165.
- . AND C. H. DODSON. 1987. Contribution of nontrees to species richness of tropical rain forest. *Biotropica* 19: 149–156.
- GRANVILLE, J. J. DE. 1978. Recherche sur la flore et la végétation guyanaises. Thèse Doctorat d'Etat, Univ. Montpellier. 272 p.
- KAHN, F. 1986. Les palmiers des forêts tropicales humides du bas Tocantins (Amazonie brésilienne). *Rev. Ecol. (Terre et Vie)* 41: 3–13.
- . AND A. DE CASTRO. 1985. The palm community in a forest of central Amazonia, Brazil. *Biotropica* 17: 210–216.
- , K. MEJIA, AND A. DE CASTRO. 1988. Species richness and density of palms in terra firme forests of Amazonia. *Biotropica* 20: 266–269.
- PIRES, J. M., TH. DOBZHANSKY, AND G. A. BLACK. 1953. An estimate of the number of species of trees in an Amazonian forest community. *Bot. Gaz.* 114: 467–477.
- PRANCE, G. T., W. A. RODRIGUEZ, AND M. F. DA SILVA. 1976. Inventário florestal de um hectare de mata de terra firme, km 30 da estrada Manaus-Itacoatiara. *Acta Amazonica* 6(1): 9–35.
- SIST, P. 1985. Régénération et dynamique des populations de quelques espèces de palmiers en forêt guyanaise. DEA Univ. Paris VI. 60 p.

Principes, 35(1), 1991, p. 26

PALM LITERATURE

MINTER, SUE, with contributions from CHRIS JONES, PETER MORRIS, and PETER RIDDINGTON. 1990. *The Greatest Glasshouse: the Rainforests Recreated*. London: HMSO. L25.00.

This attractive book is divided into two parts. The first part "Greenery among the iron: the Palm House and its collections" has ten chapters. The first three discuss the origin of the Palm House, the development of plant collections in Victorian times, and the changing methods used by the staff in caring for the important collections of plants. The remaining seven chapters present the structure of the rainforest and explain how the Palm House exhibits it. Detailed discussions of the rainforest plants grown are presented in chapters on palms, cycads and pandans, tropical climbers, fruits, flowers, and plants of the forest floor. The section on palms is 23 pages long, beautifully illustrated in color and black and white, and is a well done and very complete overview of the family. The treatments of the other plant groups are equally good.

(Continued on p. 52)