Ecology of Economically Important Palms in Peruvian Amazonia

FRANCIS KAHN

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Abstract

Most palm species are used by Amazonian natives and provide a variety of products, such as edible fruits, oil, palm heart, building materials, and basketry. However, only a few species have significant economic potential. These palms occur essentially in seasonal swamp forests on waterlogged soils covering vast areas in Peruvian Amazonia, or on sandy soils. Three especially promising species—*Jessenia bataua, Mauritia flexuosa* and *Euterpe precatoria*—constitute dense populations on these soils, which are generally considered as unfit for agriculture. The management of promising palm populations will contribute to increasing the economic value of such soils by transforming seasonal swamp forests into productive agroforestry fields.

Key words: palms, forest management, waterlogged soils, Amazonia, Peru

Resumen

La mayoría de las palmas son utilizadas por el selvâtico Amazónico forneciendo una variedad de productos como frutas, aceite, chonta, materiales de construcción y cestería. Sin embargo, pocas son las especies que tienen un buen potencial económico. Estas palmeras se encuentran principalmente en los suelos hidromórficos, periódicamente inundados, que cubren gran parte de la Amazonia Peruana, y también en los suelos arenosos. Tres especies promisoras—*Jessenia bataua, Mauritia flexuosa* y *Euterpe precatoria*—forman poblaciones muy densas en estos suelos, generalmente considerados como muy pobres para la agricultura. El manejo de las poblaciones de palmeras promisoras contribuirá a mejorar la potencialidad económica de tales suelos transformando estas vegetaciones en agroselvas productivas.

I. Introduction

Population density and species richness of palms are generally high in Amazonian forests (Boom, 1986; Kahn, 1986a; Kahn & Castro, 1985; Marmillod, 1982; Sist, 1985). Palms are generally abundant in upland forests, with a large number of understory species and a few arborescent forms (Kahn, 1986b). In contrast, seasonal swamp forests are dominated by arborescent palms (Granville, 1976, 1978; Kahn & Castro, 1985). Palms also occur in areas flooded by

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rivers and on sandy soils (campinas in Brazil, chamizales in Peru), generally with lower species richness in both cases.

Native Amerindians of Amazonia use most of the Amazonian palm species (Anderson, 1978; Balick, 1979, 1985; Boom, 1986; Braun, 1968; Cavalcante, 1974; Kahn & Mejia, 1987; Lévi-Strauss, 1950; Mejia, 1983; Schultes, 1974, 1977; Wallace, 1853). All parts of palms can be used: leaves (thatching, basketwork, house walls, fibers), petiole (building parts, arrows), trunk (house walls, floors, doors, starch, blowpipes), fruit (edible fruit, oil, charcoal), palm heart, and sometimes roots (medicine). While palm uses and exploitation are supplementary economic activities, some species can be more important (e.g., *Mauritia flexuosa* L.f., see Padoch, this volume).

Although there are a lot of uses for palms, only a few species have significant economic potential. This is the case for species with high yields of edible fruit, rich oil composition, palm hearts acceptable for canning, and/or starch production. Other, related species are also of great interest as potential sources of germplasm for genetic improvement.

II. Promising Palms in Peruvian Amazonia

The economic potential of several Peruvian palms is evaluated (one to three asterisks) in the following list by considering the value of the product (e.g., oil quality, fruit or palm heart acceptability), frequency and density of natural populations, and potential of soils on which they are generally found (good soils are used more for crops than for native palms; on poorly drained soils there is an increased potential for forest management). Most of these palms also offer products of purely local importance, e.g., as building materials or fibers (see Lopez Parodi and Mejia C., this volume). We will discuss here only those products of economic importance in the local marketplace.

Oil Palms

*** *Elaeis oleifera* (H.B.K.) Cortés (poloponta) is a stemmed, but creeping palm. Populations of this species are being prospected throughout Amazonia for further improvement and hybridization with the African oil palm, *E. guineensis* Jacq., as well as a separate breeding program. The Amazonian species offers a high quality oil, lower height because of its creeping trunk, and better resistance to diseases (Meunier, 1976; Ooi et al., 1981).

*** *Jessenia bataua* (Mart.) Burret (ungurahui) is a monocaulous, arborescent palm, 25 m in height. *Jessenia* oil is similar to olive oil (Balick, 1981, 1982), with high quality protein in the presscake (Balick & Gershoff, 1981). Natives use *Jessenia* oil for cooking and make a drink from the pulp (Schwyzer, 1981).

* *Oenocarpus* spp. (sinamillo) are medium, mono- or multi-stemmed palms, 10–15 m in height. These species are part of a genetic complex including *Jessenia* (Balick, 1981, 1986; Forero, 1983; Martin & Guichard, 1979). They are occasionally used by natives to make a drink from the pulp, and are promising species for a *Jessenia–Oenocarpus* gene bank.

Edible Fruits and Starch

* *Astrocaryum chambira* Burret (chambira) is a monocaulous, arborescent palm, 15–25 m in height. The endosperm is drunk or eaten as with coconut. The epidermis of the pinnae of young leaves is used for fibers (hammocks, bags).

*** *Bactris gasipaes* H.B.K. (pijuayo) is a multi-stemmed palm, 15–20 m in height. It is cultivated in Amazonia for its fruit (food and drink), and is never found in natural populations (see Clement, this volume).

*** *Mauritia flexuosa* L. f. (aguaje) is a monocaulous, arborescent palm, up to 30 m in height, and the most popular in Peruvian Amazonia. Its fruit (also an ice cream made from it) is sold in all the streets of Iquitos, constituting a rather important, but local, commercial trade (see Padoch, this volume). The species is dioecious and only female plants are harvested. At present, male plants are used only as sources of "suri" (beetle larvae). However, the trunk of *Mauritia flexuosa* contains a high concentration of starch and its production would permit the economic use of male plants. Today starch is extracted only by the Warao Indians of the Orinoco delta (Heinen & Ruddle, 1974), but *Mauritia flexuosa* could become an important source of starch for the

Table I

Population structure of four palm species with economic potential found in a survey area in upland forest on well-drained soils in the lower Ucayali River basin, Peruvian Amazonia

	On slope (0.43 ha)	On plateau (0.28 ha)
Jessenia bataua		
Stemmed palms	0	0
Acaulescent juveniles (≥1 m)	128	67
Seedlings (<1 m)	95	58
Euterpe precatoria		
Stemmed palms	0	0
Acaulescent juveniles (≥1 m)	7	1
Seedlings (<1 m)	22	6
Oenocarpus cf. *bacaba*		
Stemmed palms	3	1
Acaulescent juveniles (≥1 m)	3	4
Seedlings (<1 m)	4	2
Astrocaryum chambira		
Stemmed palms	0	0
Acaulescent juveniles (≥1 m)	1	0
Seedlings (<1 m)	0	0

Amazonian region as a whole (Ruddle et al., 1978).

Palm Heart

** *Euterpe precatoria* Mart. (huasai) is a monocaulous, arborescent palm, 20 m in height. Traditionally used to produce palm heart in Peruvian Amazonia, this species is less suitable for canning than multi-stemmed species such as *E. oleracea* Mart. or *Bactris gasipaes*. Nevertheless, a canning factory in Iquitos uses this palm and is responsible for the destruction of the large populations of huasai in the region.

III. Ecology of Promising Palms in the Lower Ucayali River Basin

Forest ecosystems are very diversified in Amazonia (Pires, 1974): upland (terra firme) forests (Oldeman, 1974; Prance et al., 1976; Takeuchi, 1960), seasonal swamp forests on waterlogged soils (Granville, 1978; Kahn & Castro, 1985), forests periodically flooded by rivers (Prance,

Table II

Population structure of four promising palm species in a 1 ha area of "sacha aguajal" in the lower Ucayali River basin, Peruvian Amazonia (ad: adult; trj: trunked juvenile; acj: acaulescent juvenile; N: total number of palms; BA: basal area in m²/ha)

	ad	trj	acj	N (h ≥ 1 m)	BA (DBH ≥ 0.15 m)
Mauritia flexuosa	18	53	179	250	6.94 (72.59%)
Jessenia bataua	28	73	260	361	2.16 (22.59%)
Euterpe precatoria	45	62	143	250	0.46 (4.81%)
Oenocarpus mapora	3	7	30	40	— —
					9.56 (100%)

Total BA (DBH ≥ 0.15 m) = 26.34
Dicot BA (DBH ≥ 0.15 m) = 16.78 (63.71%)
Palm BA (DBH ≥ 0.15 m) = 9.56 (36.29%)

Table III

Population structure of three promising palm species in a 1 ha area of "aguajal" in the lower Ucayali River basin, Peruvian Amazonia. This parcel is only inundated by the river during the years of highest flood (legend see Table II)

	ad	trj	acj	N (h ≥ 1 m)	BA (DBH ≥ 0.15 m)
Mauritia flexuosa	138	92	415	645	16.53 (96.55%)
Euterpe precatoria	35	7	8	50	0.59 (3.45%)
Oenocarpus mapora	18	36	67	121	— —
					17.12 (100%)

Total BA (DBH ≥ 0.15 m) = 31.11
Dicot BA (DBH ≥ 0.15 m) = 13.99 (44.97%)
Palm BA (DBH ≥ 0.15 m) = 17.12 (55.03%)

1980), and low forests on sandy soils (Anderson, 1981). All these ecosystems are found in the lower Ucayali River basin (Encarnación, 1985).

Promising Palms in Upland Forests

The economically promising palms discussed above are infrequent in the upland forests on well-drained soils (orthic acrisol), where species richness and density of palms are very high. In the lower Ucayali basin 0.71 ha of forest were surveyed; 29 species and a density of 5625 palms (or axes for multi-stemmed species) greater than 1 m in height were found. Only four of the promising species were encountered in the survey area (Table I). *Oenocarpus* cf. *bacaba* Mart. (*Kahn & Mejia 1723,* NY) is only found on well-drained soils, but generally at low density. *Astrocaryum chambira* is rarely encountered in these forests; dense populations occur in secondary vegetation and near villages where it is propagated by man. This species has potential for agroforestry on well-drained soils. Only juveniles of *E. precatoria* and *J. bataua* are found in these upland forests.

Promising Palms in Seasonal Swamp Forests

The natives usually distinguish two palm swamp forest formations: a mixed *Jessenia bataua–Mauritia flexuosa* formation called "sacha aguajal," and an almost pure *Mauritia flexuosa* formation called "aguajal."

1. Sacha aguajal

In the lower Ucayali valley, this formation stands on low terraces that are never flooded by the Ucayali River; inundations are caused by rains. The soil is a gleysol, with organic matter concentrated near the surface. A total of 18 palm species (2380 axes greater than 1 m in height) were found on the 1 ha surveyed, but among them were only four promising species: *M. flexuosa, J. bataua, E. precatoria* and *O. mapora*

Table IV

Population structure of two promising palm species of a 0.5 ha area of "aguajal" annually affected by river flooding in the lower Ucayali River basin, Peruvian Amazonia (legend see Table II)

	ad	trj	acj	N (h ≥ 1 m)	BA (DBH ≥ 0.15 m)
Mauritia flexuosa	19	23	33	75	9.57 (100%)
Euterpe precatoria	2	—	3	5	— —
					9.57 (100%)

Total BA (DBH ≥ 0.15 m) = 11.10
Dicot BA (DBH ≥ 0.15 m) = 1.53 (13.78%)
Palm BA (DBH ≥ 0.15 m) = 9.57 (86.22%)

Table V

Relationship between the population structure of *Jessenia bataua* and gleyic podzol in the lower Ucayali River basin, Peruvian Amazonia

	Gleyic podzol (0.1 ha)[a]	Gleyic acrisol transition zone (0.1 ha)[b]	Well drained orthic acrisol (0.1 ha)[c]
Adults	13	5	0
Trunked juveniles	5	2	0
Acaulescent juveniles (≥1 m)	87	57	27
Seedlings (<1 m)	209	173	22

Respectively from a—0.27 ha, b—0.19 ha, c—0.71 ha surveyed.

Karst. subsp. *mapora*, the former three in dense populations. Relative basal area of palms reaches 36.29% (Table II) on this site. The American oil palm, *E. oleifera*, occurs infrequently on such sites, but can form dense populations.

2. *Aguajal*

Mauritia flexuosa formations have been mentioned by Spruce (1871), Bouillenne (1930) and Moore (1973), and cover vast areas from the Andean piedmont to the Atlantic coast, always on waterlogged soils. In French Guiana, *M. flexuosa* formations occur almost exclusively in coastal savannah (Granville, 1978).

These formations are particularly extensive in Peruvian Amazonia. An analysis of Landsat survey data (ONERN, 1977) concluded that they cover 21% of 311,970 ha near Iquitos and 34% of 66,560 ha in the Marañon River valley.

Mauritia flexuosa reaches very high densities in natural populations. An average of 246 trunked palms per ha (CV: 24.7%) was found by Salazar and Roessl (1977) based on 10 plots of 0.5 ha surveyed along the Itaya River near Iquitos. In the upper Huallaga valley, Gonzáles (1971–1974) found an average per ha of 351 trunked palms (CV: 26%) and 297 acaulescent juveniles (CV: 43%) based on 20 plots of 0.05 ha surveyed.

In the lower Ucayali valley such formations

Table VI

Summary of the occurrence of economically promising palm species in the forest ecosystems of Peruvian Amazonia (H: high; M: medium; L: low)

Forest ecosystems	Promising species	Population density	Population frequency
1. Upland forests, on well drained, orthic acrisol.	*Astrocaryum chambira* Burret	L	M
	Oenocarpus cf. *bacaba* Mart.	L	M
	Bactris gasipaes H.B.K.	(cultivated)	
2. Seasonal swamp forests, on gleysol, periodically inundated by rains.	*Jessenia bataua* (Mart.) Burret	H	H
	Euterpe precatoria Mart.	H	H
	Mauritia flexuosa L. f.	M	H
	Oenocarpus mapora Karst.	M–H	H
	Elaeis oleifera (H.B.K.) Cortés	H	L
3. Seasonal swamp forests, on distric histosol, inundated by rains and by river during the years of highest flood.	*Mauritia flexuosa* L. f.	H	H
	Euterpe precatoria Mart.	M	H
	Oenocarpus mapora Karst.	M–H	H
4. Swamp forests, on distric histosol, flooded by river each year.	*Mauritia flexuosa* L. f.	H	H
	Euterpe precatoria Mart.	L	H
5. Forests on gleyic podzol.	*Jessenia bataua* (Mart.) Burret	H	H
	Euterpe precatoria Mart.	L	M
6. Forests on alluvial soils (eutric fluvisol).	*Euterpe precatoria* Mart.	M	M
	Oenocarpus mapora Karst.	M	M
	Bactris gasipaes H.B.K.	(cultivated)	

Table VII

Sex ratio in three populations of *Mauritia flexuosa* in the lower Ucayali River valley, which reveals the economic destruction caused by current collection methods

	Sacha aguajal (1 ha)	Aguajal (1 ha)	Aguajal (0.5 ha)
Male plants	15 (83.33%)	100 (72.46%)	13 (68.42%)
Female plants	3 (16.66%)	23 (16.67%)	4 (21.05%)
Sex unknown	— —	15 (10.86%)	2 (10.53%)
Totals	18	138	19

stand on the lowest terraces. The soil is a distric histosol, composed of organic matter, several meters in depth; soil water is acid (pH: 3.5). The organic matter is essentially *M. flexuosa* litter: fallen leaves, male inflorescences and infructescences. *Jessenia bataua* does not occur in this vegetation type.

The structures of two parcels are presented. The first area is inundated by rains and by the river only during the years of highest flood. A total of 11 palm species (1184 axes greater than 1 m in height were found on 1 ha surveyed, among them only three promising species. Total basal area (for DBH greater than 15 cm) is high, with 31.11 m^2/ha, of which 53.13% corresponds to *M. flexuosa* (Table III). The second area is flooded by the river each year. The part of the vegetation that is most exposed to the river includes numerous dead palms. Eight palm species were found on 0.5 ha surveyed, with only two promising species. The canopy is mainly composed of *M. flexuosa* with a few *E. precatoria*; a few dicotyledons are also present (Table IV).

Promising Palms on Podzols

In the lower Rio Negro valley the association of *J. bataua–Mauritia carana* Wallace–*Euterpe controversa* Barb. Rodr. is found on orthic podzol (pers. obs.). A preliminary study on the lower Ucayali River indicates a relationship between the density of *J. bataua* populations and gleyic podzol (Table V).

IV. Palms and Forest Management

All the data presented here clearly show that several of the most promising palm species in Peruvian Amazonia form large and dense populations on waterlogged and poorly drained soils (Table VI). These soils are generally unfit for agriculture. Covering vast areas as they do, they seriously limit the economic development of this region. While we do not believe that the management of palm populations on waterlogged soils can lead to any major industrial use and development, it could be important as part of a regional ecodevelopment program. The objective is to transform the seasonal swamp forests into productive agroforestry fields, to increase the economic value of such regions. The three species with the highest densities in Peruvian Amazonia—*J. bataua, M. flexuosa* and *E. precatoria*—can be used integrally; in addition to their economic potential described above, they also serve as sources of building materials.

In all tropical countries, palms of waterlogged soils are commonly used. In Brazilian Amazonia, Anderson et al. (1985) described the integration of *Euterpe oleracea* in an agroforestry system. Examples from Asia and Pacific islands are given respectively by Ruddle et al. (1978) and Barrau (1959). Uses of African *Raphia* swamps are listed by Profizi (1983), who proposes a rational management system of these swamps based on palms.

Two preliminary points must be resolved if any management plan is to succeed. First, rational management of these natural palm populations can begin only with a change in fruit-collecting practices. At present, fruit is collected by cutting down palms, and as a result the native vegetation is progressively losing its economic potential. In the case of the dioecious *Mauritia flexuosa,* there is currently a preponderance of male plants among adult palms, reflecting past collecting practices (Table VII). In contrast, Salazar and Roessl (1977) found 111 males and 69 females per ha in slightly-disturbed vegetation. This management problem also exists in other Amazonian countries. Granville (1985) has campaigned against the cutting down of palms for fruit-collecting in French Guiana. Second, it is necessary to introduce new palm uses. In Peru, starch production from the trunk of *M. flexuosa* is unknown. A technological transfer from Asia or the Orinoco delta should be attempted.

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