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Palms as key swamp forest resources in Amazonia

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ABSTRACT

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Native palms are present in all wetland forests in the Amazon basin. They provide many useful products, and have a significant place in the daily life of most inhabitants of Amazonia. Only a few species, however, have economic potential as edible fruit, oil, palm heart for canning, fiber, and starch, or constitute a gene resource that could be tapped for genetic improvement of cultivated or promising native species. The species of economic importance, mainly *Euterpe oleracea, E. precatoria, Jessenia bataua*, and *Mauritia flexuosa*, are not equally distributed in wetland forest ecosystems. They form dense and extensive populations in the seasonal swamp forests of upland valleys, and on swampy areas which are permanently flooded by standing water in the floodplain of the main rivers. In both cases, the soils are unsuitable for agriculture. The management of native palms in these swamp forests could provide several products, such as oil or starch, which at present are obtained from deforested areas of the uplands. In this way, it could contribute to limiting the destruction of species-rich terra-firme forests.

INTRODUCTION

The exploitation of Amazonian forests generally leads to their destruction. Vast areas are transformed into agro-industrial or timber plantations, and small areas, deforested by shift cultivation or timber extraction, spread irreversibly with increasing human population density.

Except those forests on periodically flooded alluvial soils which are traditionally cultivated, wetland forests have not been severely affected by deforestation because extreme ecological contraints make them unsuitable for most crops, timbers, and pastures. They are neglected in most plans for forest management.

These forests are located in the floodplains of the major rivers, and also in the network of valleys which is scoured through uplands by small streams collecting water from slopes and plateaus.

Floodplain forests are inundated by the river. Timing and frequency of flooding, nutrient content of water and sediments, and water acidity all contribute to differentiate forests periodically flooded by white-water rivers, for-

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ests periodically flooded by black-water rivers, and swamp forests permanently flooded by black or clear rivers.

In upland valleys, the seasonal swamp forests stand on soils which are permanently waterlogged. Inundations occur during the rainy season immediately following heavy rainfall.

Floodplain forests cover around 2% of Brazilian Amazonia (Adis, 1984). They represent 12% of Peruvian Amazonia (Salo et al., 1986), and cover as much as 52.5% (42.1% periodically flooded and 10.4% permanently flooded) of the region near Iquitos in the lower Marañon and Ucayali River basins (Anonymous, 1975). There are no estimates of the area covered by seasonal swamp forests in the upland valleys, but this certainly is not negligible.

PALMS IN THE WETLAND FORESTS OF AMAZONIA

Palms are present in all wetland forests. The species composition, species richness, and density vary, however, from one ecosystem to another (Kahn and Mejia, 1990).

In forests periodically flooded by white water

These forests correspond to the last stage of primary succession occurring on alluvial soils deposited by white-water rivers, i.e. the rivers with high sediment load and a coffee-and-milk-colored water as a result. The older the forest, the shorter is the time of flooding, which varies from several weeks to 3–5 months. These lands are called 'várzea' in Brazil (Prance, 1979) and 'restinga' in Peru (Encarnación, 1985).

The most frequent palm species on alluvial soils belong to the genus *Astrocaryum*, mainly represented by *A. macrocalyx* Burret and *A. murumuru* Martius, both of which form dense populations. Other palms are frequent, such as *Euterpe oleracea* Martius, *E. precatoria* Martius, *Geonoma acaulis* Martius, *G. pycnostachys* Martius, and *A. jauari* Martius, which is usually located on the river bank.

In forest periodically flooded by black water

These forests are flooded during a 5–9-months period according to their distance from the main river. Black water has a high content of humic and fluvic acids, and the sediment load is almost nil. Soils are clayey to sandy-clayey (Adis, 1984). These wetlands are called 'igapó' in Brazil (Prance, 1979) and 'tahuampa' in Peru (Encarnación, 1985).

Palm diversity is low in these forests, but palm density can be high because of the presence of clustered palms such as *Bactris maraja* Martius, *B. concinna* Martius, or *Astrocaryum jauari*. Other species form locally dense populations, such as *Leopoldinia* spp. in central Amazonia and along the Rio Negro valley (Wallace, 1853; Spruce, 1871).

In permanently flooded forests

These swamp forests stand either in the vast subsidences of the Orinoco delta and of the Amazon estuary or in the narrow depressions which lie parallel to river beds. In the latter case, the substratum is clayey and retains rainfall which blends with river water only at the time of highest flooding. These forests are heavily dominated by the palm *Mauritia flexuosa* L.f., and are consequently called 'buritizal' in Brazil, 'aguajal' in Peru, 'cananguchal' in Colombia, and 'morichal' in Venezuela and in some parts of Colombia, from the vernacular names of the species, 'buriti', 'aguaje' 'canangucha', and 'moriche', respectively.

The soil of *M. flexuosa* swamps is characterized by an accumulation of slightly decomposed organic matter, several meters in depth, in acidic water (pH = 3.5). This organic matter is chiefly composed of dead leaves, male inflorescences, and infructescences of *M. flexuosa*. The density of palms is very high, with around 130–250 adult plants per ha (Gonzales Rivadeneyra, 1971; Salazar and Roessl, 1977; Urrego Giraldo, 1987; Kahn, 1988). A comparison with the 123 plants per ha in an African oil-palm plantation underscores the very high densities reached by *M. flexuosa* formations. Moreover, these formations are extensive (Spruce, 1871; Bouillenne, 1930; Moore, 1973), especially in eastern estuaries and in the Peruvian region of the basin where they cover 21 and 34% of two areas located near Iquitos and Nauta, respectively (Anonymous, 1977, from Landsat data analysis).

In seasonal swamp forests in upland valleys

Palms are the major components of the forest canopy (Kahn and De Castro, 1985). In eastern Amazonia, these seasonal swamp forests are widely dominated by *Euterpe oleracea* (Oldeman, 1969; Kahn, 1986a) and by *Jessenia bataua* (Martius) Burret ssp. *oligocarpa* (Grisebach & Wendland) Balick in the Guianas (De Granville, 1978; Sist and Puig, 1987; Sist, 1989). In the central and western regions, three arborescent species, *E. precatoria, J. bataua* ssp. *bataua*, and *M. flexuosa*, are particularly frequent and form dense, multispecific communities. On 1 ha surveyed in the lower Ucayali River valley (Peru), the three species were represented by 279 trunks (36.3% of the total basal area, for $D_{bh} > 15$ cm) and by 861 acaulescent individuals greater than 1 m in height (Kahn, 1988). Some species are patchily distributed, such as *Manicaria saccifera* Gaertner in the Guianas, *M. martiana* Burret in central Amazonia, *Geonoma baculifera* (Poiteau) Kunth in the eastern region, *Iriartea deltoidea* Ruiz & Pavon in western Amazonia (in both seasonal swamp and terra firme forests), *Elaeis oleifera* (Humboldt, Bonpland & Kunth) Cortés and *Mauritiella* spp. throughout the basin. Other species are widely distributed, such as *Oenocarpus mapora* Karsten in the western region, and *Socratea exorrhiza* (Martius) Wendland throughout the basin on wetlands as well as uplands, with higher density in the former, however (Dransfield, 1978; Kahn, 1986b).

Useful and economically important palms in the wetland forests

Amazonian native palms provide many useful products. All parts of the plants are used: leaves (thatching, basketry, building materials, fibers), trunk (building material, starch), apical meristem (palm heart), fruit (edible fruit, oil, charcoal), and even roots (medicines). A few species have economic potential as edible fruit, or palm heart for canning, oil, fiber and starch, or constitute a gene resource for genetic improvement of cultivated or promising native species.

Native palms of significant economic importance

Most of the following species provide products important in local trade:

Euterpe oleracea is an arborescent, multistemmed species. The fruits provide a drink from the epi- and mesocarp, locally called 'vinho do assaí', which constitutes an important dietary component (Strudwick and Sobel, 1988) and, consequently, an important item in local trade in the Brazilian state of Pará, where 54 507 tons of seeds were produced in 1979 (Coradin and Lleras, 1983). This palm, which forms clusters of up to 25 axes (Cavalcante, 1974), is also used in the palm-heart canning industry.

Euterpe precatoria is an arborescent, single-stemmed species. The fruits are used in the preparation of a 'vinho do assaí' in central Amazonia (Brazil). In Peru, however, where the palm is abundant, the fruits are not consumed, but the palm is cut down to extract the heart, even though it is a single-stemmed species. Most restaurants serve it as 'ensalada de chonta', and a canning factory exploits the species. As a result, dense populations of *E. precatoria* are ever more distant from Iquitos. The trunk is split to make the walls of rural houses (López Parodi, 1988).

Jessenia bataua is an arborescent, single-stemmed palm. From the pulp of the fruit is obtained an oil of very high quality, similar to olive oil (Balick, 1986). The presscake provides highly nutritive protein (Balick and Gershoff, 1981). A single infructescence may contain 1200–2200 fruits and adult trees may produce up to four infructescences per year. This species is considered one of the most promising native palms.

Mauritia flexuosa is a large, single-stemmed palm, which can reach more than 30 m in height (Spruce, 1871). It is a dioecious species: male and female flowers are on separate plants. It is particularly exploited for its fruit, which constitutes an important trade in Peruvian Amazonia (Padoch, 1988). The orange pulp is eaten or is used to prepare a drink, cakes, and ice cream. Fruit productivity is high: 450–1000 fruits per infructescence in natural populations, and up to 2000 fruits per infructescence were counted on a tree selected and planted in a village. Each palm can produce 3–5 infructescences per year.

Fruit yield was estimated at 6.5 t/ha in the lower Ucayali River (C. Peters, personal communication, 1987) and at 9.07 t/ha in Colombian Amazonia (Urrego Giraldo, 1987). This species also provides useful fiber, the leaves are used for thatching, and the petiole is used as building material. Moreover, the trunk contains up to 60% percent of the dry-weight as starch. This permits the exploitation of male plants. As in many palms when cut down, weevil larvae (*Rhynchophorus* spp.), which are eaten as 'surí', develop in the trunk.

Native palms important as genetic resources

Elaeis oleifera is a single-stemmed palm with a creeping trunk. This palm is being prospected throughout the Amazon basin for further improvement and hybridization with the African oil palm, *E. guineensis* Jacquin. The American species offers an oil of better quality, a lower height because of its creeping trunk, and a better resistance to diseases (Meunier, 1976; Ooi et al., 1981).

Oenocarpus mapora is a medium-sized, multistemmed species. As part of the genetic complex *Jessenia/Oenocarpus* (Balick, 1986), this species must be considered as part of the gene pool available for further improvement of *J. bataua.*

Useful native palms of no current economic importance

Although not providing products of any forseeable economic potential, the following species have a significant place in the daily life of most inhabitants of the Amazon basin.

Astrocaryum jauari is an arborescent, multistemmed species. The fruits are used as bait for fishing (Wallace, 1853), and leaf segments for basketry and fibers. Some attempts were made in Brazil to exploit the species for palm-heart canning (M. Piedade, personal communication, 1983). Its distribution, which is limited to the periodically flooded riverbank, and the many spines on the trunk, reduce its potential as an economic plant.

Astrocaryum murumuru is a medium-sized, multistemmed palm, strongly armed with large spines. Oil used to be extracted from the fruit in eastern Brazil (Coradin and Lleras, 1983).

Geonoma spp. and *Hyospathe* spp. are understory, clustered palms. Their leaves are generally used for thatching.

Iriartea deltoidea is a tall, single-stemmed palm. The trunk is split to make the floors of rural houses; such floors last up to six years. It is also used for walls and doors.

Leopoldinia spp. are medium-sized, single or multistemmed palms. Leaf sheaths are highly fibrous. The fiber of *L. piassaba* Wallace is used for making ropes and brooms, and is currently exported from the upper Rio Negro (Putz, 1979). Leaves are commonly used for thatching.

Manicaria spp. are moderate-sized, single or multistemmed palms. Their large, entire leaves provide a good material for thatching.

Mauritiella spp. are medium-sized, multistemmed palms. The pulp of the fruit is eaten, as is that of *Mauritia flexuosa.*

Phytelephas microcarpa is a moderate-sized, multistemmed palm. The leaves are commonly used for thatching, and also provide fiber. When the fruit is unripe, the liquid, or later gelatinous, endosperm is eaten; when the fruit is ripe, the endosperm becomes very hard and is known as 'vegetable ivory', from which buttons and other small objects are made. Fruits and seeds are sold in the regional markets.

Scheelea spp. are large, single-stemmed palms. The leaves are commonly used for thatching, and the fruits to make charcoal.

Socratea exorrhiza is a tall, single-stemmed palm. The trunk is split for making house walls, doors and floors. Pieces of stilt roots are sold in the regional markets of medicinal products in Brazil. The sap is known to be corrosive (Grenand et al., 1987).

DISCUSSION

The native palms of economic importance are not equally distributed in the wetland forests. They form dense and extensive populations in the seasonal swamp forests of upland valleys, and on areas which are permanently flooded by standing water, e.g. *Mauritia flexuosa* swamps (Table 1). In both cases, the soils (gleysol and histosol respectively) are unsuitable for agriculture. Some of the same palm species frequently occur on alluvial soils (fluvisol), but here they rarely form dense populations. Moreover, these soils are particularly suitable for crops, and the native palms, though highly productive plants, will not be able to compete economically with most crops, without genetic improvement. There are no palms of significant economic importance in the forests which are periodically flooded by black-water rivers; only *Leopoldinia piassaba* may have economic potential as fiber.

In the swamp forests, native palms form almost monospecific stands, e.g. *Mauritia flexuosa* or *Euterpe oleracea* formations, or multispecific communities, e.g. the seasonal swamp forests of central and western Amazonia which are dominated by *Jessenia bataua, M. flexuosa* and *E. precatoria.* In both cases, the native palm stands differ from African oil-palm or coconut plantations by the occurrence of natural regeneration (nil in a plantation) and by the within-species heterogeneity, which is high in natural populations and intentionally reduced in plantations. As a result, the management of such palm stands will present more similarities to agroforestry systems than to palm plantations. In particular, product yield will be improved by increasing palm density by controlling natural regeneration and introducing seedlings of promising species, and by selecting plants with higher productivity and higher product quality.

TABLE 1

Useful and economically important palms in wetland forests of Amazonia (for codes see footnote)

	Forest type							
	Flooded						Seasonal Swamp Forests (upland valleys)	
	Periodic				Permanent		F	D
	White-water		Black-water		F	D		
	F	D	F	D				
Palms of significant economic importance								
Euterpe oleracea (E)	M /	M	–	–	–	–	H /	H
Jessenia bataua ssp. *oligocarpa* (E)	–	–	–	–	–	–	H /	H
Euterpe precatoria (W,C)	M /	M	–	–	H /	L-M	H /	H
Jessenia bataua ssp. *bataua* (W,C)	–	–	–	–	–	–	H /	H
Mauritia flexuosa (T)	–	–	–	–	H /	H	H /	M
Palms important as genetic resources								
Elaeis oleifera (T)	–	–	–	–	–	–	L /	H
Oenocarpus mapora (W,C)	M /	M	–	–	H /	M-H	H /	M-H
Useful palms of no current economic importance								
Astrocaryum jauari (T)	M-H /	M-H	M-H /	M-H	–	–	–	–
A. murumuru (T)	H /	H	–	–	–	–	L /	M
Geonoma spp. (T)	H /	H	–	–	H /	H	H /	H
Hyospathe spp. (T)	L-M /	M-H	–	–	–	–	M /	H
Iriartea deltoidea (W)	–	–	–	–	–	–	L /	M-H
Leopoldinia spp. (C)	L /	M	H /	H	–	–	–	–
Manicaria spp. (C, E)	–	–	–	–	–	–	L /	H
Mauritiella spp. (T)	–	–	–	–	–	–	L /	M-H
Phytelephas microcarpa (W)	H /	H	–	–	–	–	L /	L
Scheelea spp. (W)	H /	H	–	–	–	–	–	–
Socratea exorrhiza (T)	M /	M	–	–	H /	M-H	H /	M-H

(F: frequency; D: density – H, high; M, medium; L, low; E, East; C, Centre; W, West; T, Throughout the basin).

The management of natural palm populations will proceed by some changes at the socioeconomic level in order to efficiently reorganize the collecting activities, product transformation and trade. As a matter of fact, some customs must be abandoned and new practices must be introduced, as discussed in the following two examples:

Palm fruit collecting usually involves cutting down the tree, and this occurs throughout the Amazon basin. Only the yield of one year is generally harvested per palm. Several climbing techniques, however, are developed in Africa and Asia; these could be introduced into Amazonia, and would allow the exploitation of a palm's lifetime. Now, anyone can cut down a palm with an axe, but only an expert can climb daily to collect fruits. The introduction of these techniques supposes a social reorganization of collecting activities.

Not all natural resources are currently exploited. The case of the starch contained in the trunk of *M. flexuosa* is a particularly obvious one. In Amazonia, it was extracted only by the Warao Indians of the Orinoco delta (Heinen and Ruddle, 1974). However, the exploitation of palm starch constitutes an activity of some economic importance in Southeast Asia (Ruddle et al., 1978). The technologies for extracting starch must be introduced into Amazonia, mainly in the Peruvian part of the basin, in order to contribute to managing the vast areas covered by *M. flexuosa* swamps.

Deforestation in Amazonia mainly affects the terra-firme forests, that is, the forests which present the highest species diversity. Seasonal and permanent swamp forests have much lower diversities, and they are often dominated by only one or a few species. The management of native palms in these swamp forests could provide several products such as oil and starch which, at present, are obtained from deforested areas of the uplands. In this way, it could contribute to limiting the destruction of species-rich terra-firme forest ecosystems.

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