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Diversity and conservation status of Peruvian palms

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Indigenous palm species of Peru are listed with data on their distribution patterns, ecology, frequency, density in the ecosystems, and conservation status. Peruvian palm flora includes 140 native species in 34 genera with the following distribution patterns: strictly Andean (17), Andean and Subandean (3), strictly Subandean (19), Subandean and Amazonian (20), strictly Amazonian (78), Amazonian and South peripheral (2), South peripheral (1). About 43% of the species occur at very low or low frequency in the country and about 9% are insufficiently known *in situ* for their conservation status to be defined. There are no Extinct species. Sixteen of the 17 strictly Andean palms are threatened species; 3 of them are Endangered, while only 5 strictly Subandean, 3 Subandean-Amazonian, and 4 strictly Amazonian palms are in these categories.

Keywords: Palmae; Peru; distribution patterns; ecology; conservation status

Introduction

Macbride (1960) published the only palm flora for Peru. It is now out of date. Shortly after its appearance, Harold Moore organized an expedition throughout Andean and Amazonian Peru (Moore *et al.*, 1960). Since then, several genera have been revised: *Geonoma* (Wessels Boer, 1968), *Chelyocarpus* (Moore, 1972), *Jessenia* and *Oenocarpus* (Balick, 1986; Bernal *et al.*, 1991), *Hyospathe* (Skov and Balslev, 1989), *Dictyocaryum*, *Iriartea*, *Iriartella*, and *Socratea* (Henderson, 1990), *Ammandra* and *Phytelephas* (Barfod, 1991), *Astrocaryum* (Kahn and Millán, 1992), *Chamaedorea* (Hodel, 1992), *Aiphanes* (Borchsenius and Bernal, in press); and two new genera were described, *Itaya* (Moore, 1972) and *Aphandra* (Barfod, 1991). Several taxonomic up-datings (Gentry, 1986; Kahn, 1990) and floristic inventories of palms in forest ecosystems (Kahn and Mejía, 1990, 1991; Kahn and Granville, 1992; Young 1992) were also published. In addition, countless specimens have been collected by R.B. Foster, A. Gentry, N. Jaramillo, F. Kahn, K. Mejía, D.N. Smith, R. Vásquez, K.R. Young, and many other botanists in the last fifteen years.

An analysis of a database including about 3000 herbarium specimens has provided information on species identification rates in each genus, species distribution patterns, and palm collecting intensity throughout Peru (Kahn *et al.*, 1992). All specimens in each Subandean and Amazonian species have been listed according to the main river valley where they were collected, and never or poorly-collected areas were identified as a result (Moussa *et al.*, 1992).

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A list of indigenous palm species of Peru is presented with data on their distribution patterns, ecology, frequency and density in the ecosystems. Their conservation status is defined from these parameters.

Materials and methods

List of Peruvian palm species

The list of indigenous palm species of Peru has been established from identification of herbarium specimens (AMAZ, BH, CUZ, K, MO, MOL, NY, P, US, USM – acronyms according to Holmgren *et al.*, 1990, Index herbarorium, 8th ed.). It follows the checklist of Peruvian palms prepared by L. Brako, A. Henderson and F. Kahn, and revised by J. Dransfield, in Brako and Zarucchi's catalogue of flowering plants and gymnosperms of Peru (in press). Herbarium voucher references will be found in this catalogue and in Kahn and Moussa (1994).

Distribution patterns of Peruvian palms

Five distribution patterns are proposed: (1) Strictly Andean species occur at high elevation (>1500 m) beyond the western limit of the Amazonian drainage which is marked by the occurrence of *Dictyocaryum lamarckianum*; *Ceroxylon* spp. are typically Andean palms, they reach the western piedmont of the Andes in northern Peru near the frontier with Ecuador; (2) Andean and Subandean species; (3) strictly Subandean species occupy the eastern piedmont of the Andes; (4) Amazonian species are found in the plain (strictly Amazonian), some of them reach the piedmont valleys below 1000 m (Subandean-Amazonian) or extend beyond the southern limit of Amazonia (Amazonian-South peripheral); (5) South peripheral species are found in Madre de Dios; they dominate tree vegetation in savannas and gallery forests which extend to Beni, Bolivia, and south of Rondônia, Brazil.

Peruvian ecosystems with palms

Ten ecosystems are considered: (i) Terra firme forests on clay, usually well-drained soils with the highest palm diversity; (ii) dry white sands with low vegetation and very low palm diversity; (iii) waterlogged white sands with high palm diversity; (iv) seasonal swamp forests irregularly flooded by rainfall with high density and medium diversity of palms; (v) permanently flooded swamp forests usually composed of very dense populations of *Mauritia flexuosa*, but a rather low diversity in palms; (vi) periodically flooded whitewater forests on alluvial soils (called restinga-forests in Peru, várzea-forests in Brazil) with medium palm diversity; (vii) forests periodically flooded by blackwater with low palm diversity (called tahuampa-forests in Peru, igapó-forests in Brazil); (viii) savannas and (ix) gallery forests, both with low palm diversity; (x) mountain cloud forests above 1500 m. Some species occur in forests flooded by whitewater as well as in those flooded by blackwater; they are considered 'riparian' in the list. The ability of some forest palms to flourish in deforested areas is noted under 'open vegetation.'

Descriptions of these ecosystems in Peru are given by Marmillod (1982), Encarnación (1985), Kalliola *et al.* (1987), Lamotte (1990), and Lopez and Freitas (1990) for Amazonian lowlands, and by Weberbauer (1945), Ferreyra (1950), ONERN (1976), Young and León (1988), and Young (1990) for eastern piedmont and the Andes.

The ecosystem(s) given in the list is (are) that (those) where the species is commonly found. The attribution of only one ecosystem to a species does not exclude a certain ecological range within this species, which cannot be taken into account here. For instance, *Astrocaryum javarense* or *Chelyocarpus repens* form very dense stands on well-drained soils in terra firme forests; some individuals, however, may occur in the contiguous seasonal swamp forest.

More information on species richness, density, vertical distribution, life forms, and ecology of palms in Subandean and Amazonian forest ecosystems are proposed by Kahn and Granville (1992). Data on Andean palm flora will be found in Young (1992).

Species ecology, frequency in Peru and density in ecosystems

The attribution of the above-defined ecosystem(s) to each species, as well as the frequency and density evaluation are mainly based on the field experience of the senior author who has been working with palms for 8 years in Peru. The species which have not been seen in the field are mainly those which are known only from the type or from a few old specimens (most often destroyed at B). As far as possible, complementary information was supplied from specimen labels, ecological and floristic studies (Gentry, 1985; Young, 1992), and forest inventories. Many of the latter, however, do not take palms into account, and when they do, the frequent absence of herbarium references make most identifications questionable.

Conservation status

The following IUCN conservation categories (Dransfield *et al.*, 1988) are employed: Extinct, Endangered, Vulnerable, Rare, Indeterminate for threatened categories; Status unknown, Insufficiently known for unknown categories; and non-threatened categories.

The conservation status of each species incorporates its distribution pattern because of the difference of human impact between regions, its frequency in the region, and its density in the ecosystem.

As a general rule species which occur in very low frequency and are not known from other countries, or are known in very low frequency therein, are included in threatened categories: (i) as Endangered when there is evidence that current populations are mere remnants of former larger populations under strong human pressure; (ii) as Vulnerable when population density is low and the deforestation rate is still high; (iii) as Rare when population density is high because the species generally grow in open areas and can persist under strong human pressure; (iv) as Indeterminate when human pressure is low.

Andean and Subandean species with low frequency and low density are also included in the threatened categories while Amazonian species with the same parameters are not. As a matter of fact, human pressure is very high in Andean and Subandean parts. Terrorism in the highlands made people migrate to the eastern Andes; mountain cloud forests have been intensively cut as a result. Many people were also attracted by coca cultivation on the piedmont where many areas have been deforested. Amazonian species, even with low frequency, may be considered not threatened as yet because of the lack of access roads and the consequently low density of human settlements in Amazonian lowlands.

The unknown categories include species which have long been described and, since then, have not been found again, e.g., *Catoblastus pubescens*, *Geonoma congestissima*, *G. dicranospadix* or *Wettinia weberbaueri*.

Results

Diversity of Peruvian palms

A total of 140 native species in 34 genera has been listed (Table 1). Five species which are not indigenous palms of Peru are excluded: *Bactris gasipaes*, *Elaeis guineensis*, *Euterpe oleracea*, *Oenocarpus bacaba*, and *Phoenix canariensis*.

Distribution patterns

Strictly Amazonian palm species represent 55.7% of the 140 species listed; 13.6% of them are strictly Subandean species; 14.3% of them are common to Amazonian lowlands and Subandean peidmont. Andean species represent 12.1% of the total; only three species are common to Andean and Subandean regions. Two Amazonian species also occur beyond the southern limit of the basin (Amazonian-South peripheral palms); there is only one South peripheral species (Table 2).

Ecosystems

All Andean and several Subandean species occur in mountain cloud forests. A total of 70 Amazonian and Subandean species grow in terra firme forests, and 10 of them are also found in other ecosystems. There are 16 and 22 species in forests on periodically flooded alluvial soils and in seasonal swamp forests, respectively; six of the former and 12 of the latter present a wider ecological range, however. The other ecosystems have a few palm species, but these may be very abundant (Kahn and Granville, 1992). All species occurring in forests which are periodically flooded by blackwater, such as *Astrocaryum jauari*, *Bactris maraja*, *B. riparia*, are also found in most inundated forest types (see riparian species in Table 1). The ecology of five species is still unknown.

Frequency and density

Thirty two species occur at very low frequency, 29 at low frequency. On the whole, 43.6% of the palm species are scarce, and 70.5% of these are also found at low density. Frequency and density are unknown for 11 species.

Distribution pattern and frequency

All strictly Andean species occur at very low or low frequency (Table 2). Scarce species represent 90.0%, 45.2%, and 31.0% of the palm flora of the Andes, the eastern piedmont, and Amazonian lowlands, respectively. The South peripheral species, *Astrocaryum huaimi*, was collected once in Peru, but it is abundant in the adjacent Bolivian region.

Conservation status

There are no Extinct palm species in Peru. Twenty eight (20.0%) of the species are, however, listed as threatened; 9.3% are unknown; and 70.7% are not threatened.

Sixteen (94.1%) strictly Andean species are within the threatened categories. *Ceroxylon latisectum*, *C. verruculosum*, and *C. weberbaueri* are considered Endangered species because only small populations remain in sites where mountain forests are being intensively destroyed. *Ceroxylon crispum*, which is less scarce, is considered Vulnerable. *Aiphanes spicata* and *Euterpe luminosa*, two species described recently, and 10 species

Table 1. Checklist of Peruvian palm species with their distribution patterns, ecology, frequency in the country, density in the ecosystem, and conservation status

Species	Distribution pattern[a]	Ecosystem[b]	Frequency in country[c]	Density in ecosystem[c]	Conservation status[d]
Aiphanes aculeata Willdenow	SA/AM	TF	L	L	nt
Aiphanes deltoidea Burret	SA/AM	TF	vL	L	R
Aiphanes spicata Borchsenius & Bernal	A	MF	vL	L	V[e]
Aiphanes ulei (Dammer) Burret	SA/AM	TF	vL	L	R
Aiphanes weberbaueri Burret	SA/AM	TF/DWS	L	L	nt
Aphandra natalia (Balslev & Henderson) Barfod	AM	TF/O	vL	H	nt[f]
Astrocaryum carnosum Kahn & Millán	SA	PFAS	vL	H	R[e]
Astrocaryum chambira Burret	AM	TF/PFAS/O	H	H	nt
Astrocaryum chonta Martius	AM/SP	PFAS	M	H	nt
Astrocaryum gratum Kahn & Millán	AM/SP	PFAS/GF	M	H	nt
Astrocaryum huaimi Martius	SP	SAV	vL	M	nt[f]
Astrocaryum huicungo Dammerex Burret	SA	SSF/O	vL	H	R[e]
Astrocaryum jauari Martius	AM	R	H	M/H	nt
Astrocaryum javarense Trail ex Drude	AM	TF	M	H	nt
Astrocaryum macrocalyx Burret	AM	TF	L	H	nt
Astrocaryum perangustatum Kahn & Millán	SA	TF/O	vL	H	R[e]
Astrocaryum scopatum Kahn & Millán	AM	PFAS	vL	H	R[e]
Attalea tessmannii Burret	AM	TF	?	?	?
Bactris acanthocarpoides Barbosa Rodrigues	AM	TF	M	L/M	nt

Species	Distribution pattern[a]	Ecosystem[b]	Frequency in country[c]	Density in ecosystem[c]	Conservation status[d]
Bactris acanthospatha Trail ex Drude	AM	TF	M	M	nt
Bactris angustifolia Dammer	AM	?	?	?	?
Bactris arundinacea (Trail) Drude	AM	R	M	M	nt
Bactris bifida Martius	AM	PFAS	M	H	nt
Bactris chlorancatha Poeppig ex Martius	AM	?	?	?	?
Bactris concinna Martius	AM	R	M	M	nt
Bactris corossilla Karsten	AM	SSF	vL	L	nt[f]
Bactris fissifrons Martius	AM	TF	?	?	?
Bactris hirta Martius	Am	TF	M	L	nt
Bactris humilis (Wallace) Burret	AM	TF	M	M-H	nt
Bactris killipii Burret	AM	TF	L	L	nt
Bactris maraja Martius	AM	R	H	M	nt
Bactris monticola Barbosa Rodrigues	AM	SSF	H	H	nt
Bactris piranga Trail	AM	TF	L	L	nt
Bactris riparia Martius	AM	R	M	M	nt
Bactris simplicifrons Martius	SA/AM	TF	H	L	nt
Bactris sphaerocarpa Trail	AM	TF	M	H	nt
Bactris utilis (Oersted) Bentham & Hooker f. ex Hemsley	SA	O	M	L	nt
Catoblastus drudei Cook & Doyle	AM	TF	L	M	nt[f]
Catoblastus pubescens (Karsten) Wendland	AM?	?	?	?	?
Ceroxylon crispum Burret	A	MF	L	L	V
Ceroxylon latisectum Burret	A	MF	vL	L	E[e]

Ceroxylon verruculosum Burret	A	MF	vL	L	E[e]
Ceroxylon weberbaueri Burret	A	MF	vL	L	E[e]
Chamaedorea angustisecta Burret	SA/AM	TF	L	L	nt
Chamaedorea fragrans (Ruiz & Pavón) Martius	SA	TF	L	L	nt
Chamaedorea linearis (Ruiz & Pavón) Martius	SA	TF	L	L	nt
Chamaedorea pauciflora Martius	SA/AM	TF	M	H	nt
Chamaedorea pinnatifrons (Jacquin) Oersted	SA/AM	SSF	L	H	nt
Chelyocarpus repens Kahn & Mejía	AM	TF	vL	H	I[e]
Chelyocarpus ulei Dammer	SA/AM	SSF	vL	H	I
Desmoncus leptospadix Martius	AM	PFAS	M	L	nt
Desmoncus longifolius Martius	AM	O	L	L	K
Desmoncus mitis Martius	AM	R/O	H	L	nt
Desmoncus orthacanthos Martius	AM	TF	M	L	nt
Desmoncus polyacanthos Martius	AM	PFAS/O/R	H	L	nt
Desmoncus setosus Martius	AM	TF	L	L	nt
Desmoncus vacivus Bailey	AM	O/R	L	L	nt
Dictyocaryum lamarckianum (Martius) Wendland	A	MF	L	H	nt
Dictyocaryum ptariense (Steyermark) Moore & Steyermark	AM	TF	vL	M	R
Elaeis oleifera (Kunth) Cortés	AM	SSF	M	H	nt
Euterpe catinga Wallace	AM	WWS	L	H	nt

Species	Distribution pattern[a]	Ecosystem[b]	Frequency in country[c]	Density in ecosystem[c]	Conservation status[d]
Euterpe luminosa Henderson, Galeano & Mesa	A	MF	vL	L	V
Euterpe precatoria Martius	AM	SSF	H	H	nt
Geonoma acaulis Martius	AM	SSF/PSF	H	H	nt
Geonoma andicola Dammer ex Burret	A	MF	vL	L	V[e]
Geonoma arundinacea Martius	AM	TF	M	M	nt
Geonoma aspidiifolia Spruce	AM	WSS	L	L	K
Geonoma baculifera (Poiteau) Kunth	AM	SSF	?	?	nt[g]
Geonoma bartlettii Burret	AM	TF	vL	L	K
Geonoma bartlettii Dammerex Burret	SA	SSF	M	H	nt
Geonoma brongniartii Martius	AM	SSF/TF	M	M	nt
Geonoma camana Trail	SA	TF	?	?	?
Geonoma congestissima Burret	AM	TF	L	L	nt
Geonoma cuneata Wendland ex Spruce	AM	TF	M	L	nt
Geonoma decurrens Wendland et Burret Linden ex Wendland	A	MF	vL	L	V
Geonoma deversa (Poiteau) Kunth	AM	TF	H	M	nt
Geonoma dicranospadix Burret	SA	?	?	?	?
Geonoma ferruginea Wendland ex Spruce	SA	TF	L	L	nt
Geonoma gracipiles Dammer ex Burret	SA	TF	?	?	?
Geonoma granditrijuga Burret	A/SA	MF	M	M	nt
Geonoma helminthoclada Burret	A	MF	vL	L	V

Geonoma interrupta (Ruiz & Pavón) Martius	SA/AM	TF	M	M	nt
Geonoma juruana Dammer	AM	TF	M	M	nt
Geonoma jussieuana Martius	SA	MF/SSF	M	H	nt
Geonoma laxiflora Martius	AM	PFAS	M	M	nt
Geonoma lehmannii Dammer ex Burret	A	MF	vL	L	V
Geonoma leptospadix Trail	AM	TF	H	M	nt
Geonoma lindeniana Wendland	A	MF	vL	L	V
Geonoma macrostachys Martius	AM	SSF/PFAS	M	M	nt
Geonoma marggraffia Engel	A	MF	vL	L	V
Geonoma maxima (Poiteau) Kunth	AM	TF	M	M	nt
Geonoma megalospatha Burret	A	MF	vL	L	V
Geonoma oligoclona Trail	AM	TF/SSF	L	L	nt
Geonoma piscicauda Dammer	AM	TF	H	H	nt
Geonoma poeppigiana Martius	AM	TF	H	H	nt
Geonoma pycnostachys Martius	AM	TF	H	H	nt
Geonoma spixiana Martius	AM	TF	H	H	nt
Geonoma tamandua Trail	AM	SSF	L	L	nt
Geonoma tessmannii Burret	AM	TF	?	?	K
Geonoma trailii Burret	AM	DWS	M	M	nt
Geonoma triglochin Burret	SA	TF	M	M	nt
Geonoma trigona (Ruiz & Pavón) Gentry	A	MF	vL	L	V[e]
Geonoma undata Klotzsch	A	MF	vL	L	V
Geonoma weberbaueri Dammer ex Burret	A	MF	vL	L	V
Hyospathe elegans Martius	AM	TF/SSF	H	H	nt
Hyospathe ulei Dammer	SA	TF	vL	L	V
Iriartea deltoidea Ruiz & Pavón	SA/AM	TF/MF	M	H	nt
Iriartella stenocarpa Burret	AM	TF	H	H	nt
Itaya amicorum Moore	AM	PFAS	L	H	I
Lepidocaryum gracile Martius	AM	TF	M	M	nt

Species	Distribution pattern[a]	Ecosystem[b]	Frequency in country[c]	Density in ecosystem[c]	Conservation status[d]
Lepidocaryum tenue Martius	AM	TF	M	M	nt
Manicaria saccifera Gaertner	AM	SSF	L	M	nt
Mauritia carana Wallace	AM	WWS	L	H	nt
Mauritia flexuosa L.f.	SA/AM	SSF/PSF	vH	vH	nt
Mauritiella aculeata (Kunth) Burret	AM	DWS	M	M	nt
Maximiliana maripa (Aublet) Drude	AM	TF	M	M-H	nt
Oenocarpus balickii Kahn	AM	TF	M	M	nt
Oenocarpus bataua Martius	SA/AM	SSF/WWS/O	H	H	nt
Oenocarpus mapora Karsten	SA/AM	SSF/PSF/PFAS	H	H	nt
Oenocarpus minor Martius	AM	TF	vL	L	nt[g]
Orbignya polysticha Burret	AM	TF	H	H	nt[b]
Orbignya racemosa (Spruce) Drude	AM	TF	L	L	nt[h]
Pholidostachys synanthera (Martius) Moore	SA/AM	TF	H	H	nt
Phytelephas macrocarpa Ruiz & Pavón	SA/AM	PFAS/SSF	M	H	nt
Prestoea acuminata (Willdenow) Moore	A/SA	MF	M	L	nt
Prestoea ensiformis (Ruiz & Pavón) Moore	A/SA	MF	L	L	nt
Prestoea schultzeana (Burret) Moore	SA	TF	L	L	nt
Scheelea butyracea (Mutis ex L.f.) Karsten ex Wendland	AM	PFAS	M	M	nt
Scheelea insignis (Martius) Karsten	AM	TF	M	H	nt

Scheelea phalerata (Martius ex Sprengel) Burret	SA/AM	PFAS	M	M	nt
Socratea exorrhiza (Martius) Wendland	AM	TF/S-PSF/PFAS	vH	M/H	nt
Socratea salazarii Moore	SA/AM	TF	H	M	nt[e]
Syagrus sancona Karsten	SA/AM	TF	M	M	nt
Syagrus smithii (Moore) Glassman	AM	TF	L	L	nt
Welfia georgii Wendland ex Burret	SA	MF	vL	L	nt[f]
Wendlandiella gracilis Dammer	AM	TF	L	M	nt
Wettinia augusta Poeppig & Endlicher	SA/AM	TF	H	M	nt
Wettinia longipetala Gentry	SA	TF	vL	L	V[e]
Wettinia maynensis Spruce	SA	TF/MF	M	H	nt
Wettinia weberbaueri Burret	SA	?	?	?	?[e]

[a]Distribution patterns – A: Strictly Andean species; A/SA: Andean-Subandean species; AM: Strictly Amazonian species; AM/SP: Amazonian-South peripheral species; SA: Strictly Subandean species; SA/AM: Subandean-Amazonian species; SP: South peripheral species.

[b]Ecosystems – DWS: Dry white sands; GF: Gallery forests; MF: Mountain cloud forests; O: Open vegetation; PFAS: Forests on periodically flooded alluvial soils (várzea-forest); PSF: Permanent swamp forests (*Mauritia flexuosa* swamps); R: Riparian species (including forests periodically flooded by blackwater); SAV: Savannas; SSF: Seasonal swamp forests; TF: Terra firme forests; WWS: Waterlogged white sands; ?: Parameter unknown.

[c]Frequency and density – vL: very low; L: low; M: medium; H: high; vH: very high; ?: parameter unknown.

[d]Conservation status – E: Endangered; V: Vulnerable; R: Rare; I: Indeterminate; ?: Status unknown; K: Insufficiently known; nt: Not threatened.

[e]Endemic species.

[f]These species, rarely collected in Peru, are not included in the threatened categories because they occur at higher frequencies in other countries. *Aphandra natalia* has been reported by Mejía (1992) for Peru; it has also been collected near the Peruvian frontier in Ecuador (Borgtoft Pedersen, 1992), as well as in Acre, Brazil (Henderson 1126, NY). *Astrocaryum huaimi* has been collected in Madre de Dios, Peru (Albán 6936, USM). *Bactris utilis* is considered a synonym of *B. gasipaes* (Glassman, 1972).

[g]These species are not likely to occur in Peru – *Geonoma baculifera* and *Oenocarpus minor* are common palms in eastern and central Amazonia, respectively.

[h]These species are treated under genus *Attalea* in Brako and Zarucchi (in press).

Table 2. Diversity of Peruvian palms, number of species with very low and low frequency, and number of species in IUCN categories in relation to distribution patterns. (Legend: see Table 1)

Distribution patterns	Number of Species	Frequency vL	Frequency L	Conservation status: Threatened categories E	V	R	I	Not threatened nt	Unknown ?	Unknown K
Strictly Andean	17	15	2	3	13	0	0	1	0	0
Andean/Subandean	3	0	1	0	0	0	0	3	0	0
Strictly Subandean	19	6	5	0	2	3	0	10	4	0
SA/AM	20	3	4	0	0	2	1	17	0	0
Amazonian AM	78	7	17	0	0	2	2	65	5	4
AM/SP	2	0	0	0	0	0	0	2	0	0
South peripheral	1	1	0	0	0	0	0	1	0	0
Total	140	32	29	3	15	7	3	99	9	4

of *Geonoma* which grow in mountain cloud forests at high elevation are also Vulnerable. Most of these last occur from Venezuela to Bolivia (Wessels Boer, 1968; Glassman, 1972; Balslev and Moraes, 1989); the Vulnerable status may be severe. However, it combines (i) the high fragility of mountain forest ecosystems, (ii) the strong human pressure in these regions, and (iii) the fact that such understorey species are unable to survive in deforested areas. *Geonoma lehmannii*, *G. lindeniana*, and *G. marggraffia* have been classified as Vulnerable for Colombia (Bernal, 1989). *Dictyocaryum lamarckianum* is the only Andean species within the non-threatened categories.

The situation is not so serious for the strictly Subandean species. Only 5 of the 19 species are classified in the threatened categories; two of them, *Hyospathe ulei* and *Wettinia longipetala*, are Vulnerable. Four species are within the unknown categories, and ten are safe.

Only 7.0% of the species which occur in Amazonia are considered threatened. However, 9 species which are not sufficiently known yet to be classified are likely to increase those threatened categories.

Endemism

Endemic palms include 14 species (Table 1): six of them are strictly Andean species (3 Endangered and 3 Vulnerable); five are strictly Subandean species (1 Vulnerable, 3 Rare and 1 Unknown); one is a Subandean-Amazonian species (not threatened); and two are strictly Amazonian species (Indeterminate and Rare).

Discussion

Peruvian palm diversity

The high generic diversity of Peruvian palms is mainly due to the diversity of the Amazonian region. Thirty two of the 38 palm genera found in the Amazon basin and

the Guianas are present in Peru (Kahn and Granville, 1992). Only *Ceroxylon* and *Welfia* are not found in Amazonia.

The diversity at the specific level is certainly high. However, such data are clearly dependent on the degree of confidence of species identification. This can be considered high for those species belonging to the above-mentioned genera which have been revised recently. It is not the case of many species of some genera which do need re-assessment, such as *Bactris* which presents a low rate (55%) of identified vouchers (Kahn *et al.*, 1992).

The preceding authors also pointed out that many species of *Bactris* (about 30%, considering new taxonomic arrangements by A. Henderson, personal communication) and *Geonoma* (more than 50%) are represented by only one or a few specimens. If several species are found to have been infrequently collected, it cannot be excluded that others have been erroneously named. The material is not complete enough to check the identification with confidence in many cases. This suggests that the species list proposed here is longer than it will be when the Peruvian palm flora is updated. On the other hand, several new species have been described (Gentry, 1986; Kahn and Mejía, 1988; Kahn, 1990; Henderson *et al.*, 1991; Kahn and Millán, 1992; Borchsenius and Bernal, in press) and many species were reported new for Peru (Kahn and Mejía, 1986, 1990, 1991) in the last years. For instance, *Astrocaryum huaimi*, *Mauritia carana* and *Manicaria saccifera* were recently collected. Moreover, many locations in Peruvian Amazonia have not been explored yet, as already stated. On the whole, erroneous names will be replaced by those of the species newly described or reported for the country, and Peruvian palm diversity is not likely to decrease significantly as a result.

Future of Peruvian palms

Andean species are nearly all threatened. Current activities are for an increasing rate of deforestation. *Chamaedorea* and *Geonoma* are small palms in the understorey of mountain forests and will disappear with the forest. *Ceroxylon* are tall palms which persist in open areas, but they are commonly used as building material and consequently cut down. There are only a few roads crossing the Andes; the situation is still not catastrophic. When the economy of Peru recovers, new roads will be built to develop the country, this is an unescapable need for Peru, and that will be the end of many Andean species.

The situation will be similar in Amazonia. There are few threatened species because of the low density of human settlements. When roads and colonization extend through Amazonian lowlands, vast areas will be deforested and many species will become scarcer and scarcer. The striking fact is that 43.6% of the palm flora occur at low frequency (53% including unknown species, which are likely to be still unknown because their frequency is very low). It is easy to imagine the example of Brazilian Rondônia being transposed to the Peruvian Amazonia resulting in a similar ecological catastrophe.

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