

## Use, Production and Conservation of Palm Fiber in South America: A Review

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**ABSTRACT** South American ethnic groups traditionally use palm fiber, which provides materials for domestic, commercial, and ceremonial purposes. A literature review of 185 references was carried out in order to identify and understand the extent of palm fiber production and the sustainability of harvesting and use in South America. The reports recorded 111 palm species and 37 genera used for fiber in the region; the genera *Attalea*, *Astrocaryum* and *Syagrus* had the highest diversity of fiber-producing species. *Mauritia flexuosa* and *Astrocaryum chambira* were the species mostly reported and with the largest number of object types manufactured with their fibers. The geographical distribution of the species use nearly overlaps the natural distribution of palms in South America, reaching its highest diversity in northern Amazonia, where palms are used mostly by indigenous people and peasants. The techniques used for extraction, harvesting and processing are usually basic and minimal. Most species are represented by wild populations found on common lands, the little detailed information available suggests that when use is intensive it is mostly unsustainable, and those with a greater market demand usually become locally extinct. Market demand, ecosystem conservation, and management practices used to boost fiber production are the major variables determining the sustainability of fiber extraction.

### INTRODUCTION

Palms are an important part of everyday life for many South American peoples because of their abundance, diversity, and utility. This is particularly true for Amerindian groups and rural colonists, for whom palms provide raw materials to fulfill basic needs such as food, medicines, oils, waxes, fuel, fibers, and materials for construction and for producing ornaments and many other kinds of artifacts for domestic use, subsistence, or ceremonial purposes (see, for example, Lévi-Strauss 1952; Macía 2004; Paniagua-Zambrana et al. 2007; Macía et al. 2011). Neotropical palms have been known worldwide as a source of fiber since at least the mid 19<sup>th</sup> century, especially the *piassabas* (*Attalea funifera* and *Leopoldina piassaba*), which are used to make brooms both for domestic use and for international markets (Wallace 1853; Spruce

1860; Crizón 2001). But in many of the world's tropical areas, palm fiber use may date back to hunter-gatherer societies (Baleé 1988). According to Bellwood (2005), species with technological uses, such as fiber-producing plants, might have been the first to be managed or domesticated. In spite of this, palm fibers are poorly documented in the archaeobotanical record (Morcote and Bernal 2001), probably as a consequence of their poor preservation. The oldest palm fiber item recorded by these authors is a mat that was found in Minas Gerais, Brazil, dating from 3420 ± 120 yr before present (Morcote and Bernal 2001).

Recently, the extraction of palm fiber has increased in many areas of South America to produce handicrafts and brooms for local and regional markets (Borgtoft Pedersen 1996; Vormisto 2002; Coomes 2004). This new trend can be explained in part by the promotion of non-timber forest products (NTFPs) by governments and non-governmental organizations over the past few decades (Peters et al. 1989). The market value for some of these products, especially handicrafts, has increased, and various indigenous and rural communities have exploited the opportunity to increase their incomes, which has

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led to growing pressure on the species that provide the raw materials. Whereas some researchers consider that the extraction and use of palm fiber for commercial purposes could improve the living conditions of local communities while conserving the species involved (Nepstad and Schwartzman 1992; Macía 2006), most studies actually show that populations of useful palms are decreasing due to over-harvesting, inadequate management techniques, and ecosystem conversion (Borgtoft Pedersen and Balslev 1990; Cárdenas and López 2000; Fadiman 2003). In some cases, the use of practices that increase fiber extraction is causing a decrease in the number of palms and is threatening both palm populations and trade (Cárdenas and López 2000; Vormisto 2002). Therefore, in order to design management and conservation strategies and thus ensure the sustainable use of palms, it is necessary to identify the useful species and the ecological impacts of palm fiber extraction (Peters 1996; Dalle and Potvin 2004).

Most studies of palm fiber use in South America are restricted to lists of species in a particular area, case studies on the use of palms by an ethnic group, or in-depth studies of a single species in a given location (for example, Lévi-Strauss 1952; Schultes 1977; Anderson 1978; Pinheiro and Balick 1987; Balick 1988; Borgtoft Pedersen 1994; Hiraoka 1999). In this paper, the researchers review the published literature on palm fibers from South America, and analyze the trends in palm fiber use, extraction, management, and conservation in order to assess the sustainability of palm fiber use in South America, and to point out needs for further research.

### METHODOLOGY

This study is based on a literature review, on a study of the ethno-botanical collection of the Royal Botanic Gardens, Kew, and on unpublished field data gathered by one of us (RB). The researchers define fibers as those items whose mechanical features are due to a wide array of anatomical structures, ranging from hard aggregates of vascular bundles to long and fine strands, capable of being threaded, twisted, or pleated (Dodge 1897; Esau 1972; Tomlinson 1990). Thus, this study includes cordage and other kinds of palm-derived strings, and also various items such as brooms, hats, and clothes whose nature is ultimately based on the resis-

tance of palm tissues. Palm thatching was not included in the review as most authors consider that this use is subsumed under the general category of construction materials. The use of palm for thatch is so widely reported that it deserves a study on its own.

The literature review was carried out based on collections in the following libraries (and within their respective online resources) located in the United Kingdom (UK) and Colombia (COL): Royal Botanic Gardens, Kew (UK), The British Library (UK), Templeman Library at the University of Kent at Canterbury (UK), Natural History Museum-Botany Library (UK), Biblioteca del Instituto de Ciencias Naturales – Universidad Nacional de Colombia (COL), Biblioteca General “Ramón de Zubiría” - Universidad de Los Andes (COL), Biblioteca del Banco de la República - Luis Angel Arango (COL), Centro de Documentación del Intituto Amazónico de Investigaciones Científicas – SINCHI (COL). Bibliographical information was also collected using the online scientific databases in the areas of life sciences and natural sciences, such as BioOne, CAB Abstracts, EBSCOhost, Elsevier, IngentaConnect, JSTOR, SciElo, ScindeDirect, Springer Link, Wiley Online Library, among others.

The documents for the general analysis were selected if they met two key conditions: 1) they named (scientific name or a sufficient botanical description) a palm species used for fibre and 2) they recorded use within South America. The review comprised 185 literary references, centered in the areas of botany and ethnobotany, composed of: journal articles (98), books (57), taxonomic guides (8), country and continental floras (1), ethnographies and ethnographic monographs (4), dissertations and grey literature (reports, unpublished documents, booklets and others) (6). The information was entered into one Excel table and two word documents. To process the data collected, tables were compiled and frequencies were calculated, depending on the objective or section analysed.

The fields included in the Excel table are: 1) species, 2) common names, 3) ethnic group of the users, 4) language spoken by the users, 4) country of the record, 5) region of the record, 6) locality of the record, 7) geographic coordinates (latitude and longitude), 8) altitude, 9) palm abundance in the locality of the record/study, 10) use status: wild, semi-cultivated and cultivated, 11) reproductive stage of the harvested palms, 12)

conservation status (IUCN classification), 13) sustainability of harvest according to the conclusions and perceptions of the researcher, 14) part of the palm employed: leaves, stem, inflorescences, roots, bark, etc., 15) type of fibre extracted: description of the fibre characteristics and quality, 16) extractive and productive process: description of fibre extraction techniques and the process used to manufacture fibre items, 17) type of objects manufactured, 18) quantity of fibre collected/fibre products produced in the locality or in the country, 19) type of use: domestic, local markets, national markets and international markets, 20) prices of the fibre or fibre objects (if commercialized), 21) whether the use is current or has been abandoned, 22) substitution by other plant fibres or synthetic materials, 23) literature references or records, and 24) notes relating to synonyms, and important information to complement the information gathered.

Objects made with palm fiber that were reported in the literature were assigned to one of the following 16 categories: bags, baskets, brooms, clothes, cordage, fans, filling, furniture, hammocks, hats, mats, necklaces, nets, screens, strainers, and traps. Information about the structural features of palm fibers was obtained from the direct observation of raw fibers and fiber items in the Economic Botany Collection of the Royal Botanic Gardens, Kew. The researchers followed Dodge's (1897) economic classification, which is still the most comprehensive, but incorporated modifications made by Hill (1965). Names of the species were updated in accordance with current use, mostly following Pintaud et al. (2008), Govaerts and Dransfield (2005) and Henderson et al. (1995).

The review covered roughly 85% of the literature available for palm fibre use cited in on-line catalogs, covering literature since the 1800's to 2009. However, three sources of bias could have affected the results here presented: First, due to the requirement of a scientific name or botanical description, a considerable amount of ethnographic and economic reports was left out of the analysis; however, those sources were reviewed, and helped to find gaps in knowledge. Second, because it was not possible to physically access each relevant library in South America, many documents, such as thesis or grey literature that did not appear in online catalogs were not included in the review. And, last, there are a

number of species that are only mentioned as a fiber source in ethnobotanical lists, but in depth research about their use has not been done yet, in spite of field observations suggesting that their use is extensive and important.

## RESULTS AND DISCUSSION

### Species Used

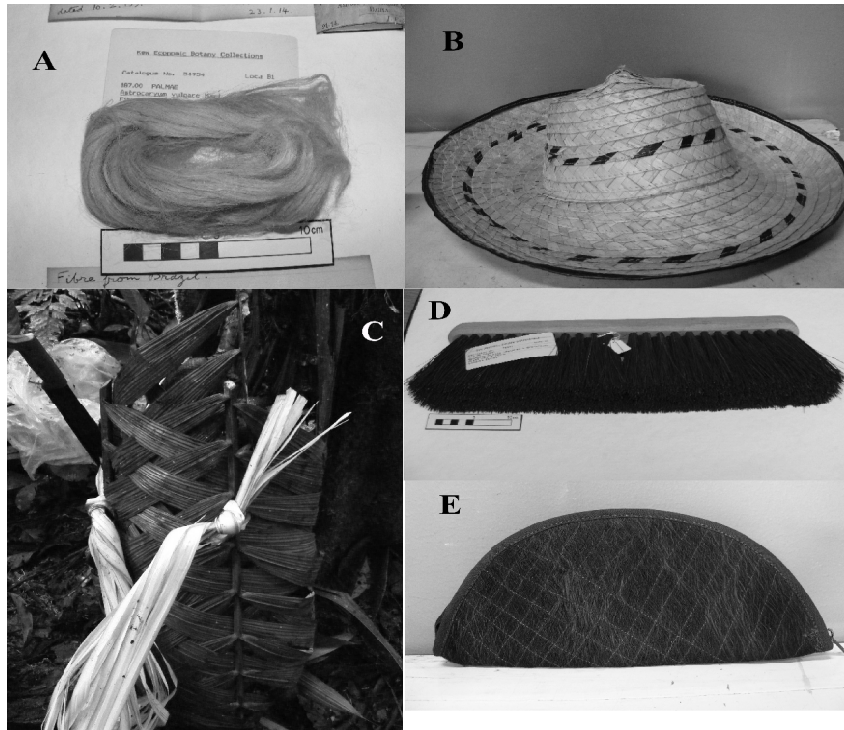
One hundred and eleven palm species in 37 genera were recorded as sources of fiber in South America (Appendix 1). This accounts for 24 % of the 457 palm species known in the sub-continent (Pintaud et al. 2008). The genera *Attalea*, *Astrocaryum*, and *Syagrus* had the highest number of useful species, with 15, 14, and 10 species, respectively (Appendix 1). Fibers of *Mauritia flexuosa* and *Astrocaryum chambira* were those used for the greatest variety of purposes, with 14 and 13 different object types, respectively.

### Kinds of Fiber

The fibers obtained from palms in South America come from the entire leaves, stems, spear leaves, petioles, leaf blades, leaf sheaths and spathes (Appendix 1). All of them are structural fibers. No record of uses of coconut coir fiber was recorded from South America, even from those areas where this species is widely cultivated.

South American palm fibers fall into five of Dodge's (1897) and Hill's (1965) major groups, (Fig. 1):

**Spinning Fibers:** Fibers mainly from leaves (leaf sheaths, petioles, and blades), stems, and roots. This category comprises fibers derived from palm leaves in different stages of development and which are not a part of the leaf's vascular system (Dodge 1897; Tomlinson 1990). The fibers are used for spinning and weaving into fine and coarse textures that can be used in clothes, home decorations, or for different industries (sails, tents, etc.), lace fibers, coarse netting fibers (such as those used for bags and hammocks), and cordage fibers (used to make strings, fishing lines, ropes and cables) (Dodge 1897). **Tie Material:** Very coarse material such as striped leaves, stems, or other coarse material without preparation. These are used as emergency cordage or construction rope. **Natural**



**Fig. 1.** Kinds of palm fibers: **A.** Spinning fiber from *Astrocaryum vulgare*, **B.** Plaiting material from *Copernicia tectorum* **C.** Tie material from *Oenocarpus bataua*, **D.** Brush fibres from *Manicaria saccifera*, **E.** Natural textures from *Manicaria saccifera*.

**Textures:** A fabric-like structure produced by naturally interwoven fibers. **Brush Fibers:** Most South American fibers in this group come from the leaf sheaths, which are shredded structural fibrous vascular bundles that persist on the plant. This group includes fibers for soft brushes (grass-like), and for hard brushes (bass fibers).

**Plaiting Fibers:** This group is the most heterogeneous, stemming from different sources such as stems, spear leaves, expanded leaves, and petioles. The plaits, made from split leaves, can be used to make hats, sandals, sleeping mats, and screens. For basketry in general, the fibers comes from split stems or other rigid organs, such as petioles.

### Useful Species and Objects

At least 16 different kinds of objects are produced that involve the use of palm fibers. This figure is not exact, as it is sometimes difficult to establish from the written source whether two objects represent different items or just variants

of a single item. For example, cordage made with various *Astrocaryum* species is woven into necklaces and is also used for fish lines or to manufacture nets. Each of these objects was assigned to one of the 16 object types in our gross classification of fiber use (Table 1). Object types produced from multiple palm species include baskets (67 species), hats (39 species), and cordage (strings and ropes) (31 species) (Table 1). For some object types, the use of a few species that yield a specific kind of fiber is prevalent, such as *Attalea funifera* and *Leopoldinia piassaba* for brooms and brushes, or *Desmoncus polyacanthos* and *Ammandra descasperma* for baskets.

### Human Groups and Palm Fiber

The researchers found records of at least 69 ethnic groups belonging to 31 linguistic families that use palms for fiber. This represents just a fraction of the several hundred ethnic groups that inhabit South America. The distribution of palm fiber use roughly corresponds to the geo-

**Table 1: Objects manufactured with palm fibers in South America, and the involved species**

<i>Object type</i>	<i>Objects included</i>	<i>Reports</i>	<i>No. of species</i>	<i>Most used species</i>
Bags		81	26	<i>Astrocaryum chambira</i> , <i>Mauritia flexuosa</i> , <i>Manicaria saccifera</i>
Baskets	Temporary baskets, mortuary baskets	221	67	<i>Desmoncus polyacanthos</i> , <i>Oenocarpus minor</i> , <i>Attalea phalerata</i> , <i>Attalea speciosa</i>
Brooms	Brooms, brushes	115	34	<i>Aphandra natalia</i> , <i>Attalea funifera</i> , <i>Leopoldinia piassaba</i>
Clothes	Straps, textiles	60	26	<i>Astrocaryum vulgare</i> , <i>Mauritia flexuosa</i> , <i>Astrocaryum chambira</i>
Cordage	Strings, lines, ropes	161	31	<i>Mauritia flexuosa</i> , <i>Astrocaryum chambira</i> , <i>Astrocaryum vulgare</i>
Fans	Fans, fly brushes	60	27	<i>Attalea speciosa</i> , <i>Parajubea sunkha</i> , <i>Astrocaryum aculeatum</i>
Filling		2	2	<i>Attalea tessmanii</i> , <i>Chelyocarpus ulei</i>
Furniture		14	9	<i>Desmoncus polyacanthos</i> , <i>Astrocaryum standleyanum</i>
Hammocks		113	16	<i>Mauritia flexuosa</i> , <i>Astrocaryum chambira</i> , <i>Astrocaryum vulgare</i>
Hats		99	39	<i>Copernicia prunifera</i> , <i>Mauritia flexuosa</i> , <i>Manicaria saccifera</i>
Mats		100	36	<i>Mauritia flexuosa</i> , <i>Attalea maripa</i> , <i>Copernicia prunifera</i>
Necklaces		16	4	<i>Astrocaryum chambira</i> , <i>Mauritia flexuosa</i>
Nets		62	15	<i>Astrocaryum chambira</i> , <i>Mauritia flexuosa</i> , <i>Astrocaryum aculeatum</i>
Screens		7	6	<i>Attalea maripa</i>
Strainers	Manioc strainers, sieves	17	14	
Traps		13	8	<i>Desmoncus cirrhifer</i> , <i>Raphia taedigera</i> , <i>Attalea speciosa</i>

**Fig. 2. Types of objects made with fibers of *Astrocaryum chambira* (A. Bag, B. Basket) and *Mauritia flexuosa* (C. Bag, D. Basket).**

graphical and altitudinal distribution of palms across South America. Most of the fiber palm species found in the literature were distributed in the Amazon, which reflects both the high palm diversity and the high cultural diversity of the area. Most ethnic groups that were recorded as using palms as a source of fiber live also in the Amazon, with a predominance of Tukanoan, Guaraní-Tupi, Chibchan and Panoan speakers. The ethnic groups with the largest recorded numbers of palm fiber uses are the Huaorani, the Cashinahua, and the Shuar, all from Ecuador. However, this result may be biased due to the greater number of detailed ethnobotanical studies done on these groups compared with other ethnic groups in South America (Bennett et al. 2002; Byg 2002; Byg and Balslev 2004). The species with most records of use within indigenous communities were *Mauritia flexuosa* and *Astrocaryum chambira* (Fig. 2). On the other hand, the use of *Astrocaryum standleyanum* and *Aphandra natalia* was remarkable for Afro-descendants inhabiting the Pacific lowlands of Colombia and Ecuador. Interaction between the numerous indigenous groups, and between them and *mestizos* or *caboclos*, has possibly increased the transfer of knowledge and the repertoire of palms species used among these groups.

### **Fiber Palm Harvest, Management and Conservation**

#### *Harvest and Management*

Detailed information about palm fiber harvest and management, as well as about the sustainability of such practices and the local conservation status of the involved species is scarce. Nearly all of the references provide only lists of palm species used by an ethnic group or within a region, and offer just a brief description of the use, parts used, and current abundance status. About 14% of the studies reviewed (27 out of 185) provided more detailed accounts, giving information on two or more aspects related to harvest, management, and sustainability. Each study generally covers different topics, leading, in most cases, to incomparable results. Consequently, the information that is useful for determining the trends in fiber production and species conservation is limited. A common fea-

ture of most fiber use cases is that functional parts such as expanded leaves, spear leaves, petioles, stems (in climbing palms) and leaf spathes are selectively harvested. However, when extractors are in urgent need of fiber, palms may be massively cut down to supply market demand; as a consequence, the palms are killed and sometimes the surrounding habitat is also heavily disturbed. This has been reported as early as the 19<sup>th</sup> century for the extraction of fibers from *Attalea funifera* (Voeks 1988), and more recently for *Aphandra natalia* (Kronborg et al. 2008; Balslev et al. 2010), *Astrocaryum chambira* (Vormisto 2002; Guel and Penn 2009), *A. standleyanum* (Borgtoft Pedersen 1994), *Leopoldinia piassaba* (Crizón 2001), and *Parajubaea torallyi* (Vargas 1994). The predominant tool used to harvest and collect palm parts is the machete. It is employed in versatile ways to cut parts, process fiber, and make objects (Jensen and Balslev 1995; Borgtoft Pedersen and Skov 2001). Ladders as well as ropes are used to reach and harvest tall palms (Fejos 1943; Borgtoft Pedersen and Balslev 1990; von Andel 2000). A simpler technique is to harvest the shedding petioles of *Copernicia prunifera* and *Aphandra natalia*, which involves manual dislodging (Dodge 1897; Demers 1909; Kirby 1950; Borgtoft Pedersen and Skov 2001).

In most cases, wild palm populations are used for fiber (97% of the species), whereas in a few cases a combination of wild and semi-cultivated populations were harvested (18% of the species); only in one case each were fibers exclusively obtained from a semi-cultivated population, or from a cultivated population. For most species, there was no information about the stage or age of plants harvested. Where information was available (ten species) it indicated that palms are harvested mostly in juvenile and mature stages (seven species); only *Mauritella aculeata* was reported as used only in juvenile stages, and one species, *Astrocaryum vulgare*, was harvested only in the mature stage.

#### *Social and Economic Aspects*

Fiber extraction, processing, and transforming is labor-intensive, employing mostly peasants and indigenous communities (Hübschmann et al. 2007; Crizón 2001; Fadiman 2003) (Fig. 3). Usually, fiber collectors and manufacturers live in rural areas where roads are poor or nonexistent-



Fig. 3. Stripping leaflets of *Astrocaryum chambira* in the Colombian Amazon

ent and, as a consequence, traveling to the nearest market place requires much time and is expensive. Furthermore, there is market competition between products made by different social groups, as is reported for products made of *chambira* (*Astrocaryum chambira*) in Peru (Vormisto 2002) and *mócora* (*Astrocaryum standleyanum*) in Ecuador (Borgtoft Pedersen 1994). Where such competition is evident, there is great variation in prices so that, at the end, manufacturers and harvesters who can access markets tend to earn little from the commercialization of fiber and fiber objects.

Despite this, fiber collecting and processing may constitute a very important part of the cash income of artisan and extractor communities and households (Lescure et al. 1992; Jensen and Balslev 1995; Crepaldi et al. 2007; Balslev et al. 2010). Fiber harvesters can earn from \$0.15 to \$19.16 USD per day with an average of more than \$1.25 USD per day, which is considered to place them above the poverty line for underdeveloped nations (Ravallion et al. 2008). Such income may be complemented with other activities such as cattle husbandry, agriculture, and the extraction of other NTFPs (Mayer 2006). Due to the importance of fibers, fiber extraction and artisanal production of fiber objects have been promoted as a source of income that can also serve to conserve resources in rural areas of South America (Artesanías de Colombia 1997; CENPOL 2000; Vantomme 2004; Saraiva 2009).

Currently, the major outlets for fiber and fiber objects are local markets and tourist markets in cities such as Quito, Lima, Bogotá, Leticia, Iquitos, Manaus, and Belém, and in tourist shops along some highways. However, many fiber crafters cannot access these markets and they frequently sell to tourists visiting their villages (Jensen and Balslev 1995; Coomes 2004). The market chains for fiber products are variable: it is usual to find two market chains for a species, which represents a strategy to increase sales and access more markets (Fig. 4). The most common are those in which the extractor is also the artisan, who sells the product to a middleman, who finally sells it to a shopkeeper or to the final buyer; in this case, the middleman earns most of the profit. Another common chain is one in which the extractor/artisan sells directly to the final buyer or shop, which is more profitable for the artisan (Crizón 2001; Vormisto 2002; Balslev et al. 2010).

Fiber production from South American palms has been repeatedly affected as fibers from other sources have provided substitutes. As early as the 19<sup>th</sup> century, African and Asian piassabas (mainly *Raffia ruffia* and *Borassus flabellifer*) began to compete with the American species (*Attalea funifera* and *Leopoldinia piassava*) that previously dominated the market (Dodge 1897; Kirby 1950). In the 20<sup>th</sup> century, synthetic fibers and fibers from other plants that are cultivated at a large scale, such as cotton or sisal, also

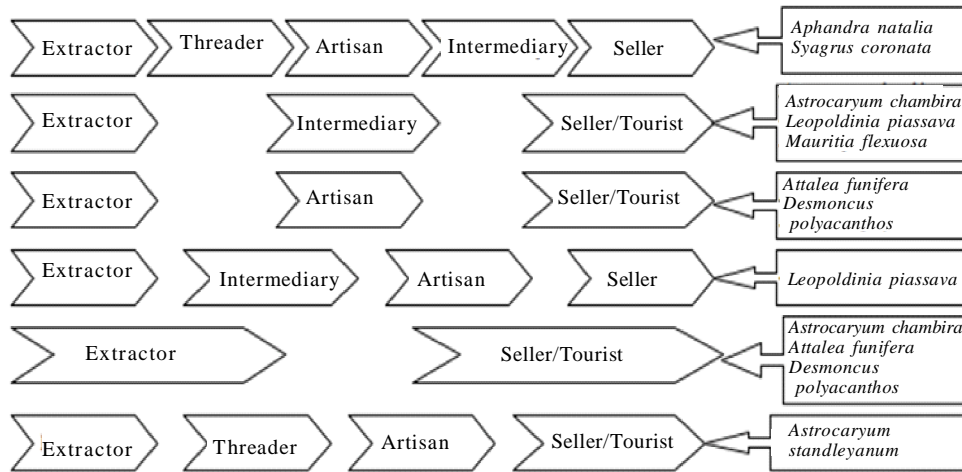


Fig. 4. Market chains for palm fiber and palm fiber objects in South America. Unless otherwise stated, the extractor is also the artisan or manufacturer

displaced South American palm fiber (Byg and Balslev 2006; Paniagua-Zambrana et al. 2007). Bags, hammocks, brooms, and fishing nets made from *Astrocaryum chambira*, *Attalea maripa* and *Leopoldinia piassaba*, have been substituted with cheaper plastic (bags), cotton (hammocks), monofilaments (brooms), and nylon (nets) (Wheeler 1970; Bernal 1992; Guánchez and Romero 1998). In some areas of the Venezuelan and Colombian Amazon, even the traditional *sebucán* used to squeeze cassava, usually woven from *Desmoncus polyacanthos*, is now made with packaging strip (Bernal, pers. obs.). However, the use of palm fiber is still prevalent for bags and hammocks because of its aesthetic appeal and durability (Vormisto 2002; Gallego 2005).

Most fiber harvesters in South America depend, to different degrees, on palm fiber extraction and handicraft production to earn cash. For many indigenous communities this income is not high nor is it represented in national economic statistics (Coomes 2004; Gallego 2005; Mayer 2006). Women and children play an important role in the activity and with it they contribute essential cash income to their households; fiber harvest and processing particularly provide women with better economic perspectives (Hiraoka 1999; Crepaldi et al. 2007; Guel and Penn 2009).

#### Conservation and Sustainable Use

Information about the conservation status of South American fiber-producing palms was

usually not reported in the studies reviewed, so this information was obtained from Dransfield et al. (1988), Borchsenius and Skov (1999) for Ecuador, and Galeano and Bernal (2005) for Colombia. Thirty-six of the 111 species reported are not threatened, and eight have 'lower concern' status; several of the most used species belong to the latter group, such as *Aphandra natalia*, *Mauritia flexuosa*, *Leopoldinia piassaba*, *Attalea funifera*, *Copernicia prunifera*, *Desmoncus polyacanthos*, and *Syagrus coronata*. There are 17 species in the group of 'vulnerable and endangered species,' including species of *Ceroxylon* and the Bolivian endemic *Parajubaea sunkha*. For some important palm species, such as *Astrocaryum chambira*, *A. standleyanum*, and *Leopoldinia piassaba*, conservation status is known only in Colombia. Five species are endemic to one country and have scattered populations, which may aggravate the effect of harvesting pressure and ecosystem threats, as is the case with *Parajubaea torallyi* that is classified as endangered (Vargas 1994).

The conservation status of a species, however, may not reflect the state of the populations in the areas where they are most used. Categorizations are usually made at national or continental scales and, in the assessment process, local depletion or extinction of populations as a consequence of over-exploitation may be buffered by the overall distribution of the species throughout other unexploited areas. This is the



case with some important species such as *Astrocaryum standleyanum*, *A. chambira*, *Mauritia flexuosa* and other twelve reported species, which are now decimated near some of their major centers of use (Linares et al. 2008; Guel and Penn 2009; Saraiva 2009), but that are still widespread in areas of undisturbed forest. The sustainability or non-sustainability of palm fiber extraction depends on the interaction between various factors, including ecosystem status, habitat specificity, growth rates, plant parts used, harvesting techniques and rates, and market demand. Other factors have a lower impact on sustainability and may act in combination with the major factors, or are triggered by them. In-depth information on sustainability is scarce: the researchers found 27 well-documented cases discussing extraction, harvest, management, and conservation, but there is still a substantial number of species for which information is poor or lacking, including some species that are heavily used, such as *Copernicia prunifera* and *Astrocaryum aculeatum* (Taube 1952; von Andel 2000; Campos and Ehringhaus 2003). The most crucial factor for palm conservation in general is habitat loss (Paniagua et al. 2007; Borchsenius and Skov 1999). Species that are not perceived as 'important' for a social group in a severely transformed ecosystem can be decimated, and knowledge about their use and management might be forgotten. In contrast, species considered to be 'important,' like *Aphandra natalia* in Ecuador, are likely to be maintained in agroforestry systems or in fallows (Borgtoft Pedersen 1992). Harvesting techniques, on the other hand, range from the entirely harmless cutting of leaf sheath fibers in low palms to the common malpractice of felling palms to facilitate rapid leaf extraction. Ultimately, the kind of economic development in the trade in fiber products is the strongest driver of sustainability. For example, where the activity is not mainly market-oriented, palms are of lower importance to local incomes and palm populations are less affected. On the other hand, in places where markets are expanding, palm populations are in decline, causing local extinctions (Belcher et al. 2005). For three of the 111 species recorded (*Attalea funifera*, *Desmoncus polyacanthos*, *Leopoldinia piassaba*), use, harvest, and management were considered sustainable (Putz 1979; May et al. 1985; Crizón 2001). For six species, use was considered to be sustainable but this was qualified, as some har-

vesters used harmful practices (Voeks 1988; Borgtoft Pedersen 1992; Vargas 1994; Fadiman 2003; Coomes 2004). For five of the species, the few reports available and field observations show that its use has a tendency to be mostly unsustainable as a result of over-harvesting and felling of palms (Dawson and Gancedo 1977; Balick 1985a; Moraes 1996; Moraes 1998; Balslev et al. 2010; Bernal et al. 2011). In most cases, the introduction of a few simple practices would make use completely sustainable. Unfortunately, for 86% of the species, the sustainability of harvesting and management practices is unknown (Bernal et al. 2011).

**Relationships with other NTFPs:** As is the case with many other NTFPs, large-scale markets for South American palm fibres are scarce, as transportation costs are too high and, with a few exceptions, such as piassava (*Attalea funifera*), the demand is low (Marshall et al. 2003; Belcher et al. 2005). Reduced market access, combined with deforestation, product substitution, and insecure land tenure, restrict markets for NTFPs worldwide (Geist and Lambin 2002; Marshall et al. 2003; Velásquez-Runk et al. 2004; Vantomme 2004). Nevertheless, as it is the case with other NTFPs, palm fibers are fundamental to local economies, in particular for indigenous people, farmers, and women. These are considered to be vulnerable population groups whose contributions to national economies in most cases are undervalued (Belcher et al. 2005; Mayer 2006; Paniagua-Zambrana et al. 2007). Indigenous groups and farmers who live in remote forested areas are increasingly being incorporated into markets, as is the case today with most palm fiber harvesters. It seems that such groups are intensifying management of wild populations and initiating cultivation schemes to increase income, especially around species perceived as 'important', as *Astrocaryum chambira* or *Aphandra natalia*. Other factors leading to intensified management and higher income are more secure land and tree tenure, so that the labor invested in sustainable management and use will be returned to the owner in the form of higher production rates (Marshall et al. 2003; Ruiz-Pérez et al. 2005). But as market demand for NTFPs grows, harvesting pressure also grows; three patterns can be identified: 1) extraction is intensified through over-harvesting, resulting in depletion of the resource, 2) intensified management is undertaken and harvesting limits are im-

posed to ensure species viability and availability, and 3) cultivation and enrichment programs are initiated to guarantee supplies (Velásquez-Runk et al. 2004; Ticktin 2004; Peters et al. 2007). These three processes are evident in palm fiber extraction activity in South America. What is clear is that both management and cultivation increase production, help to protect the species, and increase household welfare. Unrestrained use, on the contrary, may be a direct path to local species extinction.

### CONCLUSION

Of the palm species present in the region 24% are used in any extent for fiber, revealing the acknowledgement of the palm group as a key source of fiber materials. The palm species with the higher number of reports and most types of objects made from are *Astrocaryum chambira* and *Mauritia flexuosa*, both distributed mainly in the Amazon, where the highest number of palm species is used for fiber. The manufacture of utilitarian objects, such as baskets or cordage, is the primary use of fiber in the subcontinent, however due to substitution of industrially produced alike objects, palm fibre items in South America are increasingly made as handicrafts to satisfy a rising and thriving market. Fibre harvest and process is made mostly by indigenous groups and peasants, for whom the selling of palm fiber object is an important source of income that requires minimum management of the species obtained, since the majority comes from wild populations, freely harvested in terms of frequency and quantity. The harvest methods currently employed when fiber extraction is continuous and intense, are destructive, affecting the conservation of population stands and therefore the sustainability of the activity. This scenario is specially seen when the market demand of the products is increasing and there are no regulations of the species management. There are few reported cases that detail palm fiber harvest, making it a fertile ground to research and from which many people in distress depend on.

### RECOMMENDATIONS

The scarcity of in-depth information about palm fibre extraction and management in South America is remarkable - less than the 10% of the references contained this kind of information; yet, such studies, especially those related with

the species' demography, are needed, in order to develop strategies for the sustainable use of fibre palms, particularly when palm fibre extraction has been promoted by governments and non-governmental organizations as a 'sustainable' means to improve welfare, as it is the case with other NTFPs. There is still a very substantial number of fibre palm species for which use, management and extraction rates are unknown, including some species that are heavily used, such as *Astrocaryum aculeatum*, *Astrocaryum standleyanum*, *Attalea butyracea*, *Bactris setosa*, *Copernicia prunifera*, *Desmoncus polycanthos*, *Manicaria saccifera*, and *Syagrus romanzoffiana*, among others. Furthermore, there are few palm fiber studies in certain geographical areas such as the Caribbean region, the Inter-Andean Valleys, the Llanos savanna and the Great Chaco, which may harbor less palm species than other regions, but have some fiber-producing species used by local people and with a great potential but were not included in the study since formal studies of such species have not published yet.

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## APPENDIX

Appendix 1. Palm species used for fibres in South America, with the geographical record of use, parts employed, fiber types, objects manufactured and references of the reports. A. Geographic region according with ecosystem units: 1. Pacific lowlands, 2. Andes, 3. Amazonas, 4. Llanos savanna, 5. Cerrado, 6. Caatinga, 7. Mata Atlántica, 8. Great Chaco, 9. Caribbean. B. Fiber classification after Dodge (1897) 1. Spinning material, 2. Tie material, 3. Natural textures, 4. Brush fibers, 5. Plaiting, 6. Filling material and 7. Paper material. C. Types of objects manufactured: 1. Bags, 2. Baskets, 3. Brooms, 4. Clothes, 5. Cordage, 6. Fans, 7. Filling, 8. Furniture, 9. Hammocks, 10. Hats, 11. Mats, 12. Necklaces, 13. Nets, 14. Screens, 15. Strainers, 16. Traps.

Species	Countries	Geographic region	Fiber origin	Fiber type	Objects manufactured	References
<i>Acrocomia aculeata</i> (Jacq.) Lodd. ex Mart.	Argentina, Brazil, Bolivia, Paraguay	Amazonas, Cerrado, Mata Atlántica	Leaves	1	1, 2, 4, 5, 9, 10, 11, 13	Dodge 1897, Peckolt and Peckolt 1889, Bertoni 1903, Markley 1956, Cárdenas 1969, Pinheiro and Balick 1987, Lorenzi 2006
<i>Allagoptera arenaria</i> (Gomes) Kuntze	Brazil	ND	Leaves	5	2	Peckolt and Peckolt 1889, Pinheiro and Balick 1987
<i>Allagoptera campestris</i> (Mart.) Kuntze	Brazil	Mata Atlántica	Leaves	5	2	Peckolt and Peckolt 1889
<i>Ammandra decasperma</i> O.F.Cook	Colombia, Ecuador	Amazonas, pacific	Leaves, petioles	5	1, 2, 6	Bernal and Galeano 1993, Henderson et al. 1995, Macía 2004, Linares et al. 2008
<i>Aphandra natalia</i> (Balslev and A.J.Hend.) Barfod	Brazil, Ecuador, Peru	Amazonas	Leaves, leaf sheath, petioles	4	3	Borgtoft Pedersen and Balslev 1990, Barfod 1991, Borgtoft Pedersen 1991, 1992, Borgtoft Pedersen and Balslev 1992, Henderson et al. 1995, Borgtoft Pedersen 1996, Borchsenius et al. 1998, Vásquez and Baluarte 1998, Borgtoft and Skov 2001, Macía 2004, Boll et al. 2005, Meyer 2006
<i>Astrocaryum acule</i> Mart.	Brazil, Colombia, Venezuela	Amazonas	Leaves, petioles, caatinga,	5	2, 4	Wallace 1853, Dodge 1897, Peckolt and Peckolt 1889, Henderson et al. 1995, Ferreira 2008
<i>Astrocaryum aculeatissimum</i> (Schott) Burret	Brazil	Amazonas, Mata Atlántica	Leaves	1	3, 5, 10, 13	Mors and Rizzini 1966, Kitzkeand Johnson 1975, Johnson 1982, Pinheiro and Balick 1987, Henderson et al. 1995
<i>Astrocaryum aculeatum</i> G.Mey.	Bolivia, Brazil, Colombia, Guyana	Amazonas, Cerrado	Leaves, spear leaves	1, 5	2, 4, 5, 6, 9, 10, 13	Peckolt and Peckolt 1889, Dodge 1897, Schultes 1977, Johnson 1982, Pesce 1985, Boom 1986, Boom 1987, Balslev and Moraes 1989, Vormisto 2002, Campos and Ehringhaus 2003, Vargas and 2003, Amaral 2010, González 2011
Jordan <i>Astrocaryum campestre</i> Mart.	Brazil	Cerrado	Leaves	1, 5	13	Balick 1988, Henderson et al. 1995

## Appendix 1: Contd...

Species	Countries	Geographic region	Fiber origin	Fiber type	Fiber Objects manufactured	References
<i>Astrocaryum chambira</i>	Brazil, Colombia, Ecuador, Peru, Venezuela	Amazonas, Llanos savanna	Spear leaves	1	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 15, 16	Cortés 1897, Hardenburg 1913, Hodge 1947, Fejos 1943, Dugand 1961, Patiño 1967, Jordan 1970, Wheeler 1970, Schultes 1974, Patiño 1975, Glenboski 1983, Padoch et al. 1985, La Rotta 1988, Mejía 1988, Wessels Boer 1988, Borman 1992 Borgtoft Pedersen and Balslev 1992, Cerón 1995, Jensen and Balslev 1995, Gómez et al. 1996, Jensen 1997, Borchsenius et al. 1998, Cerón and Montalvo-Ayala 1998, López et al. 1998, Vásquez and Baluarte 1998, Borgtoft and Skov 2001, García 2001, Sánchez 2001, Bennett et al. 2002, Coomes 2004, Macía 2004, Gallego 2005, Castaño et al. 2007, Guel and Penn 2008 Peckolt and Peckolt 1889
<i>Astrocaryum gynacanthum</i> Mart.	Brazil	ND	Leaves	ND	ND	Peckolt and Peckolt 1889, Pinheiro and Balick 1987
<i>Astrocaryum huaimi</i> Mart.	Brazil	Amazonas	Leaves	1	4	Peckolt and Peckolt 1889, Schultes 1977, Pinheiro and Balick 1987, Mejía 1988, Borgtoft Pedersen and Balslev 1990, Gragson 1992, Henderson et al. 1995
<i>Astrocaryum jauari</i> Mart.	Brazil, Colombia, Ecuador, Peru, Venezuela	Amazonas	Leaves, petioles, spear leaves		1, 2, 6, 9, 10, 11, 14	Cortés 1897, Pérez Arbelaez 1956, Dugand 1961, Patiño 1975, Henderson et al. 1995, Patiño 1997
<i>Astrocaryum malybo</i> H.Karst.	Colombia	Andes	Leaves, spear leaves	5	2, 3, 11	Peckolt and Peckolt 1889, Dodge 1897, Lévi-Strauss 1952, Schultes 1977, Bodley and Benson 1979, Mejía 1988, Campos and Ehringhaus 2003 Sonowska et al. 2009
<i>Astrocaryum murumuru</i> Mart.	Brazil, Peru	Amazonas, Cerrado	Leaves, spear leaves	5	2, 6, 10, 11	Peckolt and Peckolt 1889, Dodge 1897, Lévi-Strauss 1952, Schultes 1977, Bodley and Benson 1979, Mejía 1988, Campos and Ehringhaus 2003 Sonowska et al. 2009
<i>Astrocaryum perangustatum</i> F. Kahn and B.Millán	Peru	Amazon	Leaf raquis	3		Peckolt and Peckolt 1889, Pinheiro and Balick 1987
<i>Astrocaryum scitophilum</i> (Miq.) Pulle	Brazil	Brazil	Amazonas	5	10, 11	Patiño 1975, Forero-Pinto 1980, Barfod and Balslev 1988, Borgtoft Pedersen 1994, Henderson et al. 1995, Barfod and Kvist 1996, Patiño 1997, Borchsenius et al. 1998, Borgtoft and Skov 2001, Velásquez-Runk 2001, Fadiman 2006
<i>Astrocaryum standleyanum</i> L.H.Bailey	Colombia, Ecuador	Pacific	Spear leaves	5	2, 5, 8, 9, 10, 11, 13	

Appendix 1: Contd...

Species	Countries	Geographic region	Fiber origin	Fiber type	Objects manufactured	References
<i>Astrocaryum vulgare</i> Mart.	Brazil, French Guiana, Surinam	Amazonas, Cerrado, Mata Atlantica, Llanos savanna	Leaves, spear leaves	1	1, 2, 5, 6, 9, 10, 11, 13	Wallace 1853, Peckolt and Peckolt 1889, Civrieux 1957, Balick 1985a, Pinheiro and Balick 1987, Baleé 1989, Oliveira et al. 1991
<i>Attalea butyracea</i> (Mutis ex L.f.) Wess.Boer	Brazil, Colombia, Peru	Amazonas, Andes, Caribbean, Llanos savanna	Spear leaves, leaves, spathe, inflorescence	5	1, 2, 3, 5, 6, 10, 11	Peckolt and Peckolt 1889, Pérez Arbelaez 1956, Bodley and Benson 1979, Campos and Ehringhaus 2003, Bernal et al. 2010
<i>Attalea colenda</i> (O.F.Cook) Balslev and A.J.Hend.	Ecuador	Pacific	Leaves, petioles	1	5	Acosta-Solis 1952, Borchsenius et al. 1998
<i>Attalea dubia</i> (Mart.) Burret	Brazil	Mata Atlantica	Leaves	5	2	Peckolt and Peckolt 1889
<i>Attalea eichleri</i> (Drude) A.J.Hend.	Brazil	Caatinga, Cerrado, Mata Atlantica	Leaves	1	1, 5	Peckolt and Peckolt 1889
<i>Attalea exigua</i> Drude	Brazil	Cerrado	Petiole	5	2	Peckolt and Peckolt 1889
<i>Attalea funifera</i> Mart.	Brazil	Mata Atlantica	Petiole	4	2, 3, 5, 10, 11	Hooker 1849, Archer 1855, Squier 1863, Moody 1863, Dodge 1897, Peckolt and Peckolt 1889, Demers 1909, Goulding 1917, Rendle 1917, Bondar 1942a, Dewey 1943, Kirby 1950, Lévi-Strauss 1952, Hodge 1961, Moses 1962, Kirby 1963, Mors and Rizzini 1966, León 1968, Kitzke and Johnson 1975, Johnson 1982, Pesce 1985, Pinheiro and Balick 1987, Voeks 1988, Prance Henderson et al. 1995, Grimarães et al. 2007 Macia 2004
<i>Attalea insignis</i> (Mart.) Drude	Ecuador	Amazonas	Petiole	5	11	
<i>Attalea maripa</i> (Aubl.) Mart.	Brazil, Bolivia, Colombia, Ecuador, Guyana, Peru, Venezuela	Amazonas, Cerrado, Llanos savanna	Leaves, petioles, spear leaves	1, 2, 5, 6, 11, 14, 16		Peckolt and Peckolt 1889, Lévi-Strauss 1952, Civrieux 1957, Moses 1962, Braun 1968b, Anderson 1978, Balick 1979, Bodley and Benson 1979, Hoyos and Braun 1984, Balick 1985b, Guánchez and Romero 1998, Vargas y Jordan 2003, Macia 2004, Rondón 2005, Oliveira et al. 2006 Peckolt and Peckolt 1889
<i>Attalea microcarpa</i> Mart.	Brazil	Amazonas	Leaves	ND	ND,	
<i>Attalea oleifera</i> Barb.Rodr.	Brazil	Mata Atlantica	Leaves, spear leaves	5	2	Peckolt and Peckolt 1889, Pinheiro and Balick 1987

## Appendix 1: Contd...

Species	Countries	Geographic region	Fiber origin	Fiber Objects type manufactured	References	
<i>Attalea phalerata</i> Mart. ex Spreng.	Brazil, Bolivia	Amazonas, Cerrado, Great Chaco	Leaves, spear leaves	4,5	1, 2, 3, 6, 10, 11	Peckolt and Peckolt 1889, Boom 1986, Boom 1987, Boom 1988, Balslev and Moraes 1989, Campos and Ehringhaus 2003, Vargas y Jordan 2003, Moraes 2004, Borchsenius and Moraes 2006 Peckolt and Peckolt 1889
<i>Attalea racemosa</i> Spruce	Brazil, Venezuela	Amazonas	Leaves, stem	1	4	
<i>Attalea speciosa</i> Mart.	Brazil, Bolivia	Cerrado, Great Chaco,	Leaves, spear leaves	1, 5	1, 2, 3, 5, 6, 10, 11, 15, 16	Irmay 1949, Lévi-Strauss 1952, May et al. 1985, Pinheiro and Balick 1987, Balick 1988, Balslev and Moraes 1989, Prance 1998, Campos and Ehringhaus 2003, Vargas and Jordan 2003, Moraes 2004 Peckolt and Peckolt 1889
<i>Attalea spectabilis</i> Mart.	Brazil	Amazonas	Leaves	1	5, 13	
<i>Attalea tessmannii</i> Burret	Brazil, Peru	Amazonas	Leaves, spear leaves	4, 5, 6	2, 3, 6, 7, 10	Bodley and Benson 1979, Campos and Ehringhaus 2003
<i>Bactris acanthocarpa</i> Mart.	Brazil	Mata Atlantica	Leaves	1	5, 13	Peckolt and Peckolt 1889
<i>Bactris brongniartii</i> Mart.	Brazil	Amazonas	Leaves	1	5	Peckolt and Peckolt 1889
<i>Bactris cuspidata</i> Mart.	Brazil	ND	Leaves	1	4, 5, 13	Pinheiro and Balick 1987
<i>Bactris gasipaes</i> Kunth	Colombia, Ecuador, Peru	Amazonas, Llanos savanna	Leaves	1	1, 4, 6, 11	López et al. 1998, Byg and Balslev 2004, Sonowska et al. 2009
<i>Bactris glaucescens</i> Drude	Brazil	Matto Grosso	Leaves	1	1, 5	Peckolt and Peckolt 1889
<i>Bactris hirta</i> Mart.	Brazil	Amazonas	ND	1	4	Peckolt and Peckolt 1889
<i>Bactris major</i> Jacq.	Bolivia	Amazonas, Andes, Great Chaco	Stem	5	3	Moraes 2004
<i>Bactris riparia</i> Mart.	Brazil, Ecuador	Amazonas, Cerrado, Matto Grosso	Leaves, stem	1, 4	3, 4	Peckolt and Peckolt 1889, Macía 2004 Peckolt and Peckolt 1889, Macía 2004
<i>Bactris setosa</i> Mart.	Brazil	Mata Atlantica	Leaves	1	1, 4, 5, 9, 10, 13	Peckolt and Peckolt 1889, Dodge 1897, Lévi-Strauss 1952, Kirby 1963, Pinheiro and Balick 1987, Fonseca-Krueel and Peixoto 2005 Peckolt and Peckolt 1889
<i>Barcella odora</i> (Trail) Drude	Brazil	Amazonas	Leaves	ND	ND	DaSilva 2008
<i>Butia capitata</i> (Mart.) Becc.	Brazil	Cerrado	Leaves	4	3	
<i>Ceroxylon alpinum</i> Bonpl. ex DC.	Venezuela	Andes	Spear leaves	5	10	Pittier 1978

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Species	Countries	Geographic region	Fiber origin	Fiber type	Objects manufactured	References
<i>Ceroxylon echinulatum</i> Galeano	Ecuador	Andes	Spear leaves	5	2	Borchsenius and Skov 1999
<i>Ceroxylon ventricosum</i> Burret	Ecuador	Andes	Spear leaves	5	4, 10, 11	Borchsenius et al. 1998, Macía 2006
<i>Chelyocarpus chuco</i> (Mart.) H.E.Moore	Brazil, Bolivia	Amazonas, Cerrado	Leaves, petioles	5	2, 10, 15	Peckolt and Peckolt 1889, Balslev and Moraes 1989, Henderson et al. 1995, Campos and Ehringhaus 2003
<i>Chelyocarpus ulai</i> Dammer	Brazil, Peru	Amazonas	Leaves	5, 6	2, 3, 6, 7, 9, 10, 12	Bodley and Benson 1979, Campos and Ehringhaus 2003
<i>Coccothrinax barbadensis</i> (Lodd. ex Mart.) Becc.	Venezuela	Caribbean	Spear leaves	5	1, 11	Hoyos and Braun 1984
<i>Copernicia alba</i> Morong	Argentina, Brazil, Bolivia, Paraguay	Great Chaco	Leaves	1	1, 5, 8, 9, 10	Markley 1955, Pinheiro and Balick 1987, Henderson et al. 1995
<i>Copernicia prunifera</i> (Mill.) H.E.Moore	Argentina, Brazil, Bolivia	Caatinga, Mata Atlantica	Leaves, petioles	1, 5	1, 2, 3, 6, 10, 11, 13	Moody 1863, Mueller 1895, Dodge 1897, Taube 1956, Mors and Rizzini 1966, Johnson 1982, Johnson 1985, Pinheiro and Balick 1987
<i>Copernicia tectorum</i> (Kunth) Mart.	Colombia, Venezuela	Llanos savanna	Leaves, spear leaves	5	2, 10	Pittier 1978, Henderson et al. 1995
<i>Cryosophila kalbreyeri</i> (Dammer ex Burret)	Colombia	Andes	Leaves	4	3	Borchsenius and Moraes 2006
<i>Desmoncus cirrhifer</i> A.H. Gentry and Dahlgren	Colombia, Ecuador, Amazonas,	Pacific	Stem	2, 5	2, 8, 13, 16	Gentry 1988, Bernal and Galeano 1993, Henderson et al. 1995, Barford and Kvist 1996, Zardini Borchsenius et al. 1998
<i>Desmoncus giganteus</i> A.J.Hend.	Brazil, Colombia, Ecuador, Peru	Amazonas, Llanos savanna	Stem	2, 5	2, 8	Henderson 1995, Henderson et al. 1995, Cerón and Montalvo-Ayala 1998
<i>Desmoncus horridus</i> Splitg. ex Mart.	Brazil, Bolivia, Colombia, Ecuador, Guyanas, Venezuela	Amazonas, Llanos savanna, Mata Atlantica	Stem	2, 5	1, 2, 6, 8, 11, 15	Civrieux 1957, Pinheiro and Balick 1987, Oliveira et al. 1991, Henderson et al. 1995, Balslev et al. 1997, Cerón and Montalvo-Ayala 1998, Oliveira et al. 2066, Guerra et al. 2008
<i>Desmoncus mitis</i> Mart.	Brazil, Colombia, Peru	Amazonas	Stem	2, 5	2	Peckolt and Peckolt 1889, Galeano 1992, Henderson et al. 1995
<i>Desmoncus polycanthos</i> Mart.	Brazil, Bolivia, Colombia, Guyana, Peru, Suriname	Amazonas, Andes	Stem	2, 5	2, 8, 15	Wallace 1853, Moody 1863, Peckolt and Peckolt 1889, Dodge 1897, Pinheiro and Balick 1987, Galeano 1992, Henderson and Chávez 1993, Henderson et al. 1995, von Andel 2000, Moraes 2004, Hübschmann et al. 2007
<i>Elaeis oleifera</i> (Kunth) Cortés	Venezuela	Caribbean	Leaves	1	5	Pittier 1978

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Species	Countries	Geographic region	Fiber origin	Fiber type	Objects manufactured	References
<i>Euterpe precatoria</i> Mart.	Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Surinam, Venezuela	Amazonas	Leaves, spear leaves	1,4,5	1, 2, 3, 4, 6, 11, 15	Balslev and Moraes 1989, Cerón and Montalvo-Ayala 1998, Henderson 1995, von Andel 2000, Campos and Ehringhaus 2003, Vargas and Jordan 2003, Byg and Balslev 2004 Oliveira et al. 2006
<i>Euterpe oleracea</i> Mart.	Brazil	Amazon	Leaves	2	2	Anderson 1978
<i>Geonoma baculifera</i> (Poir.) Kunth	Brazil	Amazonas	Leaves	5	2	
<i>Geonoma deversa</i> (Poir.) Kunth	Bolivia, Brazil, Ecuador, Colombia, Ecuador, Guyana, Peru, Venezuela	Amazonas	Leaves	5	2	Anderson 1978, Henderson 1995, Borchsenius et al. 1998
<i>Geonoma macrostachys</i> Mart.	Ecuador	Amazonas	Stem	4	3	Macía 2004
<i>Geonoma pohliana</i> Mart.	Brazil	Mata Atlantica	Leaves, petioles	1, 5	2, 5, 14	Peckolt and Peckolt 1889, Pinheiro and Balick 1987
<i>Geonoma leptospadix</i> Trail	Brazil	Amazonas, Cerrado	Petiole	5	2	Peckolt and Peckolt 1889
<i>Geonoma schottiana</i> Mart.	Brazil	Caatinga, Cerrado, Mata Atlantica	Petiole, stem	1, 5	1, 2	Peckolt and Peckolt 1889, Pinheiro and Balick 1987
<i>Hyospathe elegans</i> Mart.	Brazil	Amazonas	Stem	5	2	Peckolt and Peckolt 1889
<i>Iriartea deltoidea</i> Ruiz and Pav.	Brazil, Bolivia, Colombia, Ecuador, Peru, Venezuela	Amazonas	Leaves, spear leaves	1, 4, 5	2, 3, 5, 11	Henderson 1995, Borchsenius et al. 1998, Byg 2002, Byg and Balslev 2004, Sonowska et al. 2009
<i>Iriartella setigera</i> (Mart.) H.Wendl.	Venezuela	Amazonas	Stem	5	2, 16	Guánchez and Romero 1998
<i>Jubaea chilensis</i> (Molina) Bail.	Chile	Great Chaco	Leaves	4, 5	2, 3, 11	Grau 2006
<i>Leopoldinia major</i> Wallace	Brazil	ND	Leaves	1	4	Pinheiro and Balick 1987
<i>Leopoldinia piassaba</i> Wallace	Brazil, Colombia, Venezuela	Amazonas, Llanos savanna	Leaves, petioles	2, 4	2, 3, 5, 10	Wallace 1853, Spruce 1855, Spruce 1860, Moody 1863, Peckolt and Peckolt 1889, Cortés 1897, Dodge 1897, Goulding 1917, Rendle 1917, Dewey 1943, Kirby 1950, Lévi-Strauss 1952, Civrteux 1957, Dugand 1961, Kirby 1963, Mors and Rizzini 1966, Braun 1968a, León 1968, Schultes 1974, Kitzke and Johnson 1975, Patiño 1975, Pittier 1978, Putz 1979, Johnson 1982, Pesce 1985, Pinheiro and Balick 1987, Wessels Boer 1988, Oliveira et al. 1991, Anderson and Ioris 1992, 1992, Lescurre et al. 1992, Henderson 1995,

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Species	Countries	Geographic region	Fiber origin	Fiber type	Fiber Objects manufactured	References
<i>Leopoldinia pulcra</i> Mart.	Brazil	Amazonas	Stem	5	2	Henderson et al. 1995, Guanchez and Romero 1998, Prance 1998, Crizón 2001
<i>Lepidocaryum tenue</i> Mart.	Colombia	Amazonas	Stem	5	2	Peckolt and Peckolt 1889 Henderson 1995
<i>Manicaria saccifera</i> Gaertn.	Brazil, Colombia, Venezuela	Amazonas, Llanos savanna, Pacific	Spathe	3	1, 4, 10, 11	Wallace 1853, Moody 1863, Dodge 1897, Dugand 1961, Braun 1968b, Patiño 1975, Duke 1977, Wilbert 1980, Oliveira et al. 1991, Henderson 1995
<i>Mauritia carana</i> Wallace	Brazil, Colombia, Peru, Venezuela	Amazonas	Leaves		1995 3	Henderson et al. 1995
<i>Mauritia flexuosa</i> L.f.	Brazil, Colombia, Ecuador, Guyana, Peru, Surinam, Venezuela	Amazonas, Cerrado, Llanos savanna, Pacific	Leaves, petioles, spear leaves	1, 2	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15	Wallace 1853, Moody 1863, Squier 1863, Im Thurn 1883, Peckolt and Peckolt 1889, Dodge 1897, Fejos 1943, Acosta-Solis 1952, Lévi-Strauss 1952, Perez Arbelaez 1956, Dugand 1961, Moses 1962, Ramia 1962, Mors and Rizzini 1966, Suárez 1966, Braun 1968b, Suárez 1968, Calvacante 1977, Schultes 1977, Balick 1979, Bodley and Benson 1979, Johnson 1982, Hoyos and Braun 1984, Pesce 1985, Pinheiro and Balick 1987, Balick 1988, Mejía 1988, Oliveira et al. 1991, Anderson and Ioris 1992, Galeano 1992, Gragson 1992, Milliken et al. 1992, Henderson et al. 1995, Chávez 1996, Guánchez and Romero 1998, López et al. 1998, Prance 1998, Hiraoka 1999, von Andel 2000, Macía 2004, Oliveira et al. 2006, Sousa and Sousa 2007, Sampaio et al. 2008, Santana et al. 2008, Saratva 2009, Oening 2010, González 2011
<i>Mauritiella aculeata</i> (Kunth) Burret	Brazil, Venezuela	Llanos savanna	Leaves	1, 2	5, 6, 9, 10, 11	Pinheiro and Balick 1987, Gragson 1992
<i>Mauritiella armata</i> (Mart.) Burret	Bolivia, Brazil, Colombia, Ecuador, Peru, Venezuela	Amazonas	Leaves	1, 5	2, 4	Pinheiro and Balick 1987, Henderson 1995
<i>Oenocarpus bacaba</i> Mart.	Brazil	Amazonas, Llanos savanna	Leaves	1, 2	1, 5, 6	Dodge 1987, Prance and Silva 1975, Pinheiro and Balick 1987
<i>Oenocarpus batata</i> Mart.	Brazil, Bolivia, Colombia, Ecuador, Guyana, Peru, Venezuela	Amazonas, Andes, Llanos savanna	Leaves, petioles, spear leaves	1, 5	1, 2, 3, 4, 6, 11, 14	Beckerman 1977, Anderson 1978, Balick 1980, Hoyos and Braun 1984, Galeano 1992, Milliken et al. 1992, Borchsenius et al. 1998, Cerón and Montalvo-Ayala 1998, von Andel 2000, Byg 2002, Campos and Ehringhaus 2003, Byg and Balslev 2004, Macía 2004, Sánchez et al. 2005, Borchsenius and Moraes 2006, Sonowska et al. 2009

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Species	Countries	Geographic region	Fiber origin	Fiber type	Objects manufactured	References
<i>Oenocarpus distichus</i> Mart.	Brazil	Cerrado	Leaves, spear leaves	1, 2	1, 2, 6	Pinheiro and Balick 1987, Balick 1988
<i>Oenocarpus minor</i> Mart.	Brazil, Bolivia, Colombia, Ecuador, Peru, Venezuela	Amazonas, Pacific	Leaves, petioles, spear leaves	2, 5	2, 10, 11, 15	Barfod and Balslev 1988, Mejía 1988, Balslev and Moraes 1989, Henderson et al. 1995, Barfod and Kvist 1996, Borchsenius et al. 1998, García et al. 2001, Byg 2002, Campos and Ehringhaus 2003, Macía 2004
<i>Parajubaea sunkha</i> M.Moraes	Bolivia, Ecuador	Andes	Leaves, spear leaves	1, 5	2, 5, 6, 11	Moraes 1996, Moraes 1998, Moraes 2004, Borchsenius and Moraes 2006, Macía 2006
<i>Parajubaea torallyi</i> (Mart.) Burret	Bolivia	Andes	Leaves, spear leaves, stem	1, 2, 5	2, 5, 6, 8, 11, 15	Balslev and Moraes 1989, Vargas 1994, Henderson et al. 1995, Moraes 1996, Macía 2006, Thompson et al. 2009
<i>Pholidostachys synanthera</i> (Mart.) H.E.Moore	Brazil	Amazonas	Leaves	5	2	Peckolt and Peckolt 1889
<i>Phytelephas aequatorialis</i> Spruce	Ecuador	Amazonas, Pacific	Petiole, spear leaves	4, 5	2, 3, 4	Acosta-Solis 1952, Barfod 1991, Borgtoft Pedersen and Balslev 1992, van den Eynden et al. 2004
<i>Phytelephas macrocarpa</i> Ruiz and Pav.	Brazil, Bolivia, Peru	Amazon	Leaves, petioles	4, 5	2, 3, 6, 11	Spruce 1860, Campos and Ehringhaus 2003, Moraes 2004, Sonowska et al. 2009
<i>Phytelephas tenuicaulis</i> (Barfod) A.J.Hend.	Ecuador	Amazonas	Leaves	5	2	Macía 2004
<i>Prestoea acuminata</i> (Willd.) H.E.Moore	Ecuador	Andes	Spear leaves		54, 10, 11	Acosta-Solis 1952
<i>Prestoea ensiformis</i> (Ruiz and Pav.) H.E.Moore	Ecuador	Amazonas	Petiole	1, 5	2, 4	Byg 2002, Byg and Balslev 2004
<i>Prestoea schultzeana</i> (Burret) H.E.Moore	Ecuador	Amazonas	Leaves	1, 4	3, 5, 16	Bennett et al. 2002
<i>Raphia taedigera</i> (Mart.) Mart.	Brazil, Colombia	Amazonas, Pacific	Petiole	2, 5	1, 2, 5, 8, 10, 13, 16	Wallace 1853, Dodge 1897, Patiño 1975, Oliveira et al. 1991, Henderson 1995, Henderson et al. 1995
<i>Roystonea oleracea</i> (Jacq.) O.F.Cook	Colombia, Guyanas, Venezuela	Llanos savanna	Leaves	1	5	Patiño 1975
<i>Syagrus botryophora</i> (Mart.) Mart.	Brazil	ND	Leaves	1, 5	2	Peckolt and Peckolt 1889, Pinheiro and Balick 1987



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Species	Countries	Geographic region	Fiber origin	Fiber type	Objects manufactured	References
<i>Syagrus coronata</i> (Mart.) Becc.	Brazil	Mata Atlantica	Leaves, Spear leaves	Leaves	1, 2, 5 1, 2, 3, 4, 5, 9, 10, 11, 15	Peckolt and Peckolt 1889, Howes 1940, Bondar 1942b, Pinheiro and Balick 1987, Crepaldi et al. 2004, Antunes 2006, Lima et al. 2008 Peckolt and Peckolt 1889
<i>Syagrus inajai</i> (Spruce) Becc.	Brazil	ND	Leaves	Leaves	1 9, 11	
<i>Syagrus petraea</i> (Mart.) Becc.	Brazil, Bolivia, Paraguay	Caatinga, Cerrado, Mata Atlantica	Leaves	Leaves	5 2, 3, 9	Peckolt and Peckolt 1889, Pinheiro and Balick 1987, Henderson et al. 1995
<i>Syagrus pleioclada</i> Burret	Brazil	Mata Atlantica	Leaves	Leaves	4 3	Henderson et al. 1995
<i>Syagrus pseudococos</i> (Raddi) Glassman	Brazil	ND	Spear leaves	Spear leaves	1, 2 10	Pinheiro and Balick 1987
<i>Syagrus romanzoffiana</i> (Cham.) Glassman	Argentina, Brazil, Paraguay, Uruguay	Great Chaco	Leaves, spear leaves	Leaves, spear leaves	1, 2, 5 2, 4, 5, 6, 11	Peckolt and Peckolt 1889, Dawson and Gancedo 1977, Pinheiro and Balick 1987, Baleé 1992, Keller 2009 Henderson et al. 1995
<i>Syagrus vagans</i> (Bondar) A.D.Hawkes	Brazil	Mata Atlantica	Leaves	Leaves	5 10	Henderson et al. 1995
<i>Syagrus werdermannii</i> Burret	Brazil	Mata Atlantica	Leaves	Leaves	4, 5 3, 15	Henderson et al. 1995
<i>Syagrus yatay</i> (Mart.) Glassman	Brazil, Argentina, Paraguay	Great Chaco	Leaves	Leaves	2, 5 2, 10	Pinheiro and Balick 1987
<i>Triplrinax brasiliensis</i> Mart.	Argentina, Brazil, Bolivia, Uruguay	Great Chaco, Mata Atlantica	Leaves, petiole, spear leaves	Leaves, spear leaves	1, 4, 5 3, 4, 5, 6, 10	Peckolt and Peckolt 1889, Dodge 1897, Pinheiro and Balick 1987, Balslev and Moraes 1989, Henderson et al. 1995
<i>Triplrinax campestris</i> (Burmeister) Drude and Griseb.	Argentina, Brazil, Bolivia, Paraguay,	Andes, Great Chaco	Leaves, spear leaves	Leaves, spear leaves	5 1, 2, 6, 10	Dodge 1897, Henderson et al. 1995, Moraes 2004
<i>Welfia regia</i> H.Wendl.	Colombia	Pacific	Spear leaves	Spear leaves	4 3	Bernal and Galeano 1993
<i>Wettinia maynensis</i> Spruce	Ecuador	Amazonas	Leaves	Leaves	4 3	Byg 2002, Byg and Balslev 2004