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Abstract / Résumé

The genus Raphia (Palmae / Arecaceae) contains 22 species and represents a major multiuse resource across tropical Africa and Madagascar. Raphia species provide goods that range from food to construction material and medicine. Its species play a vital cultural role in African societies. Despite its importance, the taxonomy, ecology, and ethnobotany of this genus remain poorly understood. Here, we review the multiplicity of uses, products and cultural importance of Raphia species across its distribution. We provide a near exhaustive list of all products derived from Raphia species, classified by species and major use categories. We record nearly 100 different uses, traded and commercialized at local, regional, and national levels. Most species have several uses. Raphia wine is the most important product, followed by grubs and fiber extraction. Our review improves our understanding of the uses and cultural importance of Raphia species. If Raphia resources are managed responsibly, they will contribute to alleviate poverty, fight against hunger and conserve tropical biodiversity, especially in Africa.

Le genre Raphia (Palmae / Arecaceae) comprend 22 espèces et représente une ressource multi-usage majeure en Afrique tropicale et Madagascar. Les espèces de Raphia fournissent des produits allant des aliments aux matériaux de construction, en passant par les médicaments. Ses espèces jouent un rôle culturel vital dans les sociétés africaines. Malgré son importance, la taxonomie, l'écologie et l'ethnobotanique de ce genre restent mal comprises. Nous examinons ici la multiplicité des usages des produits et de l'importance culturelle des espèces de Raphia dans toute leur distribution. Nous fournissons une liste presque exhaustive de tous les produits dérivés des espèces de Raphia, classés par espèce et par principales catégories d'utilization. Nous enregistrons près de 100 utilisations différentes, commercialisées au niveau local, régional et national. La plupart des espèces ont plusieurs utilisations. Le vin de Raphia est le produit le plus important, suivi de l'extraction des vers et de la fibre. Notre revue améliore la

compréhension des utilisations et de l'importance culturelle des espèces de Raphia. Si les ressources de Raphia sont gérées de manière responsable, elles contribueront à réduire la pauvreté, à lutter contre la faim et à préserver la biodiversité tropicale, en particulier en Afrique.

Keywords / Mots-clés : Raffia, Palm uses, NTFPs, Cultural knowledge, Wine, Thatch, Grubs / raffia, utilisations des palmiers, PFNL, connaissances culturelles, vin, chaume, larves.

Introduction

Mahatma Gandhi referred to the harvest of local non-domesticated plant species as "an antidote to poverty" (Gandhi 1939). Even though Gandhi was specifically referring to Neera, the sap extracted from the palm species Borassus flabellifer L., his quote is true for many non-timber forest products (NTFPs). Indeed, harvesting local NTFPs plays a central role for human well-being, especially in rural communities across tropical developing countries as food, medicine and income generation (Brussaard et al. 2010; Sunderland 2011). Palms rank as one of the most economically important plant families across the tropics (Balick and Beck 1990; Balslev 2011; Brokamp et al. 2011). Continental Africa, excluding Madagascar, currently harbors 68 palm species in 18 genera (Cosiaux et al. 2018; Stauffer et al. 2017). The genus Raphia P. Beauv. is the most species rich, with currently 22 accepted species (Mogue Kamga et al. 2018). Raphia's are large palms with conspicuous trunk fibers, generally thriving in humid and swampy regions. In several African countries Raphia's are among the most important palms with a multiplicity of uses (FORENET 2010; Ingram and Schure 2010; Stauffer et al. 2014) and have been highlighted as high priority species in several central African countries (Ingram et al. 2012). Although the importance of Raphia for African populations is undisputed, we still lack fundamental baseline information for the development of more responsible management practices. This includes a basic understanding of the genus' biology, taxonomy, genetic diversity, ecology, ethno botany, applied harvesting practices and management techniques. Some studies do not even recognize or classify products derived from Raphia species as officially regulated NTFPs (Ingram and Schure 2010, Couvreur and Fumtim, 2017). Besides this lack of knowledge, species identification remains challenging, leading to much confusion in scientific literature (Beccari 1910a; Mogue Kamga et al. 2019; Tuley 1995; Tuley and Russell 1966).

Biology and Taxonomy of Raphia

Raphia species are omnipresent across tropical Africa, ranging from medium to massive palms reaching up to 30 m in height (Fig. 1A). Most species have above-ground trunks, which may be solitary or clustered, while two (R. regalis, Fig. 1B; R. vinifera, Fig. 1C) have very short or subterranean (acaulescent) trunks (Mogue Kamga et al. 2019; Tuley 1995). When the stem is above aground, it is typically hidden by old leaf sheaths and curly or straight trunk fibers. The pinnate leaves are very long reaching in some cases up to 25 or even 30 m in R. regalis (Dransfield et al. 2008; Hallé 1977; Jacques-Félix et al. 1982) Raphia palms are hapaxanthic (monocarpic, semelparous): each stem flowers only once in their lifetime and subsequently die (Dransfield et al. 2008; Russell 1965). They are monoecious, with male and female flowers on the same flowering branches (rachillae), the former at the apex and the latter at the base. The various shapes of the inflorescences constitute a key character for identification and Raphia classification (Otedoh 1982; Tuley 1995). The fruits are covered by conspicuous scales (Fig. 1D) resembling a snake skin, a common trait of the Calamoideae subfamily (Dransfield et al. 2008).

Fig. 1. A sample of Raphia species.
A: R. zamiana from northern Gabon. B. R. regalis from Gabon. C. R. vinifera from northwestern Cameroon, growing in maize and banana fields; D: Close up of a Raphia gabonica fruit.
Photos Thomas Couvreur.

Due to the massive stature, most Raphia species are rarely collected in the field, leading to a relatively poor understanding of their taxonomy (Mogue Kamga et al. 2018, 2019). Despite efforts made by several authors (Beccari 1910b; Otedoh 1982; Tuley 1995; Tuley and Russell 1966), taxonomy and species delimitation still remain insufficiently understood. Current treatments of Raphia accept 22 species (Mogue Kamga et al. 2018; Otedoh 1982) divided into five sections based on overall inflorescence morphology. See Table S1 for a list of accepted species, author names, associated synonyms and distribution.

Raphia has a disjunct distribution between Africa and the Neotropics. In Africa, it is widely distributed, occurring from west through to eastern and southern Africa and has one species in Madagascar (R. farinifera). A single species (R. taedigera) occurs in South and Central America (Dransfield et al. 2008). Its center of diversity is Central Africa, with 19 species recorded, 10 or 11 species in Cameroon and eight in Gabon (Fig. 1) (Couvreur and Sunderland 2019). Most Raphia species are well adapted to humid habitats and commonly occur in swamps, near streams in rain forests, gallery forests, and savannas. Raphia species mainly occur in lowland regions, except for R. vinifera (Mogue Kamga et al. 2019) and R. ruwenzorica,

occurring between 800 and 2000 m in Cameroon/Nigeria and eastern Democratic Republic of the Congo (DRC), respectively. Some Raphia species form dense, nearly monospecific populations stretching over large areas (Tuley and Russell 1966), providing important ecosystem services, such as water purification, limitation of soil erosion (Mphoweh et al. 2004), and carbon sequestration (Dargie et al. 2017).

Raphia Uses

Since most parts of Raphia species are exploited, we divided the uses according to the plant organ and (where possible) to the species used. We further identified and classified uses into eight ethnobotanical categories, adapted from the Economic Botany Data Collection Standard prepared for the International Working Group on Taxonomic Databases for Plant Sciences (Cook 1995): construction (CO), cultural (CU), domestic utensils and tools (D), edible (E), tools for hunting and fishing (HF), fuel (F), medicinal (M), and other uses (O) (environmental, toxic etc), and a new category: wearing apparels (W). Available studies on use and trade of Raphia species focus on particular species (e.g., R. hookeri), and species names are not usually provided (Raphia sp., "raffia", or just "palm") or probably incorrect. Here, we also report the uses for Raphia independent of the species investigated and their corresponding use categories.

Just under a hundred different Raphia uses are reported in scientific literature and span a considerable number of different categories, ranging from food (especially beverages), construction, tools, handicrafts, and energy supply through to medicinal, cultural and ecological purposes (Table 1, Table S2, Figs. 2, 3, 4, Figs. S1, S2). Although most parts of Raphia palms are useful (Tuley 1995), leaves have undoubtedly the greatest number of uses (Table S2). Indeed, leaves appear in eight of nine use categories. The petiole and rachis are commonly referred to as "bamboo" and employed in the manufacture of domestic utensils and in construction. The leaf sheaths are used as fuel wood. The leaflets are useful in two ways: fibers are extracted from young, still expanding (spear) leaflets, whereas older leaves are used for thatching material. Across Africa, leaflet midribs are used in manufacturing brooms. The least useful part, the root, only appears in two use categories (Table S2).

We show that 21 out of 22 Raphia species are useful in one or more categories (Table 1, Fig. S2), with 19 species used for construction purposes and 18 for food (Fig. S1). Few species are mentioned for the categories fuel (fuel wood), wearing apparels, and medicine. Clearly some species are exploited more extensively than others. The underlying factors determining the degree to which a species is used include product type and quality, available expertise, knowledge, and accessibility. The latter is associated with morphology and the distance to the resource. Providing raw materials that are applicable across all use categories, R. hookeri and R. vinifera are the most intensively exploited in Africa. For now, the recently described, endemic Gabonese species R. gabonica has no reported use as it is locally endemic with few individuals reported (Mogue Kamga et al. 2018).

	Species	Category	Uses
1	*R. africana* Otedoh	CO, D, E	Bamboo for construction and furniture; sap for wine; grubs
2	*R. australis* Oberm. & Strey	CO, E	Bamboo for construction and furniture; sap for wine; fibers; wax
3	*R. farinifera* (Gaertn.) Hylander	CO, E, D, CU, W	Bamboo for construction; trunk for building; sap for wine; apical meristem (palm heart/cabbage) edible; oil from fruit, mesocarp edible and traditional hair dressing; fiber for various art work; domestic utensils and traditional attires; wax
4	*R. gabonica* S.Mogue, Sonké & Couvreur		None reported
5	*R. gentilliana* De Wild.	CO, E, CU, HF, W	Thatch; sap for wine; fruit mesocarp edible; bamboo for construction; fibers for art work and attire for traditional ceremonies); fish-traps
6	*R. hookeri* Mann & Wendl.	CO, D, CU, E, F, M, HF, W and O	Petioles and rachis ("bamboo") for construction; thatch; dryers; animal cages; fibers for traditional attires; crafts; sap for wine; grubs; fruit mesocarp edible; trunk; petioles; rachis as fuel; medicinal plants infused in wine for various treatments; wine as antidiabetic, fruits for stupefying fish; various crafts and art work.
7	*R. laurentii* De Wild.	CO, E	Bamboo for construction and furniture; thatch; sap for wine; mesocarp of ripe fruit edible.
8	*R. longiflora* Mann & Wendl.	CO, E	Bamboo for construction and furniture; thatch; sap for wine
9	*R. mannii* Becc.	CO	Bamboo for construction and furniture; thatch
10	*R. matombe* De Wild.	CO, D, E, CU, W	Bamboo for construction and furniture; thatch; fibers for traditional attires; various crafts; sap for wine; grubs
11	*R. monbuttorum* Drude	CO, E, D, HF	Bamboo for construction and furniture; thatch; fences; sap for wine; grubs; oil from fruit mesocarp edible; ropes from petiole to tie grated cassava; fish traps.
12	*R. palma-pinus* (Gaertn.) Hutch.	CO, D, CU, W	Bamboo for construction and furniture; thatch; dryers; cages; fibers for traditional attires; crafts
13	*R. regalis* Becc.	CO, D, E	Bamboo for construction and furniture; thatch; midribs/midvein for brooms; mesocarp of ripe fruit contains extractable edible oil
14	*R. rostrata* Burret	E	Sap for wine
15	*R. ruwenzorica* Otedoh	D, CU	Ropes.
16	*R. sese* De Wild.	CO, E, CU, D, M, W	Thatch; sap for wine; mesocarp of ripe fruit edible; grubs; fibers for art work; fibers for decoration; extraction of oil from fruit mesocarp; fruit mesocarp used to treat diabetes.
17	*R. sudanica* A.Chev.	CO, D, E, F, M, W	Bamboo for construction and furniture; thatch; ropes; leaflets used for weaving bags, baskets; hats; sap for wine; fruit mesocarp edible; bamboo for fuel; fruit and wine for medicine.
18	*R. taedigera* Mart.	CO, D, E, HF	Bamboo for construction and furniture; thatch; bamboo as prop poles for banana harvesting; toys; fruit mesocarp edible and yields oil; petioles for fish traps
19	*R. textilis* Welw.	CO, E, D, CU	Bamboo for construction; sap for wine; piassava; fibers
20	*R. vinifera* P.Beauv.	CO, D, CU, E, F, M, HF, W and O	Bamboo for construction and furniture; thatch; dryers; animal cages; barns; ceilings; various artwork; fibers for traditional attires; crafts; sap for wine; grubs; mesocarp of ripe fruit edible; young seed edible; bamboo as fuel; fruit mesocarp as medicine; medicinal plants infused in wine for various treatments; fruits in stupefying fish; fish traps; handbags; earrings.
21	*R. zamiana* S.Mogue, Sonké & Couvreur	CO, D, E, M, HF	Bamboo for construction and furniture; thatch; sap for wine; grubs; fruit of mesocarp used against diabetes and high blood pressure; fish traps.
22	*Raphia* sp.*	CO, D, E, O	Bamboo for construction and furniture, thatch; inner soft tissue of bamboo used to weave mats, hard outer epidermis used for fencing; sap for wine, mesocarp of ripe fruit edible; oil from mesocarp used in cooking; cosmetics and medicine.

Table 1. Raphia species uses reported from the literature with their matching use category *(see text for definition).*

*This species is what Otedoh called R. vinifera. However, the name applies to a different species, and for now we do not know what species this refers to. See Mogue Kamga et al. (2019) for more details

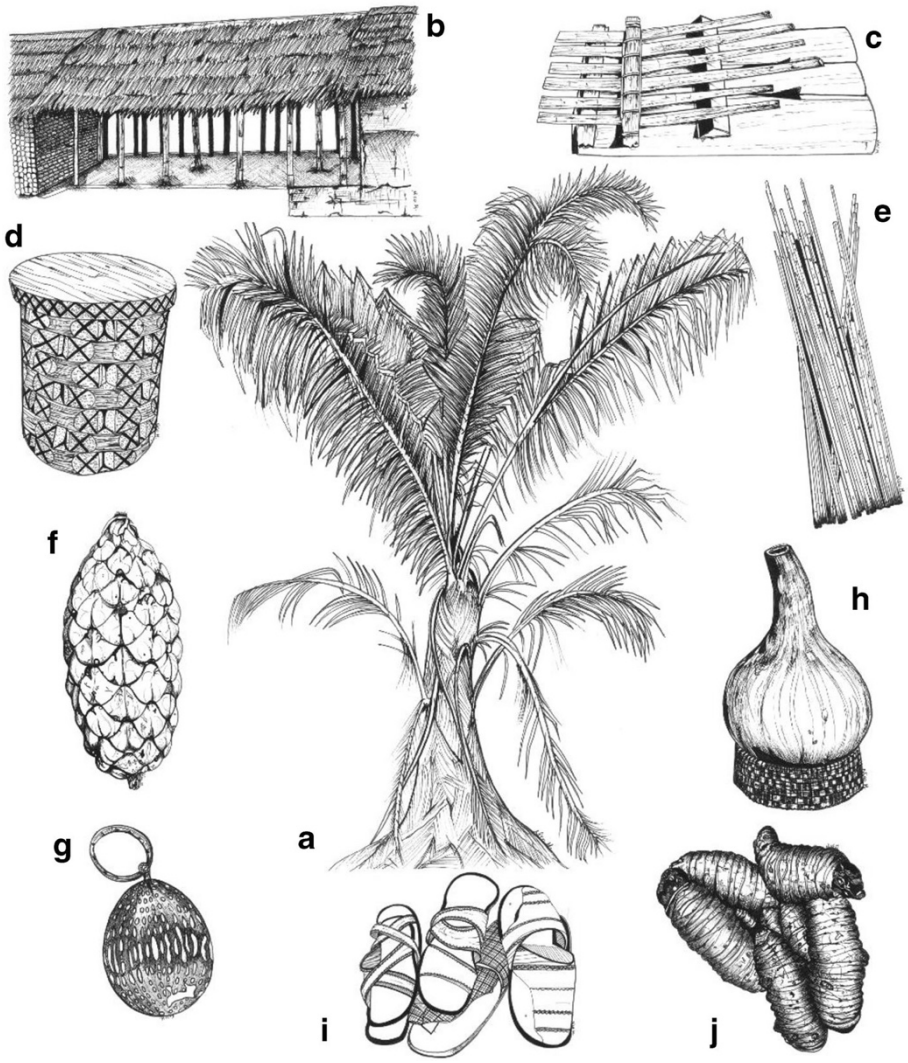

Fig. 2. Illustration of the major categories of Raphia species uses.

A. Raphia palm. B, E. construction (CO), C. cultural (CU). D. domestic utensils and tools (D). H, J. edible (E), tools for hunting and fishing (HF), fuel (F), F. Medicinal (M) and G. other uses (O) (environmental, toxic etc); I, G. wearing apparels (W).
Drawings by Nicolas Morales Arregui

Main Raphia Products and Methods of Extraction

Raphia sap and derived products

Sap is the most important resource and the derived palm wine probably the most studied products of Raphia (Ayogu 1999; Obahiagbon 2009). Most Raphia species can be used for tapping (Table 1) (Tuley 1995). Raphia hookeri is the most important and frequently used for wine production in Nigeria (Obahiagbon 2009). When several species are available, the species tapped is typically based on accessibility, distance, abundance, availability, and amount of sap produced per unit of time. Raphia hookeri is preferred in the littoral and central regions of Cameroon and R. vinifera in the Western Highlands. In certain parts of DRC, R. matombe is the main species for tapping. Finally, in Madagascar R. farinifera is used for wine extraction (Perrier de la Bathie 1931). Morphology plays an important role in choosing a species: Raphia hookeri is easily tapped since it has single stems, while R. laurentii, R. monbuttorum, or R.

zamiana, with clustering stems, forming dense clumps covered in straight sharp fibers that are harder to climb. Where only one species exists, it is tapped even though access is difficult (e.g, R. zamiana in South Cameroon).

Sap Extraction Methods

Two main methods exist for sap extraction: "down wine tapping" and "inflorescence tapping" (Tuley 1995). In the former, individuals are felled and a container is placed under the inflorescence cut to collect the sap. This is destructive and has been

observed in R. hookeri and R. monbuttorum, but is safe for the tapper, limiting accidents. Indeed, accidents related to climbing individuals are quite common (Mbuagbaw and Noorduyn 2012). Falling from a Raphia during tapping can lead to disgrace within village communities (Mogue Kamga pers. com.). In the latter method tappers climb to the base of the crown (Fig. 3A), apply an incision near the emergent inflorescence primordium allowing the sap to flow out. This method necessitates expertise and skill of the tapper to climb to the top of the palm.

Tapping occurs just before flowering, thus the emergent inflorescence primordium is scarified at an early stage of its development. Before the onset of flowering, individual palms develop leaves that are generally shorter than the previous ones, indicating the right moment to harvest (Tuley 1995). Tapping is conducted on a daily basis, early in the morning or in the late evening (Otedoh 1990). Information about sap yield remains scare in the literature. Tuley (1965) reports that R. hookeri in Nigeria can produce up to 118 l of sap per individual per year, while Obahiagbon et al. (2007) report averages between 6 and 20 l (more rarely up to 30) per induvial per week, suggesting a high variability in sap yield between individuals. More studies should be conducted to provide a more precise of the yield of Raphia wine across its distribution.

Sap Products

Three main products are derived from Raphia sap: a non-alcoholic beverage, alcoholic wine (palm wine, Fig. 3B) and a high alcoholic concentration spirit.

The freshly tapped sap, or juice, is a translucent liquid representing a sweet and non-alcoholic drink rich in vitamins and minerals (Fig. 3B). In Nigeria, it is reported that Raphia sap is consumed by over 50 million people (Obahiagbon and Osagie 2007). The fresh sap of R. hookeri is composed of sucrose (12–15%), protein, fats, organic acids, vitamins, minerals, and water (Bassir 1962, Nwokeke 2001; Obahiagbon 2007; Okafor 1975) as well as several types of sugars (e.g., arabinose, cellobiose, fructose) (Faparusi 1981; Obahiagbon 2009; Obahiagbon and Osagie 2007). It contains elements such as Ca, Cl, Cu, Fe, K, Mg, Mn, N, Na, P, and Zn (Obahiagbon et al. 2007). Raphia vinifera sap contains both useful and harmful microorganisms, which change spontaneously during fermentation at room temperature (Tiempa et al. 2013).

Subsequent fermentation converts the sap into a cloudy, alcoholic beverage named Raphia wine (Uzochukwuru et al. 1991; Obahiagbon and Osagie 2007). Fermentation is aided by adding bark and sometimes seeds of different species. For example, the bark of Garcinia lucida Vesque is added to accelerate fermentation, in addition to being medicinal (see below). The use of Garcinia in palm wine production occurs in Central and West Africa (Guedje et al. 2017; Ayogu 1999; Bouquet 1969; Irvine 1961). In Bipindi-Akom, Cameroon, a number of other plant additives from species are used. In the DRC, the bark of Bridelia scleroneura Müll. Arg. adds color, while the fruit pulp of Landolphia camptoloba (K.Schum.) Pichon and L. lanceolata (K.Schum.) Pichon enhances flavor (Moyene 2009). Long term preservation of Raphia wine for commercialization still faces challenges and is the main limitation of its large scale distribution (Levi and Oruche 1957). Sorbic acid appears as the most suitable for preservation, due to its wide bactericidal spectrum and few side effects (Okafor 1975). So far,

pasteurization at 75 °C for 45 min is the most successful method (Obahiagbon and Osagie 2007).

The wine is distilled to produce a spirit which is known as kaikai (Ikegwu 2014) in the Anambra State of Nigeria, afawfaw (Mphoweh et al. 2004) in the North West region of Cameroon, odontol or ha in southern Cameroon, ogogoro, kaikai or apeteshi in West Africa (Adeleke and Abiodun 2010; Iwuoha and Eke 1996; Obot 2000) and sodabi in southeastern Benin (Profizi 1986). The alcohol content of the distilled wine varies between 38% and 60% (Ababio 1990; Adeleke and Abiodun 2010; Oladeinde et al. 2002). As such, this spirt has been outlawed in certain parts of Cameroon due to cases of death from hazardous consumption and difficultly in controlling the total percentage of alcohol after distillation (Kouagheu 2016). On average 19–20 l of Raphia wine is required to produce 1 l of distillate (280–480 l of fermented sap for 20 l of ethanol) (Profizi 1986; Ohimain et al. 2012). Production takes between five to over 12 h using 105–155 kg of fire wood equivalent to 5.25–7.75 kg of wood/l. Palm spirit is served in bars in rural areas and dispensed at plantations and farms to motivate laborers, to preserve food, applied to soak dried fruit to bake Christmas cake by foreigners residing in the Indemili area (Ikegwu 2014) or in the sterilization of razor blades in barber shops (Mphoweh et al. 2004).

Finally, some studies have reported that R. hookeri sap can be used as a good source of bioethanol production although yields were highly variable between distillates (Ohimain et al. 2012).

Fig. 3. The multitude of uses of Raphia species - 1.

A. Raphia hookeri wine tapping, drone view, Lomié, Cameroon. B. Raphia vinifera wine shared between notables during a ceremony at Oku, Cameoon. C. Recently dyed drying Raphia fibers near Douala, Cameroon. D. Raphia fiber uses for furniture construction near Douala, Cameroon.
Photo credits: A: Foulques Couvreur; B: Thomas Couvreur; C-D: Suzanne Mogue Kamga

Fig. 4. The multitude of uses of Raphia species - 2.

A. Raphia hookeri grubs or "fos" freshly collected, Obut, Cameroon. B. Raphia monbuttorum leaflets weaved into a unit, ready for thatching, Lomié, Cameroon. C. The weaving of a fishing basket made of the epidermis of Raphia petioles. D. The pith of Raphia vinifera bamboo's crafted into toys (here a helicopter), Kumbo, Cameroon; E: A Baka making a traditional harp-zither (ngombi) out of Raphia hookeri petioles, Lomié, Cameroon; F. Another type of traditional harp-zither (mvet) partly made with a Raphia petiole, Obala, Cameroon. G. A Baka master of the Jengi-ritual in front of a Raphia curtain used during rituals.
Photo credits: A, C, D, E: Thomas Couvreur; B: Suzanne Mogue Kamga; F, G: Susanne Fürniss

Raphia fibers

Fibers are an important Raphia raw material (Kicińska-Jakubowska et al. 2012), extracted either from the leaflets or from the petioles and sheaths (Fig. 3C). Fibers are extracted from the spear leaves, which are the young and unfolded leaves (Tuley 1995). After drying, the stripped fibers are twisted into a thread, used to weave an array of products, such as mats, baskets, hats, bags, ropes, hammocks, toys, clothes, traditional attires among others (Table S1). Today, Raphia fibers are even used in the production of clothes and "haute couture" for example in Douala (Mogue Kamga, pers. obs.). The fibers are often dyed with both natural and chemical dyes (Fig. 3C). In the past, Raphia fiber was mainly obtained from R. farinifera in southern Africa or Madagascar (Beccari 1910b; Tuley 1995). Other species also provide useful fibers (Table 1), e.g. R. gentiliana, R. hookeri, R. sudanica R. textilis and R. vinifera (Elenga et al. 2011; Ouattara et al. 2015). Raphia fibers have been particularly recommended for strengthening composite materials (Elenga et al. 2013).

Fibers extracted from the disintegrating sheaths of palm leaves are collectively referred to as piassava fiber. They are used as ropes, mattress stuffing, brooms and for furniture (Fig. 3D). In the past considerable amounts of piassava from Raphia species were exported from Southeastern Nigeria, Southern Cameroon, Sierra Leone, and Liberia (Beccari 1910a; Chevalier 1932; Russell 1965; Tuley 1995; Obahiagbon 2009). However, due to strong competition from synthetic materials, the demand for Raphia fiber has declined significantly. It is documented that fiber extracted from the leaf bases of R. hookeri is suitable for paper production, but large-scale commercial production has never been performed (Tuley 1995).

White grubs – beetles' larvae

Raphia stems are an important source for grubs, but this has been little acknowledged in the literature (Dounias 2003; Obahiagbon 2009) despite their important nutritive importance across tropical Africa (Muafor et al. 2015). Several species of insects from the families Dryophthoridae (Curculionoidea) and Dynastidae (Scarabaeoidea) use the decomposing stems of Raphia for oviposition. The resulting larvae, commonly called grubs (Fig. 4A), are considered a delicacy in the Congo Basin and West Africa. It is from Raphia that most of the grub collection is undertaken in central Africa, more than from the oil palm Elaeis guineensis (Dounias 2003). These grubs are known under various common names (Figure 4A): ukolo, edon or ugbean in Nigeria (Obahiagbon 2009); fos (DeFoliart 1993; Dounias 2003), mbé, poseh, and tumbu in Cameroon (Muafor et al. 2015); Kpitran in Benin (Riggi et al. 2016). Three different species of Raphia-associated edible larvae are known (Muafor et al. 2015): two of the genus Rhynchophorus (Rhynchophorus phoenicis Fabricius and R. quadrangulus Quedenfeldt; Dryophthoridae): Ukolo and Edon collected from living and dead Raphia trunks, respectively and the third is Oryctes rhinoceros L. (Dynastidae), inhabiting dead Raphia trunks.

The traditional collection method for grub's extraction consists of walking through Raphia populations identifying young stems naturally infested with the grubs (Dounias 2003; Muafor et al. 2015). This is a difficult and hard task, and can take considerable time (Dounias 2003; Muafor et al. 2015). A semi-farming method is also described in Cameroon (Muafor et al. 2015) and consists of felling the individual, making an incision on the trunk at about 1 m from the base of the crown and covering the incision with fresh Raphia leaves. The felled trunk is left for around 1 month allowing the grubs to grow and mature. The harvesters then split the trunk and collect the grubs. This type of harvest yields more grubs per stem than the traditional method (Muafor et al. 2015).

The larvae are rich in several essential nutrients, containing proteins, carbohydrates and fats, equivalent in energy values to beef or fish (Fogang Mba et al. 2018). The larvae of Rhynchophorus phoenicis are an important protein source similar in content to termites, cow milk, eggs, and even beef (Banjo et al. 2006; Ekpo and Onigbinde 2005; Fogang Mba et al.

2018; Okunowo et al. 2017; Opara et al. 2012). They contain elements such as Ca, Cu, Fe, Mg, Mn, P, K, and Na (Muafor et al. 2015) and provide several essential and non-essential amino acids and lipids (Fogang Mba et al. 2018; Ogbuagu et al. 2011). Rhynchophorus phoenicis has been recommended in the diets of children and adults (Onyeike et al. 2005; Opara et al. 2012).

Raphia leaves

Thatch

Across its distribution, Raphia species constitutes one of the main resources for thatching (Fig. 2B) (Beccari 1910b; Calvo-Gutiérrez et al. 2013; Chevalier 1932; Obahiagbon 2009; Tuley 1995). After harvesting of leaves, the leaflets are typically woven into thatching units (Fig. 4B) while still attached to the midrib or after their removal. The thatching units are used as ceiling material especially in rural areas. Raphia roofs are not as durable as synthetic alternatives, nevertheless, they remain popular because they are cheaper, have better cooling properties and are not noisy during heavy downpours (Fig. 4B). They are reported to last between three to five years (Manvell 2017).

Nowadays, Raphia thatches are used around hotels and touristic sites to give a more authentic rural look. To a lesser extent, thatching units are also used for constructing fences. The leaves of R. monbuttorum and R. zamiana are more desirable for thatching because they remain straight when dried and last longer. Others like R. hookeri, are less resistant and easily damaged by insects. Extracted leaf midribs are often used to produce brooms, for example in Cameroon (Couvreur and Fumtim 2017). Finally, the entire leaves can be used as rough wrapping material to pack bulky farm products and fire wood for transport.

Raphia Leaf Petiole and Rachis ('Bamboo')

The petiole and rachis serve various purposes and are referred to as bamboo because the long slender poles are reminiscent to Asian bamboo (Tuley 1995). They are useful for fences, walls, ceilings, barns, and roof constructions, to manufacture handicrafts (e.g., beds, tables, and chairs, Fig. 2D, E), tools, and art work, or as support structures for the cultivation of crops (Table S1). In the Amazon esturay, R. taedigera (jupatí) is used for house construction and to make several domestic utensils (Carney and Hiraoka 1997; Wallace 1853). Traditionally, R. vinifera bamboo is used in the construction of palaces in the West and North West regions of Cameroon (Geary 1985).

Fibers extracted from the inner tissue of the Raphia poles are split into thinner units and used to make ropes, baskets, and for weaving mats and other articles (Mfouapon et al. 2014). The baskets are particularly popular for storing and transporting agricultural produce to the markets. When dry, the inner part of the petiole is robust and is used in the manufacture of artifacts. The hard outer layer of Raphia poles is also suitable for making basketry, mats and fishing baskets or fishing traps (Fig. 4C,(Couvreur and Fumtim 2017)), for example the "matapí" traps made out of R. taedigera in the Amazon estuary (Carney and Hiraoka 1997). Finally, the pith of the Raphia bamboo is an excellent and flexible material to make crafts and toys (Fig. 4D) of all sizes (Carney and Hiraoka 1997; Couvreur and Fumtim 2017).

Combined Use of Raphia Parts in the Construction of Musical Instruments

In Central Africa, the rachis is used for making various musical instruments. In the case of the traditional harp-zither, commonly referred to as mvet (Fang, Bulu), mbet (Beti-Eton) or ngiang (Ngumba) and ngombi (Baka). The name nú-peké, which translates to Raphia bird in English, refers to the way the instrument is constructed (Brisson 2010). The entire instrument is built of one Raphia bamboo and the three or four strings are made of narrow peels of the bamboo epidermis. The strings are stretched over a central wooden bridge and tied firmly at the

end of the sound board. These strings are not very durable and are now typically replaced by metal strings. Whereas most of the harp-zithers feature calabashes for sound amplification (Fig. 4E), those of the Baka and Bakoya Pygmies in Cameroon and Gabon (Fürniss, 2012a; Le Bomin and Mbot 2012) use pieces made of the pith of the Raphia petiole (Fig. 4F, see Couvreur and Fumtim (2017) for sound).

The lamellaphone (Fig. 2C), commonly referred to as sanza in Central Africa or mbira in East Africa, is another musical instrument partly made from Raphia extracted materials. The sanza is composed of a sound board mounted by small lamella, and the instrument is played with the thumbs or forefingers. The sound board can be made from three or four petioles joined together (Borel 1986; Oloa Biloa 2015), while the epidermis of the bamboo can be used for the lamella. Raphia made sanzas are widely used across Cameroon, and are also found in communities living alongside the upper Oubangui-river in the Central African Republic and the DRC (Laurenty 1962).

The pith of Raphia petioles are also used to make the sound board of the one-string harp or támìntúbà of the Bagyeli in Cameroon (Fürniss, 2012b; Oloa Biloa 2011). The rigid epidermis of Raphia bamboo provides the string of the musical bow mbèlà instrument of the Aka and Ngbaka peoples in the Central African Republic (Fürniss and Bahuchet 1995).

Other Leaf Products

Palm heart or palm cabbage, specifically the immature, whitish leaves from the center of the crown shaft, is reported as a good food source (Beccari 1910c). The palm heart is also an important component of the lowland gorilla's (Gorilla gorilla gorilla) diet in central Africa (Fay et al. 1989).

Another interesting reported use in Madagascar for R. farinifera is the extraction of a wax from the dry petioles (Beccari 1910b; Haller 1907; Jumelle 1905; Perrier de la Bathie 1931) and leaves. However, Perrier de la Bathie (1931) suggests this use is longer continued.

Raphia fruits

The pericarp of Raphia fruits is composed an outer layer or epicarp, covered by vertical rows of large scales, and a typically thick, bright yellow, and oily mesocarp, enclosing the seed. The endocarp is not differentiated (Dransfield et al. 2008), which makes the fruit a berry. The fleshy mesocarp is edible in certain species like R. hookeri, R. sese, R. sudanica, R. vinifera and R. zamiana (Mogue Kamga et al. 2018; Ouattara et al. 2014). The mesocarp varies among species in thickness, texture, and chemical composition (Tuley 1995). In West and Central Africa and in Madagascar, the fruits are consumed raw, cooked or boiled (De Wildeman 1919; Perrier de la Bathie 1931; Russell 1965) and generally eaten alongside other starchy products such as cassava (Moyene 2009; Mphoweh et al. 2004). Raphia hookeri fruits represent a rich source of vitamin A, B, and E, comparable to those in citrus fruits, or chick peas (Ogbuagu 2008). In addition, young soft endosperm of immature seeds are edible. In Amazon estuary or Central America, here is no real mention of fruits of R. taedigera being eaten (Carney and Hiraoka 1997), although Calvo-Gutiérrez et al. (2013) suggest that it could have been in the past.

Besides food, fruits also provide different products such as oil, used for hair care and cooking (Beccari 1910b; Carney and Hiraoka 1997; De Wildeman 1919; Lely 1925; Tuley 1995).

The fatty substances of the mesocarp contain saponin, a powerful ichthyotoxin used to paralyze fish (Ogbuagu 2008). Older seeds area source of vegetable ivory which is crafted into smaller items such as key holders and jewelry (Fig. 2G). In 2014, for example, more than 107 tons of dry Raphia seeds were exported from Cameroon to China (Tieguhong et al. 2015).

Cultural Significance of Raphia

A key element of social life: daily life, festivals and traditional ceremonies

Raphia wine plays a central role in the social fabric of rural villages and urban areas. Sharing wine is a sign of gratitude in business deals and personal relationships (Douglas 1958; Mbuagbaw and Noorduyn 2012). It especially important during traditional ceremonies, such as birth celebrations, endowments, dowry ceremonies, enthronement of chiefs, marriages and funerals, during which it is consumed and offered to ancestors and chiefs.

Traditional clothing and accessories woven from Raphia fibers hold high cultural value in traditional and customary ceremonies, like weddings, chief enthronements, funerals, and birth celebrations. These uphold existing customs in, the Western Highlands of Cameroon or the Teke in Gabon, Republic of Congo, and DRC. In western Cameroon, special bags woven from Raphia fibers are used to place gifts and worn by women who gave birth to twins during the Si ("Ceremony of the twins") (Cosiaux, pers. com.). In the pre-colonial era along the Loango coast (western part of the Republic of the Congo and Gabon), Raphia cloth was essential in many events: newborns were laid on Raphia cloth; youths wore Raphia cloth skirts during initiation; the suitor of a young girl brought Raphia clothing and wine as gifts to her family, and the dead were dressed in Raphia clothing (Martin 1986).

Raphia is a primary material linked to customary authority, nobility or royalty. Thatch from Raphia leaves associated to it fiber marks the presence of traditional authorities and notables in parts of Cameroon. In addition, hats and garments of kings, chiefs and traditional authorities are woven from Raphia fiber.

The stripped fibers woven into skirts are closely linked to dance in Central Africa. These "skirts" embellish the mendzan-xylophones among the Bulu-Beti-Fang people in Cameroon, Gabon, and Equatorial Guinea (Lacombe 2014). In southeastern Cameroon, long and large Raphia fibers skirts represent spirits among Pygmy populations and their neighbors (Bahuchet 1992; Fürniss, 2011, Oloa Biloa 2011). Among the Baka, a special song and dance a accompanies the presentation of raw Raphia fibers to the community, before their transformation into the habit of the forest spirit Jengi (Arom et al. 2008).

Raphia as pre-colonial currency

Raphia clothing in different socio-cultural groups, served as barter or as a currency, especially during pre-colonial times (Clist et al. 2018; Douglas 1958; Edoumba 2001; Martin 1986; Rivallain 2001). Raphia cloth was used to buy food, household items, tools (Martin 1986), pay legal fees, such as for adultery, liquidate debts, pay tributes and taxes, or purchase slaves (Douglas 1958). Cloths made of Raphia were bartered for a wide range of goods (e.g., knives, iron items, pottery, fish) from the Kasai region (Njembe, Dinga, Nkutu). The Lele, Teke, Telela, Basonge and Kongo kingdom in DRC used Raphia cloths as a currency (Clist et al. 2018; Edoumba 2001). The woven square of 40 × 40 cm, called lubongo or libongo (pl. mbongo) in the Kongo, tsulu by the Teke or madiba by the Basonge (Douglas 1958; Edoumba 2001). These pieces of Raphia were gathered together for making larger cloths: one makuta composed of 10 mbongo, and one nta of 30 tsulu. Nowadays, the term mbongo is still used in the Kikongo and Lingala languages to designate money and "wealth"(Tem 2014).

Raphia cloth and "bamboo" are essential for marriage exchanges (bride price) (Gautier and Fadani 1994; Rivallain 2001). Among the Lélé, a man can "acquire" a wife for 90 Raphia cloths. Douglas (1958) concludes that "In a sense, raffia [Raphia] keeps its high value, not because of its use as a textile, but because it gives command over women, and, in a polygamous society, women are always scarce". Although the colonial and present day currencies have been adopted and included in the dowry, they cannot replace the legal tender of Raphia products, which underlines their socio-cultural value.

Raphia products used in magico-religious practices

Raphia products are used in various ritual practices (Quiroz and van Andel 2018). In northwestern Cameroon, Raphia wine is used to control the human embodiment of mischievous or evil spirits called "juju", and is given to chiefs and notables during village festivals, funeral ceremonies and ritual libations (Mogue Kamga pers. obs.). The wine is given to ancestors during ritual offerings (Salpeteur 2009). Gifts are placed in Raphia fiber bags used to pay tribute to ancestors. Raphia leaves play an important role in spiritual protection e.g., in Liberia and certain parts of Cameroon, leaves of R. vinifera are woven into a curtain, representing a barrier against witchcraft, poison or evil (Gruca et al. 2014). The Baka in Cameroon use this curtain to separate the initiated from the public (Fig. 4G). In south-eastern Cameroon, Raphia fibers chase evil spirits during the circumcision ceremonies (Fürniss and Lussiaa-Berdou, 2004; Fürniss 2008). Leaves of R. farinifera in Madagascar are burnt as incense in churches and used to make crosses (Gruca et al. 2014). Dried roots of R. vinifera are sometimes burnt inside dwellings to expel evil spirits (Mphoweh et al. 2004). In the circumcision rituals of the people in south-eastern Cameroon, the inner fibrous parts of leaf petioles and rachis are crafted into imitations of weapons and kepis that identify the members of the ritual association as warriors. Finally, the newly circumcised can be recognized by her very long Raphia skirt (Fürniss and Lussiaa-Berdou 2004; Fürniss, 2011). The Yoruba deity Sopona, the god of illness (smallpox) is usually covered in a mask and a body suit of Raphia palm (Voeks 1997). This tradition spread to Cuba and Brazil where Raphia fiber is still imported for important ceremonies.

Medicinal Importance of Raphia

Raphia species are used for medicinal purposes including inflammatory, digestive system, muscular-skeletal system, circulatory system, blood system, mental pain, subcutaneous tissue, pregnancy and birth disorders bruises, and poisoning (Gruca et al. 2015). Medicinal herbs are often added to palm wine to cure a wide range illnesses such as malaria, measles and jaundice. They also are used to prevent diarrhea and headaches (Bassir 1962; Donfack 2012; Guedje et al. 2017;

Mphoweh et al. 2004). Raphia sap stimulates lactation in nursing mothers (Donfack 2012; Okon and Okorji 2014). The seeds of R. hookeri are specifically used to stop pulsation of the fontanels on babies' head (Gruca et al. 2014). Recently, unfermented and fermented Raphia hookeri wine was suggested to have antidiabetic and antioxidative potentials (Erukainure et al. 2019). In Gabon, the fruit mesocarp of R. zamiana is used to treat diabetes and high blood pressure (Table 1). The seeds of R. sese are used to regulate and stabilize the sugar level in patients suffering from diabetes (Moyenne and Lejoly 2006). A liquid extracted from the spathes of R. farinifera is used as laxative and the roots for treating toothaches (Pernet and Meyer 1957).

Conclusion and Perspectives

Due to their multiple uses and cultural value, Raphia species are among the most important species providing NTFPs in Sub-Saharan Africa (Ingram 2014). Barfod et al. (2015) referred to palms as being versatile, based on a number of desirable properties as seen from an agricultural perspective. According to this definition species of Raphia score high in versatility, especially R. hookeri, R. farinifera and R. vinifera, which produce a wide range of products (Table 1). Sap is the main product extracted from species of Raphia. It is used in daily life and plays a key role in traditional ceremonies. The exploitation of wine provides an important and quick access to cash for rural people. The extraction of edible grubs from Raphia stems represent other important product being a major source of protein. Entomophagy has been suggested as a sustainable and viable alternative to meat consumption and can contribute to global food security (Machovina et al. 2015; Sunderland 2011; van Huis et al. 2015). Thus, the

consumption of Raphia grubs will play a fundamental role in this sense, especially because sustainable and better harvesting methods are now being developed increasing yield and safety (Muafor et al. 2014). Other products such as Raphia fibers might gain importance with an increased interest for plastic alternatives (Kocak and Mistik 2015). Finally, Raphia taxonomy remain challenging, but recent taxonomic progress has improved species identification (Couvreur and Sunderland 2019; Mogue Kamga et al. 2018), which will be useful for future anthropological and socio-economic studies. Although substantial information on the different uses of Raphia has been published, more data is still needed on aspects of commercialization such as market structure, yields, trade volumes, geographic extent of trade, and value chains.

The distribution of continental African palm species will be seriously affected by climate change (Blach-Overgaard et al. 2015). In particular, Raphia stands are under significant pressure, generally being highly transformed by man (Profizi 1988) or destroyed for urbanization and agricultural expansion (Calvo-Gutiérrez et al. 2013; Mphoweh et al. 2004). In addition to the versatility of its species and use by man, Raphia swamps in South America, Africa and Madagascar, represent important wetland biodiversity reservoirs harboring numerous plants species and wildlife (Calvo-Gutiérrez et al. 2013), including iconic megafauna species (Rainey et al. 2010). For example, the endangered western lowland gorilla is recorded in high densities throughout the year in Raphia dominated swamps in the Republic of Congo (Rainey et al. 2010). Efficient management of Raphia products and environments where it occurs will contribute to alleviate poverty, fight against hunger and conserve tropical biodiversity in the decades to come. Thus, we need to convey governments, decision makers and stakeholders with a deeper understanding of the ecosystem services offered by Raphia species.

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References

Ababio, O.Y. 1990. Organic chemistry. New school chemistry. Isiokwe: Africana-Fep publishers Limited.

Adeleke, R.O. and O.A. Abiodun. 2010. Physico-chemical properties of commercial local beverages in Osun State, Nigeria. Pakistan Journal of Nutrition 9: 853–855.

Arom, S., N. Fernando, S. Fürniss, S. Le Bomin, F. Marandola, and J. Molino. 2008. Une perspective interdisciplinaire. In: Catégories et Catégorisations, ed. Alvarez-Pereyre, F., 273- 313. Peeters: Leuven-Paris-Dudley.

Ayogu, T.E. 1999. Evaluation of the performance of a yeast isolate from Nigerian palm wine in wine production from pineapple fruits. Bioresource Technology 69: 189–190. DOI: https://doi.org/10.1016/S0960-8524(99) 00162-5 .

Bahuchet, S. 1992. Histoire d'une civilisation forestière I. Dans la forêt d'Afrique Centrale, les Pygmées Aka et Baka. Louvain-Paris: Peeters-Selaf.

Balick, M.J., and H.T. Beck. 1990. Useful palms of the world. A synoptic bibliography. New York: Columbia University Press.

Balslev, H. 2011. Palm harvest impacts in North-Western South America. Botanical Review 77: 370–380. DOI: https://doi.org/10.1007/ s12229-011-9083-y .

Banjo, A.D., O.A. Lawal, and E.A. Songonuga. 2006. The nutritional value of fourteen species of edible insects in southwestern Nigeria. African Journal of Biotechnology, 5: 298–301.

Barfod, A.S., M. Balhara, J. Dransfield, and H. Balslev. 2015. SE Asian palms for agroforestry and home gardens. Forests, 6: 4607–4616. DOI: https://doi.org/10.3390/f6124389

Bassir, O. 1962. Observations on the fermentation of palm wine. West African Journal of Biological Chemistry, 6: 20–25.

Beccari, O. 1910a. El palmae del genere "Raphia". L'Agricoltura Coloniale 4: 137–171.

–. 1910b. Studio monografico del genere "Raphia". Webbia 3: 37–130. DOI: https://doi.org/10.1080/00837792

Blach-Overgaard, A., H. Balslev, J. Dransfield, S. Normand, and J.-C. Svenning. 2015. Global-change vulnerability of a key plant resource, the African palms. Scientific Reports, 5: 1–36. DOI: https://doi.org/10.1038/srep12611

Borel, F. 1986. Les Sanza. Neuchâtel: Musée d'ethnographie de Neuchâtel.

Bouquet, A. 1969. Féticheurs et médecines traditionnelles du Congo (Brazzaville). ORSTOM.

Brisson, R. 2010. Petit dictionnaire Baka-français. Paris: L'Harmattan

Brokamp, G., N. Valderrama, M. Mittelbach, C.A.R. Grandez, A.S. Barfod, and M. Weigend. 2011. Trade in palm products in North-Western South America. Botanical Review 77: 571–606. DOI: https://doi.org/10.1007/ s12229-011-9087-7

Brussaard, L., P. Caron, B. Campbell, L. Lipper, S. Mainka, R. Rabbinge, D. Babin, and M. Pulleman. 2010. Reconciling biodiversity conservation and food security: scientific challenges for a new agriculture. Current Opinion in Environmental Sustainability, 2: 34–42.

Calvo-Gutiérrez, C.M., F. Bonilla-Murillo, and M. Sasa. 2013. Uso y conservación de humedales de yolillo Raphia taedigera (Arecaceae) en el area de Conservación Tortuguero, Costa Rica. Revista de biología tropical, 61: 163–178.

Carney, J., and M. Hiraoka. 1997. Raphia taedigera in the Amazon Estuary. Principes, 41: 125–130. Chevalier, A. 1932. Nouvelles recherches sur les Palmiers du genre Raphia (Suite et fin). Revue de botanique appliquee et d'agricuture tropicale, 12: 198–213. Clist, B.-O., P. de Maret, and B. Koen. 2018. Une archéologie des provinces septentrionales du royaume Kongo. Oxford: Archaeopress Publishing ltd.

Cook, F.E.M. 1995. Economic botany data collection standard. Kew: Royal Botanic Gardens, Kew.

Cosiaux, A., L.M. Gardiner, F.W. Stauffer, S.P. Bachman, B. Sonké, W.J. Baker, and T.L.P. Couvreur. 2018. Low extinction risk for an important plant resource: Conservation assessments of continental African palms (Arecaceae/Palmae). Biological Conservation, 221: 323–333. DOI: https://doi.org/10.1016/ j.biocon.2018.02.025

Couvreur, T.L.P. and J. Fumtim. 2017. A l'Echelle du Raphia / On Raphia and Man. https://www. youtube.com/watch?v=avSoLIusCCs&t=1167s

– and T.C.H. Sunderland. 2019. Flore du Gabon-Palmae. Leiden: Margraf Publishers.

Couvreur, T. L. P. and T. C. H. Sunderland. 2019. Flore du Gabon–Palmae. Leiden, the Netherlands: Margraf Publishers.

Dargie, G.C., S.L. Lewis, I.T. Lawson, E.T. Mitchard, S.E. Page, Y.E. Bocko, and S.A. Ifo. 2017. Age, extent and carbon storage of the central Congo Basin peatland complex. Nature, 542: 86–90. DOI: https://doi.org/10.1038/ nature21048

De Wildeman, E. 1919. Sur quelques palmiers congolais. Annales du Musée colonial de Marseille, 7: 1–28.

DeFoliart, G.R. 1993. Hypothesizing about palm weevil and palm rhinoceros beetle larvae as traditional cuisine, tropical waste recycling, and pest and disease control on coconut and other palms - can they be integrated? Principes, 37: 42–47.

Donfack, P. 2012. Importance of Forest products from raffia forests (Rafia farinifera) and impacts of some harvesting methods on natural regeneration in West regions of Cameroon. IUFRO-FORNESSA Regional Congress.

Douglas, M. 1958. Raffia cloth distribution in the Lélé Economy. Africa: Journal of the International African Institute 28: 109–122.

Dounias, E. 2003. L'exploitation méconnue d'une ressource connue: la collecte des larves comestibles de charançons dans les palmiers raphias au sud Cameroun. In: Les insectes dans la tradition orale, eds E. Motte-Florac and J.M.C. Thomas, 205–226. Paris-Louvain: Peeters Publishers.

Dransfield, J., N.W. Uhl, C.B. Asmussen, W.J. Baker, M.M. Harley, C.E. Lewis, and E. Al. 2008. Genera Palmarum: The evolution and classification of palms. Kew, Kew Publishing.

Edoumba, P. 2001. Aperçu sur les monnaies d'Afrique. Revue numismatique, 157: 105–119. Ekpo, K.E., and A.O. Onigbinde. 2005. Nutritional Potentials of the Larva of Rhynchophorus phoenicis (F). Pakistan Journal of Nutrition, 4: 287–290.

Elenga, R.G., G.F. Dirras, J.G. Maniongui, and B. Mabiala. 2011. Thin-layer drying of Raffia Textilis Fiber. BioResources, 6: 4135–4144. Elenga, R.G., P. Djemia, D. Tingaud, T. Chauveau, J.G. Maniongui, and G. Dirras. 2013. Effects of alkali treatment on the micro-structure, composition, and properties of the Raffia textilis fiber. BioResources, 8: 2934–2949.

Erukainure, O.L., O.A. Oyebode, C.I. Chukwuma, M.G. Matsabisa, N.A. Koorbanally, and M.S. Islam. 2019. Raffia palm (Raphia hookeri) wine inhibits glucose diffusion; improves antioxidative activities; and modulates dysregulated pathways and metabolites in oxidative pancreatic injury. Journal of Food Biochemistry, 43: e12749. DOI: https://doi.org/10.1111/jfbc. 12749

Faparusi, S.I. 1981. Sugars identified in Raphia palm wine. Food Chemistry, 7: 81–86.

Fay, J.M., M. Agnagna, J. Moore, and R. Oko. 1989. Gorillas (Gorilla gorilla gorilla) in the Likouala swamp forests of north central Congo: Preliminary data on populations and ecology. International Journal of Primatology, 10: 477– 486. DOI: https://doi.org/10.1007/ BF02736372

Fogang Mba, A.R., G. Kansci, M. Viau, L. Ribourg, J. Fogoh Muafor, N. Hafnaoui, P. Le Gall, and C. Genot. 2018. Growing conditions and morphotypes of African palm weevil (Rhynchophorus phoenicis) larvae influence their lipophilic nutrient but not their amino acid compositions. Journal of Food Composition and Analysis, 69: 87–97.

FORENET. 2010. Subregional workshop on harmonization of national reviews on "Non-timber forest products (NTFPs) in Central Africa", Douala, General Report; Establishment of a Forestry Research Network for ACP Countries (FORENET).

Fürniss, S. 2008. The adoption of the circumcision ritual bèkà by the Baka-Pygmies in Southeast Cameroon. African Music: Journal of the International Library of African Music, 8: 92–113.

–. 2011. Partages et emprunts de musiques rituelles au Sud-Est-Cameroun. In: Territoires musicaux mis en scène, eds. M. Desroches, M.-H. Pichette, C. Dauphin, and, G.E. Smith, 263–277. Montréal: Presses de l'Université de Montréal.

–. 2012a. Musiques aka et baka : une parenté de référence. Journal des Africanistes, 82: 107–136.

–. 2012b. Usages, variations, migrations: la harpe-en-terre d'Afrique centrale face à la classification universelle des instruments de musique. In: Morphologie et usages: La harpe-en-terre d'Afrique centrale face à la classification universelle des instruments de musique, ed. I.

Fürniss, S. and C. Lussiaa-Berdou. 2004. Bèkà. Rituel de circoncision chez les Baka occidentaux du Cameroun. Villejuif, France.

Fürniss, S. and S. Bahuchet. 1995. Existe–t–il des instruments de musique pygmé ? In: Ndroje balendro. Musiques, terrains et disciplines. Textes offerts à Simha Arom, ed., V. Dehoux, 87–109. Paris–Louvain: Peeters Publishers.

Keyser de, 9–20. Tervuren: Annual Meeting of the International Committee of Musical Instruments Museums and Collections, MRAC.

Keyser de and S. Bahuchet. 1995. Existe-t-il des instruments de musique pygmées ? In: Ndroje balendro. Musiques, terrains et disciplines. Textes offerts à Simha Arom, ed. V. Dehoux, 87–109, Louvain Paris: Peeters Publishers.

Gandhi, M. 1939. Speech at opening of the village industry exhibition in Brindawan Bihar.

Gautier, D. and A. Fadani. 1994. Le raphia face à a crise: une production complémentaire qui pourrait être (re)valorisée. In: Le village camerounais à l'heure de l'ajustement, ed. G. Courade, 318-333. Paris: Karthala.

Geary, C.M. 1985. Palace and chieftaincy in Weh (North West Province, Cameroon). Paideuma, 31: 183–201.

Gruca, M., T.R. Van Andel, and H. Balslev. 2014. Ritual uses of palms in traditional medicine in sub-Saharan Africa : a review. Journal of Ethnobiliogy and Ethnomedicine, 10: 1–24. DOI: https://doi.org/10.1186/1746-4269-10-60

Gruca, M., A. Blach-Overgaard, and H. Balslev. 2015. African palm ethno-medicine. Journal of Ethnopharmacology, 165: 227–237. DOI: https://doi.org/10.1016/j.jep.2015.02.050

Guedje, N.M., F. Tadjouteu, J.M. Onana, E. Nnanga Nga, and O. Ndoye. 2017. Garcinia lucida Vesque (Clusiaceae): from traditional uses to pharmacopeic monograph for an emerging local plant-based drug development. Journal of Applied Biosciences, 109: 10594–10608. DOI: https://doi.org/10.4314/jab.v109i1.4

Hallé, F. 1977. The longest leaf in palms? Principes, 21: 18.

Haller, A. 1907. Sur la cire du palmier Raphia Ruffia de Madagascar et sur l'alcool arachique. Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, 144: 594–598.

Ikegwu, J.U. 2014. The value of palm wine tapping in the food production practices of Igbo-Land : A case study of Idemili South Local Government Area, Anambra State. Research on Humanities and Social Sciences 4: 49–54

Ingram, V. 2014. Win-wins in forest product value chains? How governance impacts the sustainability of livelihoods based on non-timber forest products from Cameroon. Amsterdam: University of Amsterdam

Ingram, V., O. Ndoye, D.M. Iponga, J.C. Tieguhong, and R. Nasi. 2012. Non-timber forest products: contribution to national economy and strategies for sustainable management. In: The Forests of the Congo Basin: State of the Forest 2010, eds. C. de Wasseige, P. de Marcken, N. Bayol, F. Hiol-Hiol, P.H. Mayaux, B. Desclée, A. Billand, P. Defourny and R. Atyi, 137–154. Luxembourg: Publications Office of the European Union.

Ingram, V., and J. Schure. 2010. Review of non timber forest products (NTFPs) in Central Africa: Cameroon. Establishment of a Forestry Research Network for ACP Countries (FORENET). Yaoundé.

Irvine, F. R. 1961. Woody plants of Ghana with special reference to their uses. London: Oxford University Press.

Iwuoha, C.I. and O.S. Eke. 1996. Nigerian indigenous fermented foods: their traditional process operation, inherent problems, improvements and current status. Food Research International, 29: 527–540.

Jacques-Félix, H., R. Letouzey, and B. Satabié. 1982. Note sur le stipe hypogé du Raphia regalis Becc. (Arecaceae-Lepidocaryeae). Bulletin du Muséum National d'Histoire Naturelle Section B, Adansonia, botanique, phytochimie, 4: 161–176.

Jumelle, H. 1905. Le Raphia Ruffia. palmier à cire. Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, 141: 1251–1252.

Kicińska-Jakubowska, A., E. Bogacz, and M. Zimniewska. 2012. Review of natural fibers. Part I—vegetable fibers. Journal of Natural Fibers 9: 150–167.

Kocak, D., and S.I. Mistik. 2015. The use of palm leaf fibres as reinforcements in composites. Biofiber Reinforcements in Composite Materials, 273–281.

Kouagheu, J. 2016, November. Au Cameroun, la difficile lutte contre l'odontol, un alcool artisanal qui fait des ravages. Le Monde. https://www.lemonde.fr/afrique/article/2016/11/21/au-cameroun-la-difficile-lutte-contre-l-odontol-unalcool-artisanal-qui-fait-des-ravages_5035229_ 3212.html

Lacombe, C. 2014. Les archives sonores comme terrain d'investigations : l'exemple des xylophones fang. Journal des africanistes, 84: 80– 105.

Laurenty, J.-S. 1962. Les Sanza du Congo. (Vol 1.). Tervuren: Musée Royal de l'Afrique Centrale.

Le Bomin, S. and J.E. Mbot. 2012. The musical heritage of the Gabon Bongo: Heritage under influence. Before Farming: The Archaeology and Anthropology of Hunter-Gatherers, 1: 1– 19.

Lely, H. V. 1925. The useful trees of Northern Nigeria. London, The Crown Agents For The Colonies. DOI: https://doi.org/10.1093/ oxfordjournals.afraf.a100664

Levi, C.S. and C.B. Oruche. 1957. The preservation and bottling of palm wine. Lagos: Federal Ministry of Commerce and Industry Research Report, vol. 1.

Machovina, B., K.J. Feeley, and W.J. Ripple. 2015. Biodiversity conservation: The key is reducing meat consumption. Science of The Total Environment, 536: 419–431. DOI: https://doi.org/ 10.1016/j.scitotenv.2015.07.022

Manvell, A. 2017. Thatch Geographies in Liberia: An Introduction. http://www.adammanvell.info/sites/default/files/pdfs/Thatch%20Geographies%20in%20Liberia%20An%20Introduction%20%282017%20Version%201.0%29. pdf. Accessed: 12-06-2018

Martin, P.M. 1986. Power, Cloth and Currency on the Loango Coast. African Economic History, 15: 1–12.

Mbuagbaw, L. and S.G. Noorduyn. 2012. The palm wine trade: Occupational and health hazards. Review. The International Journal of Occupational and Environmental Medicine 3: 157–164.

Mfouapon, A., M. Moupou, J. Mefire, and J.-N. Ngapgue. 2014. Risques économicoenvironnementaux liés aux emballages traditionnels pour vivres frais utilisés dans le bassin maraîcher de Foumbot (Cameroun). La revue électronique en sciences de l'environnement, 14: 1–29.

Mogue Kamga, S., R. Niangadouma, F.W. Stauffer, B. Sonké, and T.L.P. Couvreur. 2018. Two new species of Raphia (Palmae/Arecaceae) from Cameroon and Gabon. PhytoKeys, 111: 17– 30. DOI: https://doi.org/10.3897/phytokeys. 111.27175

Mogue Kamga, S., B. Sonké, and T.L.P. Couvreur. 2019. Raphia vinifera (Arecaceae; Calamoideae): Misidentified for far too long. Biodiversity Data Journal 7: e37757. DOI: https://doi.org/10. 3897/BDJ.7.e37757

Moyene, B. A. 2009. Valorisation des produits forestiers non ligneux des plateaux de Bateke en peripherie de Kinshasa (R. D. Congo). Acta Botanica Gallica, 156 : 2, 311–314. https://doi.org/10.1080/12538078.2009.10516161.

Moyenne, B. A. and J. Lejoly. 2006. Etude de l'exploitation et du marché des produits forestiers non ligneux à Kinshasa. Tropicultura, 24: 183–188.

Mphoweh, J.N., M. Tchindjang, and A.H. Mfondoum Ngandam. 2004. The Degradation Of Raffia Palms and its Socio-Economic and Ecological Repercursions: The Case Study of Bamunka, Ndop, North West Province
Cameroon. University of Yaoundé I. https://www.academia.edu/4136633/The_degradation_of_raffia_palms_and_it_s_socio-economic_and_ecological_consequences_the_case_study_of_Bamunka_Ndop_North_West_Province_Cameroon. Accessed 16-02-2018

Muafor, F.J., A.A. Gnetegha, P. Le Gall, and P. Levang. 2015. Exploitation, trade and farming of palm weevil grubs in Cameroon. Working paper, 178. Bogor: Center for International Forestry Research (CIFOR), DOI: https://doi.org/ 10.17528/cifor/005626

Muafor, F.J., P. Le Gall, and P. Levang. 2014. Improving rural livelihoods through participative research on the domestication and breeding of the palm weevil larvae (Rhynchophorus phoenicis Fabr.) : the African palm weevil project : Final project report 22. http://www.documentation.ird.fr/hor/fdi:010062139AN. Accessed 14-12-2018

Nwokeke, N. V. 2001. Palm wine preservation using traditional plant that have preservative bases. B.Sc. Imo State University Owerri, Nigeria.

Obahiagbon, F.I. 2007. Raphia vinifera Sap: Some Physico-Chemical and Biochemical Profiles. A Comparative Study. Journal of Research in Agriculture, 4: 1–3.

–. 2009. A review of the origin, morphology, cultivation, economic products, health and physiological implications of raphia palm. African Journal of Food Science, 3: 447–453.

Obahiagbon, F.I. and A.U. Osagie. 2007. Sugar and macrominerals composition of sap produced by Raphia hookeri palms. African Journal of Biotechnology, 6: 744–750.

Obahiagbon, F.I., P. Oviasogie, M.E. Ukhun, and P.N. Oviawe. 2007. Comparative studies of the thiamine and riboflavin contents in the sap of Raphia hookeri palm-by the applications of fluorimetric method and Arrhenius Equation. Trends in Applied Sciences Research 3: 260– 263.

Obot, I.S. 2000. The measurement of drinking patterns and alcohol problems in Nigeria. Journal of Substance Abuse, 12: 169–81.

Ogbuagu, M.N. 2008. Vitamins, phytochemicals and toxic elements in the pulp and seed of raphia palm fruit (Raphia hookeri). Fruits, 63: 297–302.

Ogbuagu, M.N., I. Ohondu, and C. Nwigwe. 2011. Fatty acid and amino acid profiles of the larva of Raffia Palm Weevil: Rhynchophorus phoenicis. The Pacific Journal of Science and Technology 12: 392–400.

Ohimain, E.I., P.E. Tuwon, and E.A. Ayibaebi. 2012. Traditional Fermentation and Distillation of Raffia Palm Sap for the Production of Bioethanol in Bayelsa State, Nigeria. Journal of Technology Innovations in Renewable Energy, 1: 131–141.

Okafor, N. 1975. Preliminary Microbiological Studies on the Preservation of Palm Wine. Journal of Applied Bacteriology, 38: 1–7.

Okon, U.E., and E. C. Okorji. 2014. Economic Analysis of Raphia Palm (Raphia spp .) Wine Production in Akwa Ibom State, Nigeria. International Journal of Agriculture and Crop Science, 7: 347–352.

Okunowo, W.O., A.M. Olagboye, L.O. Afolabi, and A.O. Oyedeji. 2017. Nutritional Value of Rhynchophorus phoenicis (F.) larvae, an edible insect in Nigeria. African Entomology, 25: 156–163.

Oladeinde, F.O., E.I. Nwankwo, O.A. Moronkola, M.A. Amosu, and Farayola B. 2002. African Journal of Biomedical Research. African Journal of Biomedical Research, 5: 73–76.

Oloa Biloa, C. 2011. La musique des pygmées Bagyéli (Sud-ouest Cameroun). Étude des conséquences du changement de mode de vie sur le patrimoine musical. Nanterre: Université de Paris-Ouest.

–. 2015. The Bagyéli of South-west Cameroon. The impact of sedentarisation on musical and dance practices. Hunter Gatherer Research, 1: 317–331.
Onyeike, E.N., E.O. Ayalogu, and C.C. Okaraonye. 2005. Nutritive value of the larvae of raphia palm beetle (Oryctes rhinoceros) and weevil (Rhyncophorus pheonicis). Journal of the Science of Food and Agriculture, 85: 1822– 1828.
Opara, M.N., F.T. Sanyigha, I.P. Ogbuewu, and I.C. Okoli. 2012. Studies on the production trend and quality characteristics of palm grubs in the tropical rainforest zone of Nigeria. Journal of Agricultural Technology, 8: 851–860.
Otedoh, M.O. 1982. A revision of the genus Raphia Beauv.(Palmae). Nigerian Institute of Oil Palm Research, 6: 145–189.
–. 1990. Sweet raphia palm wine. The Nigerian Field 55: 59–64.
Ouattara, D.N., P. Ekpe, A. Bakayoko, and F.W. Stauffer. 2015. Ethnobotany and conservation of palms from Ghana. Palms 59: 85–103.
Ouattara, D.N., F.W. Stauffer, and A. Bakayoko. 2014. Lectotypification de Raphia sudanica A. Chev. (Arecaceae, Calamoideae), et commentaires sur la biologie et la conservation de l'espèce. Adansonia 36: 53–61. https://doi. org/10.5252/a2014n1a5
Pernet, R. and G. Meyer. 1957. Pharmacopée de Madagascar. http://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers13-05/ 010057844.pdf. Accessed 12-12-2018
Perrier de la Bathie, H. 1931. Le Raphia de Madagascar. Journal d'agriculture traditionnelle et de botanique appliquée, 113: 4–17.
Profizi, J.-P. 1986. Biologie et modes de gestion des marécages à Raphia hookeri Mann and Wendland au Sud-Est du Bénin. Journal d'agriculture traditionnelle et de botanique appliquée, 49–58.
–. 1988. Swampy area transformations by exploitation of Raphia hookeri in southern Benin (West Africa). Human Ecology, 16: 87–94.
Quiroz, D., and T. van Andel. 2018. The cultural importance of plants in Western African religions. Economic Botany 72: 251–262.
Rainey, H.J., F.C. Iyenguet, G.-A.F. Malanda, B. Madzoké, D. Dos Santos, E.J. Stokes, F. Maisels, and S. Strindberg. 2010. Survey of Raphia swamp forest, Republic of Congo, indicates high densities of Critically Endangered western lowland gorillas Gorilla gorilla gorilla. Oryx 44: 124–132. DOI: https://doi.org/10.1017/ S003060530999010X
Riggi, L.G., M. Veronesi, G. Goergen, C. MacFarlane, and R.L. Verspoor. 2016. Observations of entomophagy across Benin – practices and potentials. Food Security, 8: 139–149. DOI: https://doi.org/10.1007/s12571-0150509-y
Rivallain, J. 2001. Monnaies d'Afrique: visions africaines et visions européennes. Revue numismatique 157: 121–130.
Russell, T.A. 1965. The Raphia palms of West Africa. Kew Bulletin 19: 173–196. http://www.jstor.org/stable/4108027. Accessed 1512-2018
Salpeteur, M. 2009. Du palais à l'autopsie: les doublures animales dans une chefferie bamiléké (Cameroun). Ph.D., Paris: Muséum National d'Histoire Naturelle.
Stauffer, F.W., D. Ouattara, and A.L. Stork. 2014. Palmae (Arecaceae). In: Tropical African Flowering Plants: Monocotyledons (Vol. 8), eds. Lebrun, J. P., and Stork, A.L. 326–354. Genève: Conservatoire et Jardin Botanique Ville de Genève.
Stauffer, F.W., D.N. Ouattara, D. Roguet, S. Da Giau, L. Michon, A. Bakayoko, and P. Ekpe. 2017. An update to the African palms (Arecaceae) floristic and taxonomic knowledge, with emphasis on the West African region. Webbia: Journal of Plant Taxonomy and Geography, 72: 17–30. DOI: https://doi.org/10. 1080/00837792.2017.1313381
Sunderland, T.C.H. 2011. Food security: why is biodiversity important? International Forestry Review, 13: 265–274.
Tem, K.A. 2014. Lingala/Falansé Français/Lingala, Paris: Karthala.

Tieguhong, J.C., N. Sonne, and D.H. Nzene. 2015. Mapping of Forestry Investments and timber trade involving Chinese companies in Cameroon. WWT Report Cameroon June: 132. DOI: https://doi.org/10.13140/RG.2.1. 1564.4881

Tiempa, N.E.F., N.F. Zambou, E.E. Agbor, and M.F. Tchouanguep. 2013. Physicochemical changes of raffia sap (Raphia mambillensis) contents during spontaneous fermentation. African Journal of Biotechnology, 12: 6013–6018.

Tuley, P. 1965. The production of Raphia wine in Nigeria. Experimental Agriculture 1: 141–144.

–. 1995. The palms of Africa. Cornwall: Trendrine Press.

Tuley, P. and T.A. Russell. 1966. The Raphia palms reviewed. Nigerian Field, 32: 54–65.

Uzochukwuru, B.U., F. Balogh, and P.D. Ngoddy. 1991. Standard pure culture inoculum of natural fermented Palm sap. Nigeria Journal of Microbiology, 9: 67–77.

van Huis, A., M. Dicke, and J.J.A. van Loon. 2015. Insects to feed the world. Journal of Insects as Food and Feed, 1: 3–5.

Voeks, R.A. 1997. Sacred leaves of Candomble: African magic, medicine and religion in Brazil. Texas: University of Texas Press.

Wallace, A.R. 1853. Palm trees of the Amazon and their uses. London: Kessinger Legacy Reprints.