Amerindian and Afro-American Perceptions of Their Traditional Knowledge in the Chocó Biodiversity Hotspot

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The Chocó biodiversity hotspot is one of the most biodiverse and threatened regions on earth, yet the traditional knowledge (TK) of its inhabitants about biodiversity remains little studied. The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) aims to integrate different knowledge systems, including scientific and TK, to assess the state of the planet's biodiversity. We documented the TK of three ethnic groups: Afro-Colombians (n = 86 participants), Amerindian Emberá (n = 88), and Tsa'chila (n = 52), focusing on their perceptions about (i) the most important palms, (ii) current vs. past uses, (iii) and TK transmission. We found 46 useful palm species and 520 different uses of palms. The species that were most important in local people's views also had high use value, based on a commonly used quantitative index in ethnobotany. Although construction was the most commonly mentioned use category, palm materials were absent in Afro-Colombian and Tsa'chila homes, and were being increasingly replaced in Emberá homes. In all three cultures, it was generally believed that TK was not being transmitted to the younger generations. In aggregate, the current perceptions of decreasing transmission of TK, decreasing use of forests, and intergenerational differences in perceptions in the Chocó could accelerate the erosion of TK. Therefore, this could ultimately limit the contribution of Amerindian and Afro-Colombian TK to IPBES's goals of assessing on-the-ground changes in biodiversity.

El punto caliente de biodiversidad del Chocó es una de las regiones más biodiversas y amenazadas de la Tierra, sin embargo el conocimiento tradicional (CT) de sus habitantes sobre la biodiversidad está poco estudiado. La Plataforma Intergubernamental sobre Biodiversidad y Servicios de los Ecosistemas (IPBES) tiene como objetivo integrar los diferentes sistemas de conocimiento, incluidos los conocimientos científicos y tradicionales, para evaluar el estado de la biodiversidad del planeta. Documentamos el CT de tres grupos étnicos: los Afro-Colombianos (n = 86 participantes), Amerindios Emberá (n = 88), y Tsa'chila (n = 52), enfocándonos en sus percepciones sobre (i) las palmeras más importantes, (ii) los usos actuales *vs*. pasados, (iii) y la transmisión del CT. Encontramos 46 especies de palmeras útiles y 520 usos diferentes. Las especies que fueron más importantes según las poblaciones locales también tuvieron un valor de uso alto, en base a un índice cuantitativo de uso común en etnobotánica. Aunque construcción fue la categoría de uso más comúnmente mencionada, no se encontraron materiales de palmeras en los hogares Afro-Colombianos y Tsa'chila, y en los hogares Emberá se estaban remplazando cada vez más. En las tres culturas se tuvo la percepción general de que el CT no se está transmitiendo

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a las generaciones más jóvenes. Además, la percepción actual de disminución en la transmisión del CT, el menor uso de los bosques y las diferencias en las percepciones intergeneracionales en el Chocó podrían acelerar la erosión del CT. Por lo tanto, todo ello podría limitar la contribución del CT de los Amerindios y Afro-Colombianos a los objetivos de IPBES para evaluar los cambios locales en la biodiversidad.

Key Words: Cultural change, ecosystem services, indigenous peoples, palms, local knowledge, plant valuation, quantitative ethnobotany, local perceptions.

Introduction

The Chocó hotspot extends from Mesoamerica to northwestern South America and is one of the most biodiverse and threatened regions on Earth. In addition to its ~11,000 vascular plant species, of which 25% are endemic, this hotspot houses a substantial fraction of the earth's undiscovered species (Joppa et al. 2011). Only one-quarter of its original vegetation remains, and the infrastructure development forecasted for the coming years threatens the region's biocultural diversity (Saenz et al. 2013). Protected areas are poorly represented (Forero-Medina and Joppa 2010; Sarkar et al. 2008; Sierra et al. 2002), and many habitats show levels of protection of only 1–5% (Forero-Medina and Joppa 2010). The vast lands collectively titled to Amerindian and Afro-American groups represent a unique conservation opportunity to counteract the forecasted threats. In Colombia, Amerindian reserves and territories collectively owned by Afro-Americans cover >6 million hectares, or 50% of Colombia's Pacific region (Forero-Medina and Joppa 2010). In Ecuador these lands are smaller, and the recognition of Amerindian and Afro-American territories has been minor (Riascos et al. 2008).

The integration of traditional knowledge (TK) in conservation assessments is increasing globally (Huntington 2011; Thaman et al. 2013). Platforms like the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) aim to support the establishment of participatory mechanisms to facilitate linkages between indigenous and local communities and scientists (Díaz et al. 2015; UNEP 2012). Traditional knowledge, according to the IPBES, refers to "knowledge and know-how accumulated by regional, indigenous or local communities over generations that guide human societies in their interactions with their environment" (UNEP 2012, p. 18). The IPBES recognizes and considers that TK systems can complement science-based models to reinforce the delivery of the IPBES's objectives of assessing the state of the planet's biodiversity, its ecosystems, and the essential services they provide to society (IPBES 2014; UNEP 2012). The importance of TK to the conservation and sustainable use of ecosystems was acknowledged in the IPBES's Operating Principles, as well as in Article 8(j) of the Convention on Biological Diversity and Aichi Biodiversity Target 18 (UNEP 2012).

The TK of Chocó inhabitants remains vastly underdocumented (Cámara-Leret et al. 2014a; Macía et al. 2011), limiting the possibility of including TK in one of the four functions of the IPBES: to produce assessments of the state of the planet's biodiversity (UNEP 2012). Cross-cultural studies in the Chocó that have been based on interviews with local people include Barfod and Kvist (1996), who registered 931 species used by the Amerindian Tsa'chila, Chachi, and Awá of Ecuador. In coastal Ecuador, Cerón and collaborators documented the ethnobotanical knowledge of Afro-Ecuadoreans (Cerón 2001), Awá (Cerón and Montalvo 2002), Tsa'chila (Cerón et al. 2004), and mestizos (Cerón 1993, 2002; Cerón et al. 2004). In Colombia, Galeano (2000) in a quantitative study of trees >5 cm dbh in 1.8 hectares of rainforest showed that 18 Afro-Colombian participants knew 208 useful species. Recent comparative studies on palm ethnobotanical knowledge have shown that (i) Afro-Americans know nearly as much as Amerindians (Cámara-Leret et al. 2014b), and (ii) that formal education has a significant negative association to TK, that age has a positive significant association to TK, and that men that participated in the study are generally more knowledgeable than women (Paniagua-Zambrana et al. 2014).

Here, we investigate how Amerindian and Afro-American perceptions about palms in the Chocó compare with quantifying use reports. Palms (Arecaceae) are an excellent model group for contrasting local views and quantitative methods because palms are the most useful plant family in tropical America (Macía et al. 2011). The subsistence needs of thousands of tropical forest dwellers are met by palms (e.g., Balslev 2011; Balslev et al. 2008; Barfod and Balslev 1988; Macía 2004), and many different palm uses and useful palm species have been documented in this region (Barfod and Balslev 1988; Barfod and Kvist 1996; Cámara-Leret et al. 2014a, b; Macía et al. 2011). Moreover, the Chocó palms have been intensively studied and their well-resolved taxonomy faciliates rapid field inventories (Borchsenius et al. 1998; Galeano and Bernal 2010).

Specifically, we test three hypotheses. First, we assess whether local perceptions within the social group are congruent with those of researchers regarding the most important palm species. Our hypothesis here was that people would attribute greater importance to species with many uses than to those with few uses (Phillips and Gentry 1993). Second, we assess whether participants' responses about palm uses are congruent with present-day practices. We focused on palms used in construction because many construction uses require destructive harvest of individual plants, and the potential for unsustainable practices is high, e.g., when harvesting palm leaves for thatch (Flores and Ashton 2000). Our hypothesis was that participants' responses about construction uses reflect current practices. Third, we assess the perceptions of different age groups on whether TK is being transmitted between generations or not. Our hypothesis was that most people perceive that TK is not being transmitted, because our sites are exposed to the influence of markets, and access to markets and services often lead to lower TK transmission (Reyes-García et al. 2013). We also hypothesized that in more remote communities perceptions about knowledge transmission would be more optimistic than in less remote communities (Byg and Balslev 2001b).

Methods

Study Area

The Chocó extends over 1,500 km from Panama through the coastal plains of Colombia and Ecuador to northwestern Peru, encompassing 274,538 km^2 (Conservation International 2014). Our study sites in Colombia included one Afro-American locality and one Emberá locality, and in Ecuador one Tsa'chila locality (Fig. 1). In the Chocó department of Colombia, Afro-Colombians represent the dominant group with 286,000 individuals (0.7% of Colombia's population in 2005), and the Emberá are the largest Amerindian group with about 80,000 individuals (0.2%) (DANE 2007). In Ecuador, the Tsa'chila represent the dominant Amerindian group, with 2,500 individuals in seven settlements (Rivera 2013), representing 0.01% of Ecuador's population in 2010.

We studied the Afro-Colombian community of Puerto Pervel consisting of 1,500 inhabitants and located 30 km south of Quibdó, the capital of the Chocó department (Table 1). This community has a health post, primary school, electricity, and more than 10 shops. Most inhabitants earn a living from gold mining, wage labor, commerce, agriculture, and fishing. The most common forest type surrounding Puerto Pervel is tropical rainforest affected by logging.

Our Emberá study site, the *Resguardo Indígena Emberá Río Purricha*, is accessible by river from Pizarro, the capital of Bajo Baudó municipality. In the northern sector of the indigenous reserve we visited the community of Aguacate, and three hours downriver in the southern sector we visited Villanueva (Table 1). Both communities have a primary school, but lack health posts and electricity. In Aguacate, 98% of participants spoke Emberá and 82% spoke Spanish. Villanueva appears to be more acculturated: 48% of participants spoke Emberá and 93% spoke Spanish, and this community has several shops and a bakery. Classroom education levels in both communities are very low (Table 1). Of all participant groups studied, the Emberá are the least involved in market activities. They maintain a subsistence livelihood based on agriculture, hunting, and fishing, and trade of products derived from the wild with Afro-Colombians. The most common forest type surrounding both Emberá communities is tropical rainforest not affected by industrial logging.

The Tsa'chila study communities of Chuigüilpe and Peripa are accessible by road, have a health post, primary school, and electricity. All participants spoke Tsafiqui and Spanish (Table 1). The Tsa'chila subsistence and livelihood depends on agriculture (69% of active population), traditional medicine (10%), crafts (7%), wage labor (7%), ethno-tourism (6%), and as shop-keepers (1%) (Rivera 2013). Both Tsa'chila communities have facilities to showcase Tsa'chila material culture, music, and dance to tourists. Both communities are surrounded by small patches of logged tropical rainforests, but mostly by industrial plantations.

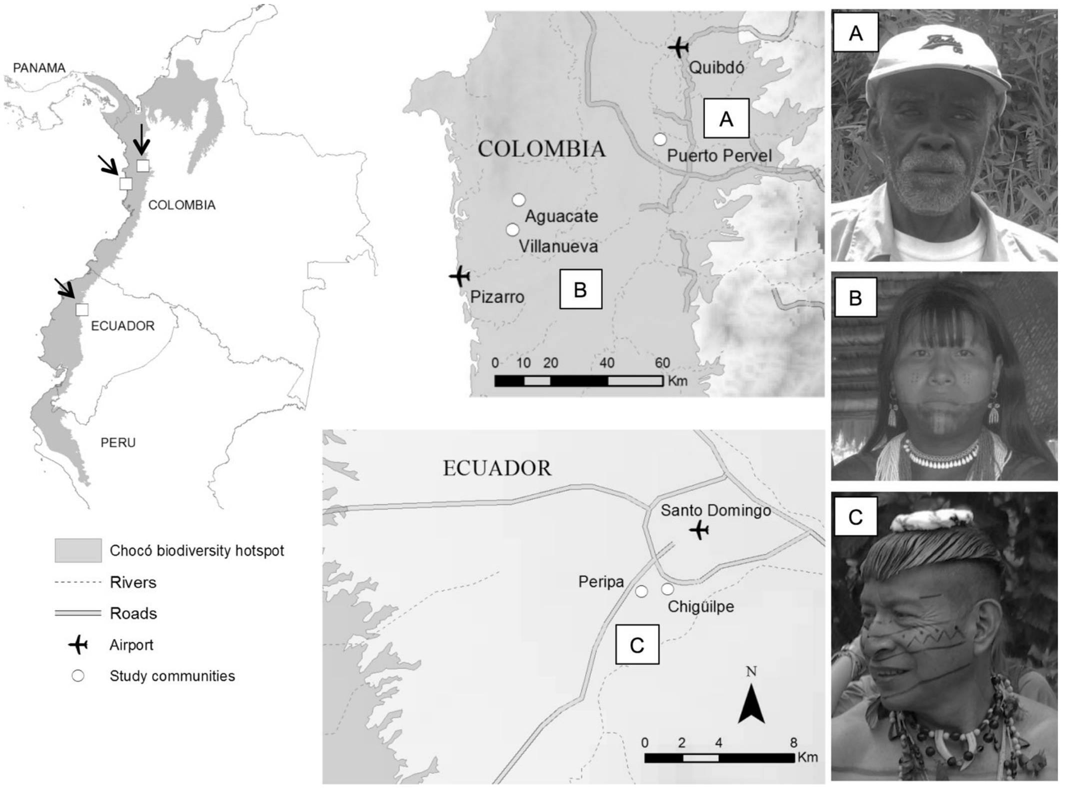

Fig. 1. Map of the study area in the Colombian and Ecuadorean Chocó and examples of the people living there: (A) Afro-Colombian, (B) Emberá, and (C) Tsa'chila.

Data Sampling

From November 2010 to December 2011, we interviewed 226 participants about their TK of palm uses and their perceptions about TK transmission using a standardized protocol (Cámara-Leret et al. 2012; Paniagua-Zambrana et al. 2010). Data were collected with two types of participants: 1–7 experts (n = 18) and 18–79 general participants (n = 208) in each community (Table 1). Experts were selected by consensus during a meeting of community members. In Puerto Pervel, with a population exceeding 1,000 inhabitants, experts were recruited by asking several general participants to recommend their most knowledgeable peers. Experts were mostly men (83%) and over 40 years old (78%). We performed walks in the field with each expert to identify all palm species growing in the surrounding forest, register their vernacular names, and document their uses. Palm species were identified in the field using Galeano and Bernal (2010) and Borchsenius et al. (1998), and specimens were collected when our field identifications needed confirmation. Voucher specimens were deposited in the herbaria of AAU, CHOCO, COL, and QCA (acronyms according to Thiers [2015]). Once experts were interviewed, we used the list of compiled vernacular names, images of palms in the field, and images in Galeano and Bernal (2010) as the basis for interviews with general participants. We selected general participants in a stratified manner to have a representative sample of gender (women 50%, men 50%) and age classes (18–30 years [27%], 31–40 [22%], 41–50 [19%], 51–60 [17%], >60 [15%]). We conducted structured interviews to gather personal data (age, gender, education, ethnicity) and household data (house construction materials) of all participants. Depending on the number of palm species and palm uses known by each participant, interviews with experts lasted between half to a whole day, and interviews with general participants lasted between 30 minutes

TABLE 1. THE FIVE COMMUNITIES STUDIED IN THE COLOMBIAN AND ECUADOREAN CHOCÓ.

Community	Puerto Pervel	Aguacate	Villanueva	Chigüilpe	Peripa	Total
Ethnicity	Afro-Colombian	Emberá	Emberá	Tsa'chila	Tsa'chila	
Population	~1500	312	199	130	130	
Access	Road	Fluvial	Fluvial	Road	Road	
Distance to markets (hours)	Close (2)	Remote (24)	Remote (24)	Close (0.5)	Close (0.5)	
Average plot size (ha) (±SD)	0.44 ± 0.74	0.94 ± 1.17	0.91 ± 0.87	3.63 ± 4.61	6.89 ± 3.99	
No. informants	86	44	44	33	19	226
No. expert informants	7	5	3	2	1	18
No. general informants	79	39	41	31	18	208
Speaking Spanish (%)	100	82	100	100	100	
Speaking indigenous language (%)	0	98	48	100	100	
Completed primary school (%)	52	9	11	73	56	
Completed secondary school (%)	11	2	2	12	22	
No. men	47	24	18	17	7	113
No. women	39	20	26	16	12	113
Age (years)						
18–30	18	16	16	7	4	61
31–40	14	10	13	8	5	50
41–50	19	9	5	5	5	43
51–60	16	7	7	8	0	38
>60	19	2	3	5	5	34

to 2 hours. Interviews were conducted in Spanish or with the help of a local interpreter in the Emberá communities.

DATA ANALYSIS

Data were analyzed at the species level, with the exception of *Bactris gasipaes* Kunth for which we differentiated the wild var. *chichagui* from the cultivated var. *gasipaes*. Palm use reports were classified into one of 10 use categories and subcategories following the Economic Botany Data Collection Standard (Cook 1995), with modifications proposed by Macía et al. (2011). Use categories included Animal Food, Construction, Cultural, Environmental, Fuel, Human Food, Medicinal and Veterinary, Toxic, Utensils and Tools, and Other Uses (including uses not classifiable within the previous categories, mainly indirect use of palms such as the use of beetle larvae that develop in rotting trunks). We defined each "palm use" following Macía et al. (2011) as the use of a palm part from a given species associated to a use category and subcategory.

To determine which species were most important in the local knowledge systems, we asked each participant the following questions: Which palm species is the most important for you? What is it that makes this species so important to you? We collated answers from all respondents anonymously within each group, and from this list we ranked species by their frequency of citations. When participants reported more than one species, we included all reports in the final sum. To determine which species were most important according to the quantitative indices that are commonly used in ethnobotany, we computed the use value (UV) for each species (Phillips and Gentry 1993), with the simplification proposed by Rossato et al. (1999) as:

$$UV_s = \sum U_i / N \tag{1}$$

where U_i is the number of uses mentioned by each participant *i,* and *N is* the total number of participants interviewed in the ethnic group.

To determine if the uses for construction mentioned in the interviews were also being practiced, we inspected, with permission of the owners, the households of participants in each community. We recorded whether the type of construction materials used for floors, frames, walls, and roof in the homes were of palms or commercial materials, and we identified *in situ* the used palm species. We summed all answers for each house part and calculated the overall percentage of each registered material for each community.

To evaluate local perceptions of the transmission of TK, we asked each participant the following questions: Is knowledge about plants being transmitted from the older to the younger generations in the community? Why is this so? We collated answers from all participants within each group, and analyzed them separately for each age group in each community. To assess if participants' perceptions match current trends in TK, we determined how TK was distributed across different individuals in the three participant groups. We performed a Kruskal-Wallis analysis to test for significant differences in the number of palm species and palm uses cited by different age classes, men and women, and between general and expert participants. All statistical analyses were conducted in R 3.1.3 (R Development Core Team 2015).

Ethics Statement

Approval for this study was granted by the Committee for Ethical Research of the Autonomous University of Madrid (#48-922; PI Manuel J. Macía). Before initiating *in situ* data collection, we obtained oral informed consent at the community level and then from the participant prior to each interview. Participants were made aware of their right to discontinue the interviews at any time and that all of the information provided would be anonymized.

Results

A total of 520 different palm uses from 46 species were recorded in the 226 interviews (Table 2). The Emberá knew more useful palm species than the other groups, and together with Afro-Colombians they mentioned more palm uses than the Tsa'chila, although the number of interviews was also lower for the Tsa'chila. In contrast, the Tsa'chila of Chigüilpe knew more palm uses per species than the other groups, but these differences were not statistically significant. The use categories Human Food, Utensils and Tools, Cultural, and Construction generally had the highest numbers of palm uses among all communities and groups.

For all ethnic groups, six to seven of the ten species identified as most important by the

Table 2. Number of useful palm species, total number of uses, mean number of uses per species, and number of uses in ten ethnobotanical categories in the five study communities in the Colombian and Ecuadorean Chocó.

				No. uses per use category									
Country/Community	No. useful species	No. palm uses	Mean no. uses per species (±SD)	Animal food	Construction	Cultural	Environmental	Fuel	Human food	Medicinal & veterinary	Toxic	Utensils & tools	Other uses
Colombia													
Puerto Pervel	29	232	8.0 ± 4.7	3	49	26	15	1	51	22	2	60	3
Aguacate	35	233	6.7 ± 4.8	6	37	38	4	7	71	14	0	51	5
Villanueva	30	189	6.3 ± 3.8	7	39	22	2	4	66	11	0	35	3
Ecuador													
Chigüilpe	20	176	8.8 ± 5.9	2	30	35	4	3	39	17	0	29	17
Peripa	17	104	6.1 ± 5.1	0	19	25	1	1	32	8	0	8	10
Total	46	520	11.3 ± 8.8	11	82	93	18	11	117	60	2	106	20

TABLE 3. THE 10 MOST IMPORTANT PALM SPECIES FOR (A) AFRO-COLOMBIAN, (B) EMBERÁ, AND (C) TSA'CHILA PARTICIPANTS, ACCORDING TO LOCAL VIEWS AND QUANTITATIVE METHODS IN THE COLOMBIAN AND ECUADOREAN CHOCÓ. UV: USE VALUE.

A. AFRO-COLOMBIAN VIEWS				A. QUANTITATIVE METHODS		
Rank	Species	No. participants	Explanation of importance	Rank	Species	UV
1	*Oenocarpus bataua* Mart.	30	Human food	1	*Manicaria saccifera* Gaertn.	3.9
2	*Cocos nucifera* L.	22	Human food	2	*Oenocarpus bataua* Mart.	3.5
3	*Bactris gasipaes* Kunth *var. gasipaes*	16	Human food	3	*Bactris gasipae*s Kunth var. *gasipaes*	3.3
4	*Socratea exorrhiza* (Mart.) H. Wendl.	6	Construction	4	*Oenocarpus minor* Mart.	3.3
5	All are important	6	-	5	*Euterpe oleracea* Mart.	3.3
6	*Mauritiella macroclada* (Burret) Burret	5	Construction	6	*Attalea allenii* H.E. Moore	2.9
7	*Elaeis guineensis* Jacq.	5	Human food	7	*Cocos nucifera* L.	2.3
8	*Wettinia quinaria* (O.F. Cook & Doyle) Burret	3	Construction	8	*Mauritiella macroclada* (Burret) Burret	2.1
9	*Welfia regia* H. Wendl.	2	Thatch; Utensils and tools	9	*Socratea exorrhiza* (Mart.) H. Wendl.	2.1
10	*Manicaria saccifera* Gaertn.	2	Thatch	10	*Bactris coloniata* L.H. Bailey	2
B. EMBERÁ VIEWS				B. QUANTITATIVE METHODS		
Rank	Species	No. participants	Explanation of importance	Rank	Species	UV
1	*Iriartea deltoidea* Ruiz & Pav.	60	Construction	1	*Oenocarpus bataua* Mart.	4.4
2	*Welfia regia* H. Wendl.	7	Thatch	2	*Bactris gasipaes* Kunth var. *gasipaes*	4
3	*Socratea exorrhiza* (Mart.) H. Wendl.	7	Construction	3	*Iriartea deltoidea* Ruiz & Pav.	3.9
4	*Bactris gasipaes* Kunth *var. gasipaes*	5	Human food	4	*Astrocaryum standleyanum* L.H. Bailey	3.8
5	*Oenocarpus bataua* Mart.	5	Human food	5	*Welfia regia* H. Wendl.	3.7
6	*Wettinia quinaria* (O.F. Cook & Doyle) Burret	4	Construction	6	*Oenocarpus minor* Mart.	3.5
7	*Oenocarpus minor* Mart.	3	Construction	7	*Cocos nucifera* L.	2.6
8	*Bactris coloniata* L.H. Bailey	1	Hunting tools	8	*Wettinia quinaria* (O.F. Cook & Doyle) Burret	2.4
9	*Cocos nuccifera* L.	1	Food	9	*Attalea allenii* H.E. Moore	2.3
10	All are important	1	-	10	*Phytelephas macrocarpa* Ruiz & Pav.	2.2
C. TSA'CHILA VIEWS				C. QUANTITATIVE METHODS		
Rank	Species	No. participants	Explanation of importance	Rank	Species	UV
1	*Iriartea deltoidea* Ruiz & Pav.	41	Construction; many uses	1	*Iriartea deltoidea* Ruiz & Pav.	7.3
2	*Wettinia quinaria* (O.F. Cook & Doyle) Burret	17	Construction; many uses	2	*Bactris gasipaes* Kunth *var. gasipaes*	7
3	*Bactris gasipaes* Kunth *var. gasipaes*	6	Many uses; medicinal	3	*Phytelephas aequatorialis* Spruce	4.6
4	All are important	5	All are important	4	*Wettinia quinaria* (O.F. Cook & Doyle) Burret	4.3
5	*Elaeis guineensis* Jacq.	1	Human food	5	*Attalea colenda* (O.F. Cook) Balslev & A.J. Hend.	3.8
6		1	Medicinal	6	*Oenocarpus bataua* Mart.	2.9

(Continued)

TABLE 3. (CONTINUED).

A. AFRO-COLOMBIAN VIEWS				A. QUANTITATIVE METHODS		
Rank	Species	No. participants	Explanation of importance	Rank	Species	UV
	Attalea colenda (O.F. Cook) Balslev & A.J. Hend.					
7	*Phytelephas aequatorialis* Spruce	1	Utensils and tools	7	*Bactris gasipaes* var. *chichagui* (H. Karst.) A.J. Hend.	2.6
8	-	-	-	8	*Wettinia equalis* (O.F. Cook & Doyle) R Bernal	2.5
9	-	-	-	9	*Cocos nucifera* L.	2.5
10	-	-	-	10	*Astrocaryum standleyanum* L.H. Bailey	2.3

participants coincided with the 10 species having the highest Use Value Index, although species' ranks differed between the lists (Table 3). For Afro-Colombians, the most important species was used for human food, whereas for the Emberá and Tsa'chila, the most important species were largely employed for construction purposes.

In Afro-Colombian and Tsa'chila communities, the palms mentioned as most useful for construction purposes were generally not being used any more (Table 4). In contrast, the more remote Emberá communities generally did use palm materials cited in interviews. For instance, the split stems of *Iriartea deltoidea* Ruiz & Pav. were the most commonly used for floors, and those of *Socratea exorrhiza* (Mart.) H. Wendl. for walls. For roofing, however, tin has progressively replaced palm materials in the Emberá community of Villanueva (97% of households), whereas in Aguacate 42% of the households still use *Welfia regia* H. Wendl. leaves for thatching. In all communities except Aguacate, the use of palms in frames was negligible.

Overall, most participants thought that TK was not being transmitted from the older to the younger generations (Fig. 2). This view was most pronounced among Afro-Colombians, with an average among age classes of 85% believing there is a lack of knowledge transmission. Opinions of poor knowledge transmission were similar across Emberá age classes, with a mean of 61% of respondents having that opinion. The Tsa'chila had the lowest overall values but the highest variation between generations, and 40% of Tsa'chila individuals aged 41–50 and 25% aged 51–60 believed that TK was not being passed on.

Within each participant group, we found that the overall ethnobotanical knowledge differed among communities (Table 5), and that the TK of

TABLE 4. CONSTRUCTION MATERIALS USED IN HOUSEHOLDS WITHIN THE FIVE STUDY COMMUNITIES IN THE COLOMBIAN AND ECUADOREAN CHOCÓ.

	Current construction materials (% households interviewed)			
Community	Floors	Frame	Walls	Roof
Puerto Pervel	Cement (91), wood (9)	Cement (91), wood (9)	Cement (91), wood (9)	Tin (100)
Aguacate	*Iri del* (96), wood (4)	Wood (85), *Oen min* (12), *Wet qui* (3)	*Soc exo* (50), open* (42), wood (8)	Tin (58), *Wel reg* (42)
Villanueva	*Iri del* (98), wood (2)	Wood (97), *Iri del* (3)	*Soc exo* (83), *Iri del* (7), wood (7), open* (3)	Tin (97), *Wel reg* (3)
Chigüilpe	Cement (87), soil (9), wood (4)	Cement (83), bamboo (13), *Wet qui* (4)	Cement (83), bamboo (13), wood (4)	Tin (97), fern (3)
Peripa	Cement (91), soil (9)	Cement (91), wood (9)	Cement (91), bamboo (9)	Tin (91), fern (9)

Abbreviated palm species: *Iri del: Iriartea deltoidea* Ruiz & Pav.; *Oen min: Oenocarpus minor* Mart.; *Soc exo: Socratea exorrhiza* (Mart.) H. Wendl.; *Wel reg: Welfia regia* H. Wendl.; *Wet qui: Wettinia quinaria* (O.F. Coook & Doyle) Burret; *Traditional Emberá houses lack walls (open).

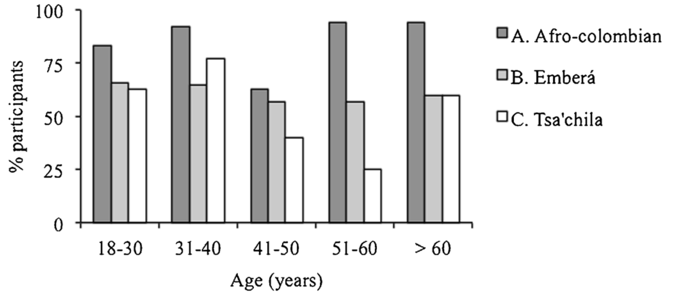

Fig. 2. The percentage of Afro-Colombian, Emberá, and Tsa'chila participants from five generations that reported a lack of transmission of TK.

individuals varied in relation to at least one of the analyzed socio-demographic factors (age, gender, expertise) (Fig. 3). Among Afro-Colombians, participants' age significantly explained differences in the number of useful species (χ^2 = 36.33, p <0.001) and palm uses cited (χ^2 = 21.35, p <0.001) (Fig. 3A-B). Older individuals (>60 years) knew more palm species and palm uses than participants aged 18–30 (p <0.001), and more palm species than those aged 31–40 years (p <0.04), but just as many species as participants aged 41–60 years. Men knew on average more species than women (χ^2 = 19.77, p <0.001) and more palm uses (χ^2 = 6.16, p = 0.013). Afro-Colombian experts knew more palm species than general participants (χ^2 = 4.83, p = 0.03), but the number of palm uses was similar in both groups.

The knowledge of the Emberá was also determined by age and expertise, but not by gender (Fig. 3C-D). Age classes differed only in their TK of palm uses (χ^2 = 15.31, p = 0.004). Although young participants aged 18–30 knew significantly fewer uses than individuals aged 51–60 (p = 0.007), they knew just as many uses as the remaining age classes, including that of the oldest participants aged over 60. Experts knew more useful palm species (χ^2 = 18.33, p <0.001) and more palm uses (χ^2 = 20.88, p <0.001) than general participants.

Among the Tsa'chila, age and gender, but not expertise, were the main drivers of knowledge differences (Fig. 3E-F). The youngest individuals aged 18–30 knew significantly fewer palm species (χ^2 = 34.38, p <0.001) and palm uses (χ^2 = 20.45, p <0.001) than the older age classes. Individuals aged >60 knew more palm species than all other age classes, and more palm uses than those aged 18–30. Men knew significantly more palm uses than women (χ^2 = 20.88, p <0.001).

Discussion

Overall, we found that the palm species that were important in the view of local people also ranked high in our quantitative analysis based on the Use Value Index, suggesting that quantitative methods can adequately approximate local views about the overall importance of plants in a site (Phillips and Gentry 1993). Given the different order in ranks between qualitative and quantitative results, our first hypothesis that people would attribute greater importance to species with many uses than those with few uses was not supported. For example, *Cocos nucifera* L. was the second-most important palm for Afro-Colombians despite this species being ranked seventh in Use Value. Similarly, *Iriartea deltoidea* was by far the most important palm for the Emberá but its Use Value was lower than *Oenocarpus bataua* Mart. and *Bactris gasipaes* var. *gasipaes*. Other studies have also shown that the importance that local people attribute to species is not necessarily linked to materialistic usefulness or actual frequency of use (Byg and Balslev 2001a, b). Thus, when selecting which species to prioritize for conservation and management actions, the use of ranking exercises will more closely approximate local views than the Use Value, which emphasizes species that provide many uses compared to others with a few but highly important uses (Reyes-García et al. 2006).

Our second hypothesis, that participants' responses about construction uses reflect current practices, was only supported in the Emberá communities. Although construction was among the most

TABLE 5. ETHNOBOTANICAL KNOWLEDGE OF PALMS IN THE FIVE STUDY COMMUNITIES OF THE COLOMBIAN AND ECUADOREAN CHOCÓ.

Species	Puerto Pervel	Aguacate	Villanueva	Chigüilpe	Peripa
Ammandra decasperma O.F. Cook	Co, Cu, Hu, Ut	-	-	-	-
Asterogyne martiana (H. Wendl.) H. Wendl. ex Hemsl.	Co, En, Hu, Me, Ut	An, Co, Fu, Hu, Ut	Co, Hu	-	-
Astrocaryum chambira Burret	Cu, Ut	-	-	-	-
Astrocaryum standleyanum L.H. Bailey	An, Co, Cu, En, Hu, Ut	An, Co, Cu, Fu, Hu, Me, Ut	An, Co, Cu, Fu, Hu, Ut	Co, Cu, Hu, Me, Ot, Ut	Co, Cu, Hu, Ot
Attalea allenii H.E. Moore	Co, Cu, En, Hu, Me, Ot, Ut	Co, Cu, Hu, Ut	Co, Cu, En, Hu, Me, Ot	-	-
Attalea butyracea (Mutis ex L.f.) Wess. Boer	Cu	-	-	-	-
Attalea colenda (O.F. Cook) Balslev & A.J. Hend.	-	-	-	An, Co, Cu, En, Hu, Ot, Ut	Co, Cu, Hu, Me, Ot
Attalea cuatrecasana (Dugand) A.J. Hend., Galeano & R. Bernal	Cu, Hu	Cu, Hu	Co, Cu, Hu		
Bactris barronis L.H. Bailey	-	Hu, Me, Ot, Ut	An, Co, Hu, Me, Ut	-	-
Bactris coloniata L.H. Bailey	Co, Cu, En, Hu, Ut	Hu, Me, Ut	Hu, Ut	-	-
Bactris coloradonis L.H. Bailey	-	Hu, Me, Ut	Hu, Ut	-	-
Bactris gasipaes var. *chichagui* (H. Karst.) A.J. Hend.	-	Hu	-	Co, Cu, Fu, Hu, Me, Ot, Ut	Cu, Hu, Ot
Bactris gasipaes Kunth var. *gasipaes*	An, Co, Cu, En, Hu, Me, Ut	An, Co, Cu, Hu, Me, Ot, Ut	An, Co, Hu, Me, Ot, Ut	Co, Cu, Fu, Hu, Me, Ot, Ut	Cu, Hu, Me, Ot, Ut
Bactris chocoensis R. Bernal, Galeano, Copete & Cámara-Leret	Co, Hu, Ut	-	-	-	-
Bactris maraja Mart.	Co, Cu, En, Hu, Ut	Hu, Me, Ut	Hu	-	-
Bactris setulosa H. Karst	-	Co, Hu, Ut	Co, Hu, Ut	An, Cu, Hu, Ot, Ut	Hu
Chamaedorea pinnatifrons (Jacq.) Oerst.	-	Hu, Ut	-	-	-
Chelyocarpus dianeurus (Burret) H.E. Moore	Co, Ut	-	-	-	-
Cocos nucifera L.	Co, Cu, Hu, Me, Ut	Cu, Fu, Hu, Me, Ut	Co, Cu, Hu, Me, Ut	Cu, Hu, Me, Ot, Ut	Hu
Desmoncus cirrhifer A.H. Gentry & Zardini	Co, Hu, Me, Ut	Co, Cu, Ut	Co, Hu, Ut	-	-
Dictyocaryum lamarckianum (Mart.) H. Wendl.	-	-	-	Co, Ot	Co
Elaeis oleifera (Kunth) Cortés	Cu, Hu, Me	-	Hu	-	-
Elaeis guineensis Jacq.	An, Co, Cu, En, Hu	-	-	Hu, Ot	Hu, Ot
Euterpe oleracea Mart.	Co, En, Hu, Me, Ut	Co, Cu, En, Hu, Ut	Co, Cu, En, Hu, Ut	Co, Hu	-

(Continued)

TABLE 5. (CONTINUED).

Species	Puerto Pervel	Aguacate	Villanueva	Chigüilpe	Peripa
Euterpe precatoria Mart.	Co, En, Hu, Ut	Co, Cu, En, Hu	-	-	-
Geonoma calyptrogynoidea Burret	-	Co, Hu	Co, Hu	-	-
Geonoma cuneata H. Wendl. ex Spruce	Co, Cu, Ut	Co, Hu	Co	Co, En, Ut	Cu
Geonoma deversa (Poit.) Kunth	-	Co, Ut	Co, Ut	-	-
Geonoma triandra (Burret) Wess. Boer	.	.	Me, Ut	-	-
Iriartea deltoidea Ruiz & Pav.	Co, En, Ut	Co, Cu, Hu, Me, Ot, Ut	Co, Cu, Hu, Ot, Ut	Co, Cu, En, Fu, Hu, Me, Ot, Ut	Co, Cu, En, Fu, Hu, Me, Ot, Ut
Manicaria saccifera Gaertn.	Co, Cu, Hu, Me, Ut	Co, Cu, Hu, Me, Ut	Co, Cu, Hu, Me, Ut	-	-
Mauritia flexuosa L.f.	Co, Hu, Ot	-	-	-	-
Mauritiella macroclada (Burret) Burret	Co, En, Ut	Co, En, Ut	Co	-	-
Oenocarpus bataua Mart.	Co, Cu, En, Hu, Ot, Ut	Co, Cu, Fu, Hu, Ot, Ut	Co, Cu, Fu, Hu	Co, Hu, Me, Ot, Ut	Co, Cu, Hu, Ot
Oenocarpus minor Mart.	Co, Cu, En, Hu, Me, Ut	Co, Cu, Fu, Hu, Ot, Ut	Co, Cu, Hu, Ut	Co, Hu, Ot, Ut	-
Pholidostachys dactyloides H.E. Moore	-	Co, Me	-	-	-
Phytelephas aequatorialis Spruce	-	-	-	Co, Cu, En, Hu, Me, Ot, Ut	Co, Cu, Hu, Me, Ot
Phytelephas macrocarpa Ruiz & Pav.	Co, Hu, Ut	Co, Cu, Hu, Ut	Co, Cu, Hu, Me	-	-
Prestoea decurrens (H. Wendl. ex Burret) H.E. Moore	-	Co, Cu, Hu	Co, Cu, Hu, Ut	-	-
Prestoea pubens H.E. Moore	-	Ut	-	Hu	Co, Hu
Socratea exorrhiza (Mart.) H. Wendl.	Co, Cu, En, Ut	Co, Cu, Hu, Ut	Co, Hu, Ut	Co, Cu, Hu, Ot, Ut	Co, Cu, Hu, Ot
Socratea hecatonandra (Dugand) R. Bernal	-	Co	-	-	-
Synechanthus warscewiczianus H. Wendl.	-	Co	An	Co, Cu, Ut	Cu
Welfia regia H. Wendl.	Co, Cu, En, Fu, Hu, Ut	An, Co, Fu, Hu, Ut	Co, Cu, Fu, Hu, Ut	Co	-
Wettinia aequalis (O.F. Cook & Doyle) R. Bernal	-	Co	-	Co, Cu, Hu, Me, Ot, Ut	Co, Hu, Me, Ot
Wettinia quinaria (O.F. Cook & Doyle) Burret	Co, En, Hu, To, Ut	Co, Cu, En, Hu, Ut	An, Co, Fu, Hu, Ut	Co, Cu, Hu, Ot, Ut	Co, Cu, Hu, Ot, Ut
Wettinia radiata (O.F. Cook & Doyle) R. Bernal	Co, Ut	Co, Cu, Ut	Co, Hu, Ut	Co	Co, Cu, Hu

An: Animal food; Co: Construction; Cu: Cultural; En: Environmental; Fu: Fuel; Hu: Human food; Me: Medicinal & Veterinary; To: Toxic; Ut: Utensils & tools; Ot: Other.

important uses for all three ethnic groups, it was obvious that palms are no longer used for construction in the Afro-Colombian and Tsa'chila communities, which are both closer to cities and have greater access to markets and services than the Emberá communities. Similar discrepancies

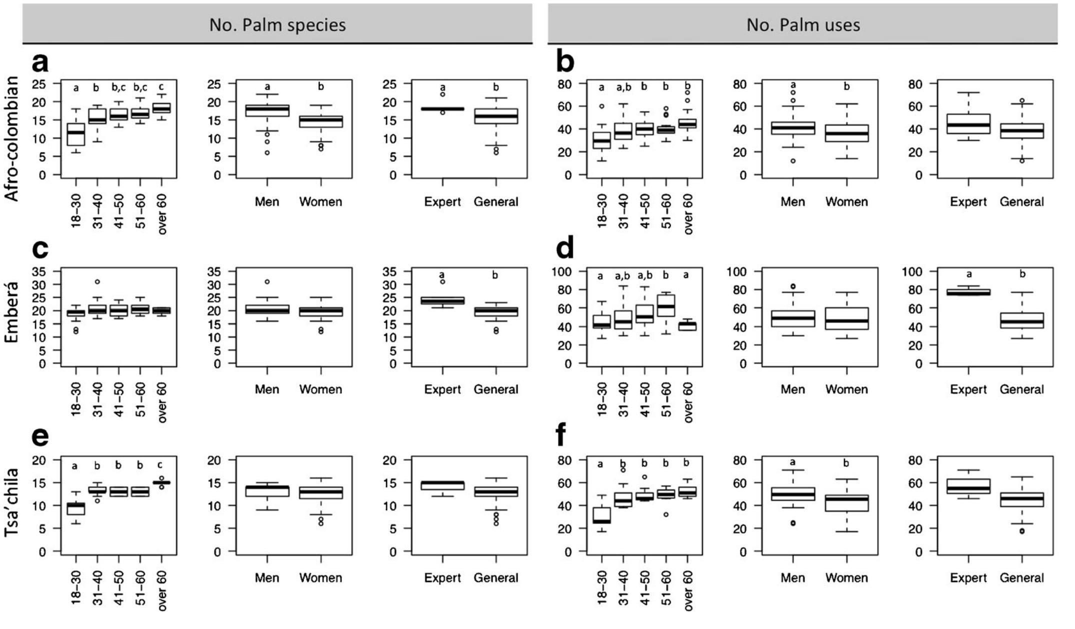

Fig. 3. Influence of socio-demographic factors (age, gender, expertise) on the TK of Afro-Colombian (A-B), Emberá (C-D), and Tsa'chila (E-F) participants.

between the actual use of palms and the answers given in interviews have been documented for palm-based construction practices in Madagascar (Byg and Balslev 2001b), and for wild food consumption in the Americas (Ladio and Lozada 2004). These findings highlight the need of distinguishing between past and present uses in interviews, especially in studies interested in determining the actual impact of local communities on their surrounding plant communities (Kvist et al. 1995). Accounting for changes in use over time would furthermore allow a qualitative understanding of TK erosion that is rarely studied (but see Brosi et al. 2007). The tendency to replace palm construction materials, even in the remote Emberá sites, resembles the situation in remote communities within other hotspots such as Madagascar (Byg and Balslev 2001a). Further research is needed to assess whether replacement tendencies of palm materials with materials acquired in markets could ultimately lead to erosion of certain cultural practices. On the other hand, in the case of construction, replacement tendencies could have positive long-term conservation effects for palm populations by reducing harvest pressure.

Most participants in all three ethnic groups generally agreed that TK was no longer being transmitted between generations, lending support to our third hypothesis. We also found that overall perceptions in the more remote communities (e.g., Emberá) were not necessarily more optimistic than perceptions in less remote communities (e.g., Tsa'chila). Abandonment of TK relates to new socioeconomic conditions under which most groups often look toward new forms of knowledge and young members of traditional societies seek new opportunities away from the forests. Even remote Chocó communities may desire to enter the market economy (Theodossopoulos 2010), and at any given time, their resource-use strategies respond to the relative value of alternative activities and local and external demands for commodities (Sierra 1999). An average of 60% of Tsa'chila participants aged 41–60 maintained that transmission of TK still takes place. We observed that these views were related to increased intergenerational interaction that is the result of strong commitment of parents to teach their children about traditional culture, and also by ethno-tourism, which promotes exchange of TK. This exchange may be especially important in relation to the plant materials selected for making utensils and tools, personal adornment, and for healing, all of which are important elements in ethno-tourism. There are similar situations elsewhere where communities that engage in year-round indigenous tourism have revitalized their traditions (Theodossopoulos 2010). Further, each Tsa'chila community maintains a *pone* or shaman who, despite increasing acculturation of villagers, remains central to Tsa'chila everyday life and is responsible not just for healing, but is also linked closely to Tsa'chila spirituality and worldviews (Rivera 2013). Traditional healers were also present in Emberá and Afro-Colombian sites, but were few in comparison to Tsa'chila healers, and were less involved in commercial activities or ethno-tourism.

Age, gender, and expertise were all important factors explaining individual differences in TK in the Chocó. Our finding that TK was generally positively associated with age is in accordance with previous studies (Luoga et al. 2000; Phillips and Gentry 1993; Voeks and Leony 2004; Zent 2009). As we would expect under a situation of gradual acquisition of knowledge, TK generally increased progressively across age groups. One exception, however, was the case of the remote Emberá communities where the number of palm species was remarkably similar across age groups. One possible explanation could be that knowledge of species is accumulated at an early age, whereas knowledge about uses develops over longer periods. Additionally, the similarity in number of palm uses between the oldest and the youngest Emberá individuals, which was in turn lower than that of intermediate-aged individuals, could reflect acquisition of new knowledge across cultural groups as has also been observed in Amazonia (Campos and Ehringhaus 2003). Intermediate-aged Emberá individuals often travel downriver to exchange goods and in doing so, the likelihood of observing and learning about other ways of using palms from Afro-Colombians increases.

Gender-differentiated livelihood roles were common in all study sites, but a comparatively greater time spent in forests by Emberá women than women of other groups explains why they knew just as many palm uses and palm species as men. Time spent in forests has been shown to affect TK levels (Zent 2009), and at the Emberá sites, both men and women generally work in the local fields on a daily basis. It is also common for families to leave for several days to tend distant fields. It is plausible that during these periods women can exchange knowledge about forest plants with men. The similarity in TK between Emberá men and women differs with findings from a study on medicinal TK of Panamanian Emberá, where TK could be separated into three groups, including medicinal plants of common use, medicinal plants used by women only, and specialized plants known to medicine men (Potvin and Barrios 2004). This illustrates that medicinal knowledge is more partitioned than general knowledge about palms. Although Tsa'chila and Afro-Colombian women also participate in agricultural work, they spend a great portion of their time in households taking care of children and in domestic chores, which would explain their differences in palm TK with men.

Expertise was a determinant factor in the TK levels of Emberá and Afro-Colombians. Our Emberá experts were locally esteemed hunters that spend more time in forests. Afro-American experts were generally older men who have relied more on forests than the younger generations. A lack of differences between experts and general participants within the Tsa'chila shows that, unlike medicinal knowledge that is generally regarded as being higher in Tsa'chila shamans (Barfod and Kvist 1996), knowledge levels about palms are more similar across both participant groups.

In conclusion, our assessment evidences strong perceptions of poor knowledge transmission, decreasing use of forests, and intergenerational differences in perceptions and knowledge in the three study sites of the Chocó. Our results do not show a definitive pattern in factors affecting levels of TK because TK varies considerably across age, gender, and expertise. Accordingly, an adequate documentation of TK will require working with experts (Cartaxo et al. 2010; Davis and Wagner 2003) but also with general participants. Furthermore, recommendations to stratify age and gender groups (Reyes-García et al. 2007) should be taken into account in order to gather the full gamut of TK. Our sample of 226 participants may be insufficient to generalize our findings across the Chocó, so better coverage in all ethnic groups in both countries is needed for a complete view of the overall state of TK across the hotspot. Still, if these conditions persist in our study sites and markets continue to encroach, the TK of Amerindian and Afro-American communities may eventually shift toward practices attuned to market demands, and as a result much TK may be lost. Our case study is not isolated, but adds to mounting evidence of cultural erosion among indigenous societies in other biodiversity hotspots, including erosion of plant use knowledge in Mesoamerica (Benz et al. 2000), of canoe-making knowledge in Polynesia-Micronesia (Brosi et al. 2007) and of food plant knowledge in Sundaland (Sujarwo et al. 2014). Although IPBES's aims are laudable, they also face many challenges at local levels (Soberón and Townsend 2015). For instance, IPBES assumes that TK can be tapped to fill gaps, but does not clarify which criteria and protocols will be used to select indigenous and local communities. This is crucial because TK abandonment is taking place in various degrees across communities as highlighted by the Amerindian and Afro-American perceptions documented in this study, but also because TK may not be held equally across communities of even the same ethnicity (Table 5, Cámara-Leret et al. 2014c).

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