The consequences of methodological choices in assessing wild plant knowledge and use – a case study among the Baka in Cameroon

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Preface

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Foreword

Dear reader, this manuscript is the result of several months of field work, data processing, writing and discussing; all condensed into a concise journal-style paper. I would like to express my gratitude to everyone who has helped this thesis come about, specifically my supervisors Tinde van Andel and Sandrine Gallois. Their support has been, almost literally, lifesaving. Furthermore, I am indebted to the Baka people for sharing the knowledge this work is based on. I would also like to thank Justine van Burgsteden for her valuable comments on this manuscript and the Alberta Mennega Stichting and Treub Maatschappij for helping to fund this research project.

Abstract

In ethnobotany, free listing and dietary recalls are frequently used methods to assess wild edible plant (WEP) knowledge and use, respectively. Though these ex-situ interviewing methods are practical to perform, they are known to be limited by the informant's memory and cognitive bias. Alternatively, the much more laborious walk-in-the-woods method may be used, in which informants point out edible plants and consumption data are collected in-situ. In this study, we assessed how these three methods capture the diversity of wild edible plant knowledge and use among the Baka of Southeastern Cameroon. We show that within a single population, walk-in-the-woods results in a more detailed description of WEP knowledge and that it is useful to gather consumption data in conjunction with this technique. Our results imply that previous studies based only on free listing and dietary recall data underestimate the importance of WEP for local communities. We propose future studies on WEP knowledge and use take an in-situ approach.

Introduction

Tropical rainforest ecosystems are under a variety of anthropogenic pressures worldwide. The effects of these pressures may become apparent over long timescales (Martínez-Ramos et al., 2016) and are increasingly thought to interact with one another (Brodie et al., 2012). The complexity that arises from these cross-scale interactions can only be understood by accurate comprehension of the relevant spatio-temporal scales. As ecosystem functions and services depend on local biodiversity (Newbold et al., 2015), considering the interactions between local people and their environment is fundamental in efforts to understand large scale changes.

The value of local and traditional ecological knowledge in informing conservation and environmental management is well established (Chazdon et al., 2009; Pandey & Tripathi, 2017; Pardo-de-Santayana & Macia, 2015). Knowledge on useful plants may be especially valuable in this regard (Cummings & Read, 2016). For example, in an ethnobotanical study in Rio Formoso, Northeastern Brazil, Da Cunha and De Albuquerque (2006) found that the main product of over half of the useful plant species was wood , indicating the need for conservation initiatives to provide an alternative for this source of fuel and construction material.

Local knowledge and use of plants may be assessed through different ethnobotanical methods, of which the interview is one of the most prominent categories. Different types of interview methods are deployed based on the research question addressed and can vary considerably between studies (Thomas et al., 2007). For instance, free listing is an interviewing method in which informants are asked to list all items they know within a given category (Martin 2010). This technique reveals cultural salience and variations in individuals' topical knowledge (Quinlan, 2005). Free listing is frequently used in ethnobotany as a starting point for studying traditional plant knowledge (e.g., Mengistu and Hager, 2008; Ghorbani et al., 2012). This method is then often followed by the walk-in-the-woods method in which species listed during the interviews are collected and identified. The resulting dataset is then used to draw conclusions about plant knowledge of a certain group of people.

There is, however, an unintended but significant bias in ethnobotanical research that takes free listing as a starting point. Data elicited from free listing appear to be specific to the context in which they were collected (Martin, 2010; De Sousa et al., 2016). Gathering the dataset *ex situ* (away from the ecological context in which people collect their plants) may result in lists of only the most salient plant species. Furthermore, the success of free listing has shown to be dependent on the informants' correct understanding of the category (or cultural domain, e.g. food plants) under discussion (Da Cunha & De Albuquerque, 2006; Quinlan, 2005; Quiroz et al., 2016).

Dietary recalls were recently introduced in ethnobotany as an additional method in order to provide information on the actual use of edible plant species. In a dietary recall, informants are asked to list all species/items they have consumed within a given time period. Such research has often led to a surprisingly low number of species actually being consumed (e.g. Termote et al., 2011; Termote, 2012; Do Nascimento *et al.*, 2013; Gallois et al. in press.). For example, Termote et al. (2012) found that wild edible plants were rarely consumed in the highly biodiverse context of the Democratic Republic of the Congo. Likewise, Gallois et al. (in press) recorded only 15 species to be eaten by the Baka people of Southern Cameroon, in stark contrast to the wide variety of wild plant knowledge reported earlier by Bahuchet (1992) and Dounias (1993) for the same ethnic group. Like free listing, dietary recalls are limited by the subject's memory (Grandjean, 2012) and may therefore underreport plant use.

In this study, we wanted to explore how different ethnobotanical methods capture the diversity of wild edible plant knowledge and use among a community of forager-horticulturalists: the Baka of Southeastern Cameroon. We attempt to answer the following questions:

1) Which wild edible plant species (WEP) were mentioned by the Baka during previous free listing and dietary recall studies?

2) Which species were reported during the walk-in-the-woods survey when informants were asked to point out any WEP they knew and when they had consumed it?

3) How and why do the results obtained by these three methods differ in terms of number of species and frequency of consumption?

4) What are the general characteristics of the WEPs used by the Baka?

We hypothesized that walk-in-the-woods would result in a larger number of plant species than the other two methods, while species that were said to have been recently consumed by our walk-in-the-woods informants would also appear in the free listing and dietary recalls.

Methods

Study site

Data were collected around the villages of Le Bosquet (3°07'38''N13°52'57''E) and Kungu (3°02'40"N 14°06'57"E), located in the Haut Nyong region, Southeastern Cameroon. The communities are located at least eight hours by car from the capital Yaoundé, of which four hours on an unpaved logging road. The accessibility of this area highly depends on the weather, as the road quickly deteriorates during the rainy season. The area is covered by a mixture of evergreen and moist semi-deciduous forest within altitudinal ranges of 300–600 m (Letouzey, 1985). In populated areas, the forest cover is largely or completely removed in favor of settlements, cocoa plantations, logging activities and small-scale agriculture. This creates a mosaic of dense primary forest, selectively logged primary forest, secondary forest and agricultural fields, interspersed with trails. The climate of the region is tropical humid, with a major rainy season between late-August and late-November and a major dry season between late-November and mid-March. The annual precipitation reaches about 1500 mm and the average temperature is 25°C (Leclerc, 2012).

The area is populated by two main ethnic groups: the Nzimé, Bantu-speaking farmers, and the Baka. Until roughly 50 years ago the Baka were nomadic foragers, relying on hunting, fishing, gathering, and the exchange of non-timber forest products against agricultural products with their farming neighbors. Since the 1960s, the Baka have been facing several changes in their livelihood. Due to a government program of sedentarization (Leclerc, 2012), they have progressively left their forest camps and settled in villages along the logging roads. Nowadays, their livelihood is mostly based on the combination of foraging activities, agricultural work in their own fields and wage labor for the Nzime or for logging companies.

Data collection

For this paper, a combination of three different datasets were used: previously collected free listing and interview data and our own ethnobotanical field survey data. We retrieved information on WEP from 55 free listing interviews (55 informants) and 143 dietary recall interviews (83 informants, the majority of which were interviewed twice) conducted among the two villages by Sandrine Gallois. The interviews were performed during two fieldwork periods: February-March 2018 (major dry season) and October-November 2018 (major rainy season). Before data collection ensued, Free Prior and Informed Consent was obtained from all individuals who participated in the interviews. Data were collected through interviews with Baka individuals of 17 years and older (Gallois et al., in press). The dietary recall protocol was adapted from the FAO Guidelines for Assessing Dietary Diversity (Kennedy 2011). Informants were asked to list all items they had consumed within the previous 24 hours, and to mention the origin of each food item (e.g., collected from the wild, cultivated, bought at the market). From the local names of wild edible plants mentioned during these interviews and literature on Central African wild food plants (e.g., Bahuchet, 1992; Dounias, 1993; Yasuoka, 2012),we constructed a preliminary database of potential species consumed by the Baka.

The walk-in-the-woods method (Phillips & Gentry, 1993) was performed during a third fieldwork period: April-May 2019. We asked the community to suggest several people knowledgeable on wild edible plants from different ages and genders that would agree to join us on our collection trips as informants. We took between one and four informants on a given collection day. In total, we had 14 different informants (7 women, 7 men, between 10 and 80 years old). Half of our informants had also participated in the dietary recalls and free listing exercises in the previous year. During 14 collection days into the area surrounding Le Bosquet and Kungu, we asked our informants to point out any edible plant they saw. We also searched for the species on our preliminary list of wild food plants.

When a wild edible plant was found, herbarium material was collected and labeled, using standard botanical methods (Martin, 2010) and a short interview was conducted. We asked our informants for the following information: 1) local name in Baka, (and French and Nzime if known); 2) plant part(s) used; 3) preparation and application; 4) whether the plant was sold; 5) when they had last consumed the plant; and, in case of a tree or tree seedling, 6) whether it was commercially logged. Furthermore, the plant's GPS coordinates and the vegetation type were noted.

Additionally, during the forest walks, we counted the number of logged tree trunks along the forest trails and asked our informants for the local names of every felled tree. Collections were made of its (dried) leaves for botanical verification. We did this to be able to analyze conflicts between commercial timber harvesting and the availability of wild food plants for the Baka.

Voucher specimens were prepared in triplo and two triplicates were deposited at the National Herbarium of Cameroon (YA) in Yaoundé and Naturalis Biodiversity Center (L) in The Netherlands. The third triplicate was left at the study site for further use in discussion on local names and uses with Baka villagers. Plant identification took place at the Naturalis Herbarium by using central African specimens and the literature (e.g., Hutchingson & Dalziel 1958, Hawthorne & Jongkind 2006, Harris & Wortley 2018). For species

difficult to identify, we consulted botanical experts worldwide (e.g., D.J. Harris at the herbarium of Edinburgh, J.J. Wieringa at Naturalis Biodiversity Center and Carel Jongkind and Marc Sosef at Meise Botanical Gardens, Brussels).

Data analysis

In order to assess the differences between the three methods, we compared the total number of species resulting from each method. To assess whether the full potential of the methods had been utilized, species accumulation curves were produced for each of the methods (De Albuquerque et al., 2014). These were produced by calculating the cumulative number of species that were collected after a certain amount of collection days (walk-in-the-woods method) and the cumulative number of species that were recorded after interviewing a certain number of informants (free listing and dietary recalls). Contrary to usual practice, the data was not randomized before producing the species accumulation curves, as several relevant features of the data would have been lost.

Information from the walk-in-the-woods on the last consumption of species by our informants was categorized according to Gallois et al. (in press.) in the following categories: 1) today/yesterday; 2) within the week, 3) within the month; 4) within the year; 5) between 1 and 2 years; 6) more than two years; and 7) never. A bar chart was produced to visualize the ranking of the most recently consumed species (within the month or more recently).

To assess the general characteristics of the species used by the Baka, information on species was categorized for all plants in a Microsoft Excel table. For each plant, the following information was categorized: life form, part used, habitat, whether they were logged and when they were last consumed. Pie charts were produced to show the distribution these characteristics. Furthermore, all species that were said to be logged were cross-referenced with CITES- and IUCN databases to assess their current conservation status and the trade names of these species were identified through their dried leaves and the International Tropical Timber Organization’s website.

Results

Comparison between methods

The dietary recalls and free listing resulted in 11 and 38 wild edible plant species respectively. One of the species found through dietary recalls was not found through free listing, namely *Amaranthus dubius* Mart. ex Thell. Initially, 49 local names were identified through free listing, but 11 of those were later excluded because they were synonyms of Baka plant names that had already been mentioned (three names) or they were found to refer to several species of wild mushrooms (two names) and types of honey (six names).Through the walk-in-the-woods method, we collected ca. 93 wild edible plant species. The exact number of species is unclear, as some could only be identified to genus level, and for several wild yam species (*Dioscorea* spp.), the taxonomy remains unclear. The Baka are actively domesticating several wild yam species, but also recognize different forms within single species. For example, within *D. minutiflora*, the Baka distinguish "njakaka", "baloko" and "kuku", all with different leaf and tuber morphology. The taxonomic species delimitation is not clear for many of the West- and Central African *Dioscorea* species (Magwé-Tindo et al., 2018).

All species mentioned during the dietary recalls and free listing were also collected during the forest trips (See the supplementary table for the list of all species, local names and the method(s) through which they were recorded).

The species accumulation curve for the dietary recall method gradually approaches the asymptote (Figure 1), indicating near saturation after interviewing 69 people. Between respondents 39 and 69, only one new species was mentioned during the dietary recalls. This suggests that interviewing more respondents would not have led to many more wild edible plant species, so the dietary recall appeared to have captured most of the diversity of WEPs that was possible by using this method.

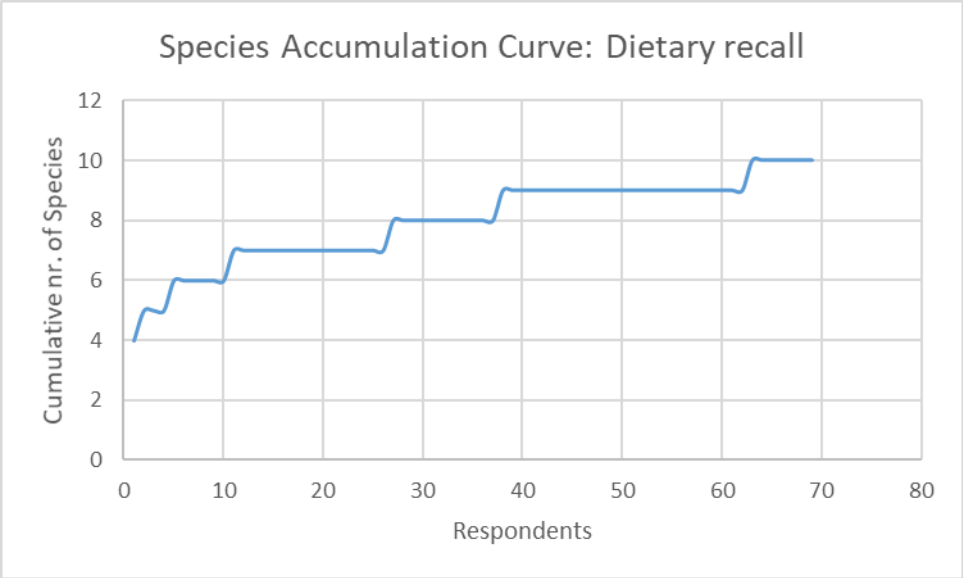

Figure 1: Species accumulation curve of wild edible plants mentioned during 69 dietary recall (DR) interviews in Le Bosquet and Kungu, Cameroon.

The species accumulation curve for the free listing method approaches the asymptote as well, with a total of 38 species (Figure 2). This indicates that the free listing method has efficiently captured the requested information, at least within the limitations of this method. Typically, 14 of the 55 respondents reported not knowing any wild edible plants, which resulted in several flat sections in the curve. This may be due to the fact that not everyone understood the concept of a "wild edible plant", as there is no specific word for edible non-timber forest products of vegetal origin (Gallois et al., in press). However, as wild edible plants play an important role in Baka livelihood (e.g., Dounias, 1993; Bahuchet, 1992), it seems unlikely that people do not know any of them.

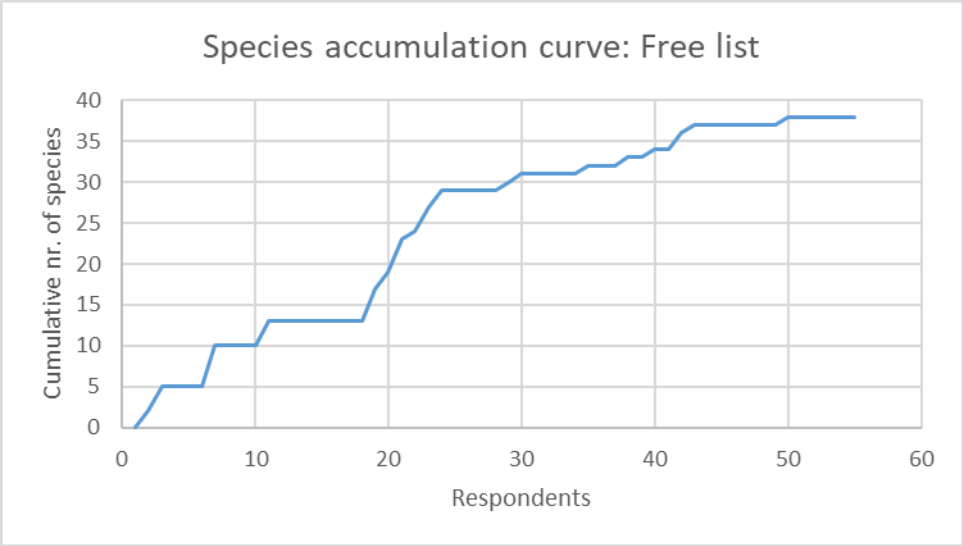

Figure 2: Species accumulation curve of wild edible plants for the 55 free listing interviews in Le Bosquet and Kungu, Cameroon.

The species accumulation curve for the walk-in-the-woods method started to flatten after 11 days, but not completely (figure 3). This suggests that the dataset was not yet saturated, i.e. more WEP would have been recorded if fieldwork had been continued. Our Baka informants also mentioned that there were additional rare edible species (e.g., *Mammea africana* Sabine*, Coula edulis* Baill.*, Afzelia* sp.) that could only be found after walking for hours in the forest.

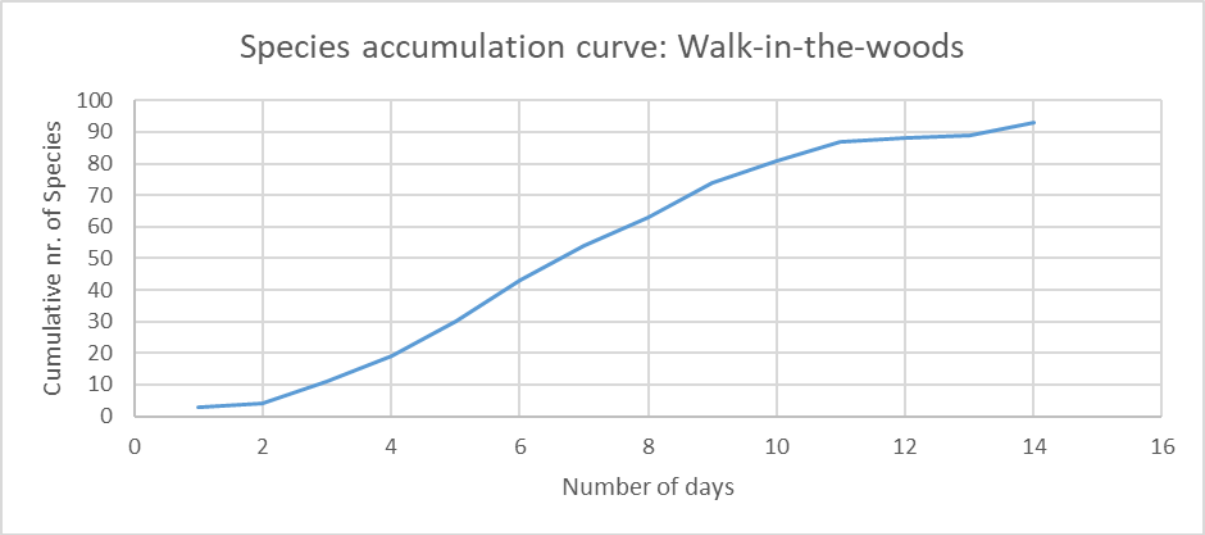

Figure 3: Species accumulation curve for the 14 collection days (walk-in-the-woods method) in Le Bosquet and Kungu, Cameroon. In total, 14 different informants provided information and 93 different species were found.

Species characteristics

The ca. 93 collected plant species belonged to 43 different plant families. The four best represented families were Dioscoreaceae (ca. 9 species of wild yams), Irvingiaceae (bush mangoes, 8 spp.), Anacardiaceae (5 spp., including 4 species of *Trichoscypha* fruits) and Zingiberaceae (5 spp. of *Aframomum*).

Most plant species were collected in secondary forest (figure 4a). We found very little primary forest untouched by loggers, explaining the large percentage of selectively logged primary forest (31%) vs. primary forest (4%). The only patch of primary forest that did not show signs of logging was a forest dominated by *Gilberiodendron dewevrei* (De Wild.) J.Leonard, located at ca. two hours walking distance from Le Bosquet. Most species collected were trees, constituting 46% of the species collected, followed by climbers (26%) (Figure 4b). Fruits and seeds were the most frequently mentioned plant parts, consisting of 37% and 27% of all parts recorded as edible, respectively (Figure 4c). This means most plant parts used are generative.

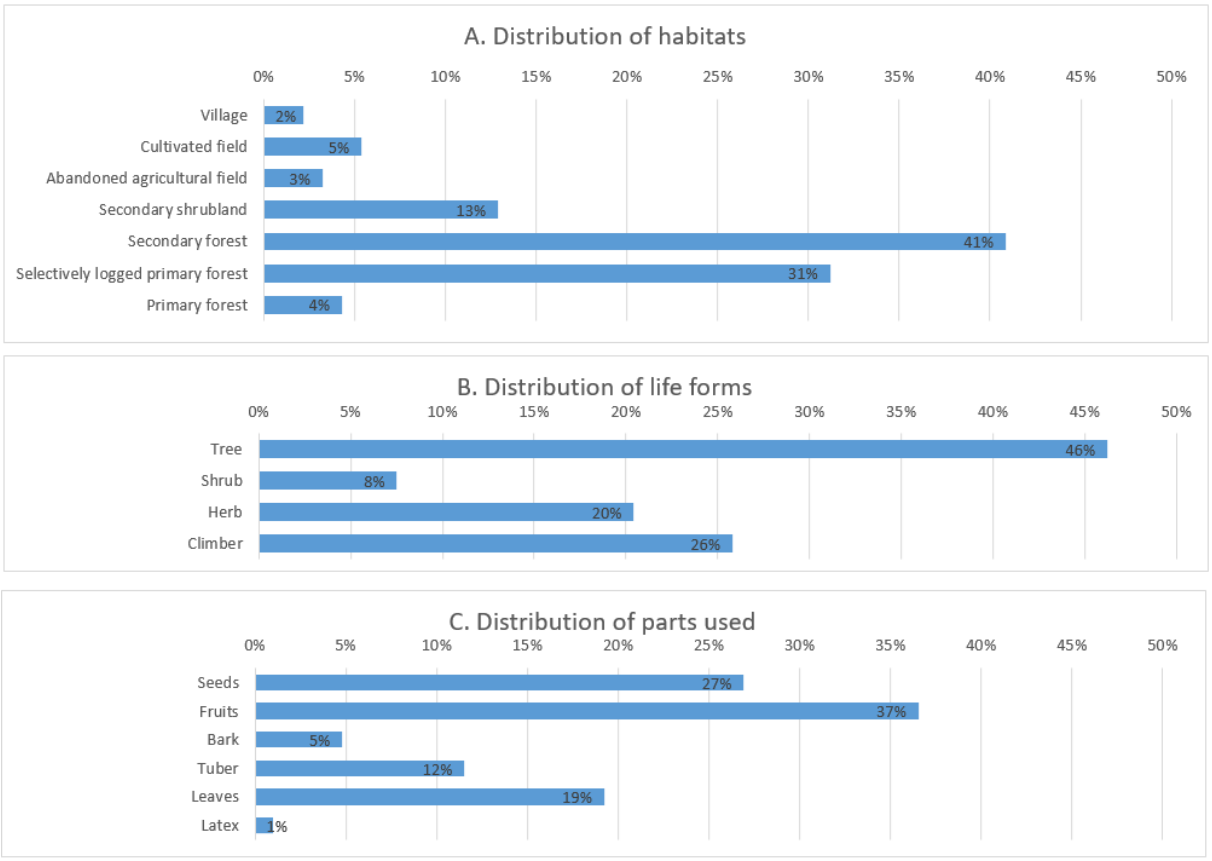

Figure 4: Distributions of A. habitats the plants were collected in (93 species in total), b. life forms of collected plant species (93 species in total) and c. different plant parts used as a percentage of all uses mentioned (104 uses in total). Data collected through walk-in-the-woods method.

Logging

During our forest walks, we identified six wild edible plant species that were said to be logged (Table 1). Only two of these were mentioned in the free listing interviews (*Baillonella toxisperma* and *Chrysophyllum lacourtianum*), while only one of them was recorded through the dietary recalls (*B. toxisperma*).

Table 1: Tree species producing edible fruits and/or seeds and said to be logged by our informant(s), their Baka and trade names, and their current conservation status.

Scientific name	Baka name	Trade name	IUCN status
Baillonella toxisperma Pierre	Moabi	Moabi	Vulnerable
Chrysophyllum lacourtianum De Wild.	Bambú	Longhi, Abam	Not evaluated
Diospyros cf. *crassiflora* Hiern	Lembe	(Gabon) Ebony	Vulnerable
Trichoscypha cf. abut Engl. & Brehmer	Agbo	-	Least concern
Desbordesia insignis Pierre	Ntuo	Alep	Not evaluated
Sterculia oblonga Mast.	Egboyo	Eyong	Vulnerable

During our 14 days of field work, we encountered logged trunks of several species along forest trails and on the back of logging trucks), namely the edible species *B. toxisperma* (8 in forest +1 on truck), *D. crassiflora* (2+0) and *Afzelia* spp. (3+0) (not collected), and the inedible *Entandrophragma cylindricum* (Sprague) Sprague (4+1), *Pterocarpus soyauxii* Taub. (5+0), *Piptadeniastrum africanum* (Hook.f.) Brenan (4+0), *Cylicodiscus gabunensis* Harms (1+0), *Rodognaphalon brevicuspe* (2+0) and *Triplochiton scleroxylon* K.Schum. (2+4). Although these are inedible species, they do have several uses. For example, *E. cylindricum* commonly hosts edible caterpillars, while the red sawdust of *P. soyauxii* has several ritual uses. Our informants mentioned that *B. toxisperma* trees are only cut down after they have exceeded 1m in diameter, so several living trees could still be observed. During the forest walks, we also encountered (smaller) trees cut down by the Baka themselves, most of them to obtain fresh leaves of *Gnetum* sp. lianas, a few to harvest honey and one to collect the bitter bark of *Garcinia kola* Heckel., which is added to palm wine as a flavoring agent.

Recently consumed species

For 74 of the 93 wild edible plant species recorded during our forest survey, we also recorded the last time our informants had eaten them. In total, 14 different informants supplied information on last consumption, averaging 2.5 persons per species. Of the 74 WEPs, 35 species had been consumed over a month ago, but within the past year, while 11 species had been last consumed over a year ago. For four species, our informants indicated they had never eaten it.

We identified 22 species that had been consumed by our informants in the past day, week or month (Figure 6). Ten of those had been consumed within the past week. Of these 22 species, only 10 were mentioned during the free listing interviews and only three appeared through dietary recall. Twelve recently consumed species would not have been identified if only the free listing interviews and dietary recalls had been performed in the two villages. These species are the edible ferns *Pteridium aquilinum* (L.) Kuhn and *Diplazium sammatii* (Kuhn) C. Chr., the spices *Xylopia parviflora* Spruce, *Olax latifolia* Engl. and *Ricinodendron heudelotti* (Baill.) Heckel, the fruits of *Passiflora foetida* L., *Solanum erianthum* D. Don and *Uapaca* cf. *paludosa* Aubrév. & Leandri, the edible inner stem of *Laccosperma secundiflorum* (P.Beauv.) Kuntze , the oily seed of *Irvingia tenuinucleata* Tiegh., the drinkable water from the stem of *Tetracera* sp. and the leaves of *Geophila lancistipula* Hiern, which was eaten as a luck charm.

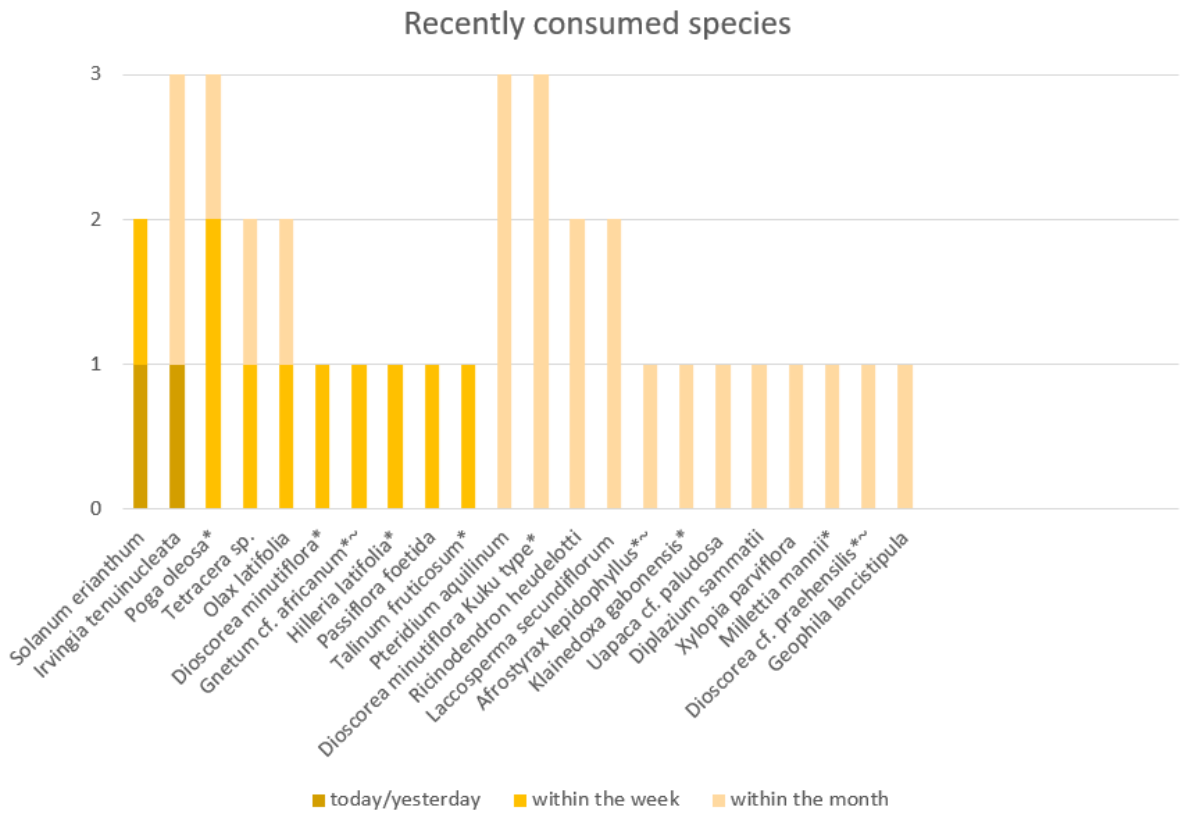

Figure 6: Species that our informants consumed within the past month (n=83). An asterisk * and tilde ~ indicate species that were found through free listing and dietary recall respectively.

Discussion

In this study, we assessed how different ethnobotanical methods capture the diversity of wild edible plant knowledge and use among the Baka of Southeastern Cameroon, in order to provide insights about their limitations and advantages. Our results show that these different methods applied among the same population resulted in substantial differences in the collected data.

Firstly, assessing WEP knowledge through free listing did not capture the full breadth of knowledge available. Our walk-in-the-woods method showed many more WEP species were known and formed part of the cultural domain ‘wild food plant’. This supports that free listing may only assess saliency of certain plant species, which is highly confounded by the spatio-temporal context in which the method is performed (De Sousa et al., 2016). Additionally, the fact that many of the items that came up during free listing were not wild but cultivated plants or no plants at all shows that there were limitations due to linguistic and cultural issues. The term "wild edible plants" does not have a literal translation in Baka, a reason why the free listing did not limit to plants. Moreover, the presence of cultivated plants shows the potential misunderstanding between the researcher and informants about the cultural domain of wild versus domesticated; another indication of the importance of assessing plant knowledge in the ecological context.

Secondly, our walk-in-the-woods data indicated that a larger number of plant species were recently consumed than the dietary recall data suggested. Even asking this information from a relatively small sample of only 14 informants size elicited 12 recently consumed species that did not appear through the dietary recall or free list at all. We speculate that these may be species that people are ashamed of eating

(ferns, leaves of weedy species), are easily forgotten (spices and condiments) or could be missed due to differences in the interpretation of the term “wild edible plant” (lianas drinking providing drinking water, ritual food plants).

Conversely, only three species that were identified by our walk-in-the woods as recently consumed were shared by the dietary recall, indicating that both methods have their flaws. When assessing frequency of plant use through walk-in-the-woods, the relatively small sample size of informants that can be attained is a large drawback. We therefore suggest that walk-in-the-woods and dietary recalls should be employed as complementary methods when assessing plant use.

Regarding the use of ethnobotanical data for conservation purposes, free listing and dietary recalls identified only two of the seven species that were used by the Baka and also actively logged by commercial timber companies. What is more, all of these species were used for their reproductive parts. Loggers generally take the largest trees of a certain species, which are also the trees that are producing the most fruit. Therefore, the individual trees that are the most likely to be logged, are the ones on which Baka (and local wildlife) depend on the most.

Several studies based on dietary recalls have concluded that WEPs do not play an important role in local diets. Termote et al. (2012) states in her study in Central Africa that “the main finding of this study was that WEP are rarely consumed and do not contribute substantially to diets in this highly biodiverse region”, while in a Brazilian study Do Nasciamento (2013) states that “…these foods contribute little to dietary enrichment”. Our results indicate that these conclusions may not be justified because of the limited capacity of free listing and dietary recall methods to capture the full diversity of wild food plants consumed.

We propose that plant knowledge and use should be assessed through an “open” walk-in-the-woods, in which informants are encouraged to mention any WEP they know or randomly encounter, after which they are asked when they last consumed it. Free listing and dietary recalls can then be used afterwards to supplement the walk-in-the-woods results, but they should not limit it. Alternatively, dietary recalls and free listing as well as additional sources may be consulted to form a list of possible WEPs that can then be actively searched for, but informants should always be asked to point out any WEP they know, also the ones that do not appear on preliminary lists or published literature. The walk-in-the-woods method has its impracticalities, as it is laborious to perform and requires botanical collection and taxonomic skills. It may also result in some species that are particularly hard to identify, for which the help of botanical specialists and support from herbaria is needed. However, ethnobotanical research based on the limited methods of free listing and dietary recall alone is not sufficient to assess the full diversity of wild edible plant knowledge or use.

The implications of study are limited by the fact that it was performed on a single, relatively small population and the sample size for all methods was relatively small. Nevertheless, the results of this study illustrate that care should be taken in drawing conclusions about plant knowledge and use. In the policy sphere, wild edible plant use is used as a proxy for the importance of an ecosystem to local people, even though it does not even consider edible mushrooms, wildlife, and other vital ecosystem services such as craft fibers, construction material and herbal medicine. In turn this may lead to local people losing access to the ecosystem they are so intimately connected to.

Conclusion

Employing the walk-in-the-woods technique merely to collect and identify the plant species elicited through free listing exercises limits the capacity of this powerful technique to assess wild plant knowledge and use. In much the same way, dietary recalls do not assess plant use sufficiently to base conclusions on the importance of plant species for local people on. We suggest future ethnobotanical research into this subject to follow an "open" walk-in-the-woods method, where informants are encouraged to point out any useful plant they know. Additionally, it is informative to also ask informants about their last consumption/harvesting of all encountered species, as this provides valuable information on plant use. Omitting the walk-in-the woods method altogether or collecting only the species mentioned during previously conducted interviews may result in conclusions that forest-dwelling people do not use many wild plant species or do not consume them frequently, which seriously underestimates their use and dependency of forest resources.

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