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Dynamics of Local Ecological Knowledge

**A case study among the Baka children
from southeastern Cameroon**

Sandrine Gallois

PhD Dissertation – November 2015
Institut de Ciència i Tecnologia Ambientals, ICTA
Universitat Autònoma de Barcelona, UAB
Muséum National d'Histoire Naturelle, Paris, France

Supervisors:
Dr. Victoria Reyes-García
Dr. Serge Bahuchet

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UAB
Universitat Autònoma
de Barcelona



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A case study among the Baka children from
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PhD Dissertation

Sandrine Gallois

under the supervision of

Dr. Victoria Reyes-García

Dr. Serge Bahuchet

PhD Programme in Environmental Science and Technology

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Muséum National d'Histoire Naturelle, Paris, France

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A vous, à vos sourires, à vos regards.

A vous, qui m'avez accueilli dans vos foyers, dans vos vies.

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aventure se termine. Tu es partie trop vite.*

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Abstract

The importance of local knowledge has been increasingly recognized worldwide for its potential contribution both to local livelihoods and biodiversity conservation. Due to the increasing pressures faced by small-scale societies, researchers have studied the impacts of social-ecological changes on their local knowledge systems. However, such research has often neglected both the dynamic nature of local knowledge systems and children's knowledge. This PhD thesis analyzes the processes of local ecological knowledge acquisition among children (between 5 and 16 years-old) of a hunter-gatherer society under rapid social-ecological changes: the Baka from southeastern Cameroon. I pay particular attention to the context in which knowledge acquisition occurs and how such context is nowadays being transformed. In its five empirical chapters, this thesis investigates: a) the local ecological knowledge held by Baka children; b) the context in which children acquire local ecological knowledge (i.e., their involvement in daily activities); c) children's social organization during subsistence activities; d) the relation between parental livelihood strategies and children's daily activities; and e) adult's and children's perceptions of their daily activities and livelihood.

The results of this dissertation show that children's local ecological knowledge varies according to child's sex and the age, and that children's hold specific knowledge, i.e. different than adult's knowledge. My findings also show that Baka children frequently engage in subsistence activities, underlying the central place of such activities for the acquisition of local ecological knowledge during childhood. I also found that children's engagement in daily activities vary according to the child's sex from an early age and that the choice of activities changes with age, with increasing involvement in newly introduced activities (i.e., listening to modern music and playing soccer) as children grow up. Moreover, my results also provide evidence of the presence of multiple patterns of social organization among Baka children during their subsistence activities, highlighting a high diversity of pathways for the acquisition of local ecological knowledge during childhood. Additionally, findings from this work illustrate how the livelihood strategies adopted by Baka parents, a proxy for social changes, are not related to children's involvement in daily activities, suggesting that social changes

might be best assessed at the community level. Finally, I also found that individual's expectations towards adult's livelihood differ between generations, with children favoring daily activities related to a sedentarized way of living.

This thesis brings new insights to the discussion on the impacts of social-ecological changes on local ecological knowledge by considering the importance of children's daily lives and perceptions in a context of change. By highlighting the specificity of children's local ecological knowledge system, results from this work stress the importance of developing methodological tools adapted to research with children. This thesis also illustrates the high autonomy and independence of Baka children and underlines that the actual behavior of children seem to be shaped by the overall community cultural setting more than by the specific parental behavior. Since childhood is a key period for the acquisition of cultural knowledge, results from thesis call for further research focusing on the potential impacts of new activities (i.e., schooling, agriculture, TV watching) on the acquisition of local ecological knowledge among the Baka. Finally, this work highlights the importance of assessing social-ecological changes not only by examining various knowledge domains and diverse social groups, but also to the broader social context and considering what people do and how they perceive their own reality.

Resumen

Existe un creciente consenso sobre la importancia del conocimiento local, tanto para las sociedades con economía de subsistencia como para la conservación de la biodiversidad. Dadas las crecientes presiones a las que están expuestas las sociedades de pequeña escala, diversos investigadores han intentado entender los impactos de los cambios socio-ecológicos sobre los sistemas de conocimiento local. Sin embargo, tales investigaciones ni o han considerado la naturaleza dinámica de los sistemas de conocimientos locales ni los conocimientos de los niños.

Esta tesis de doctorado analiza los procesos de adquisición de conocimiento ecológico local por parte de los niños (entre cinco y dieciséis años) en una sociedad de cazadores-recolectores en un contexto de rápidos cambios socio-ecológicos: los baka de sureste de Camerún. El principal enfoque de la tesis es en el contexto en el cual ocurre la adquisición de los conocimientos y las actuales transformaciones de este contexto,. En sus cinco capítulos empíricos, esta tesis investiga: a) los conocimientos ecológicos locales de los niños baka; b) el contexto en el cual los niños adquieren los conocimientos ecológicos locales (es decir su participación en actividades cotidianas); c) la organización social de los niños durante sus actividades de subsistencia; d) la relación entre las estrategias de vida de los padres y las actividades cotidianas de los niños; y e) las percepciones de adultos y niños de sus actividades cotidianas y su modo de subsistencia.

Los resultados de esta tesis muestran que los conocimientos ecológicos de los niños varían según su sexo y su edad, y que los niños poseen conocimientos específicos, diferentes de los conocimientos de los adultos. Mis resultados también muestran que los niños baka se involucran frecuentemente en actividades de subsistencia, lo cual demuestra la importancia de estas actividades para la adquisición de conocimientos ecológicos locales durante la niñez. Según mis resultados, las actividades cotidianas de los niños varían según el sexo desde una edad temprana y cambian con el tiempo, con una creciente participación en actividades introducidas recientemente (como escuchar música moderna o jugar al fútbol) a medida que los niños crecen. Además, mis resultados demuestran la existencia de múltiples esquemas de organización social de los niños baka durante sus actividades de subsistencia, sugiriendo la diversidad de procesos

de adquisición de conocimientos ecológicos locales durante la niñez. Asimismo, los resultados de este trabajo muestran que las variables seleccionadas para medir el grado de cambio social entre los padres, no están asociadas a diferente participación de los niños en actividades cotidianas, sugiriendo que el impacto de los cambios sociales en los niños se debería evaluar a nivel de la comunidad. Finalmente, los resultados de esta tesis demuestran que las expectativas sobre qué significa ser adulto son diferentes entre niños y adultos, con los niños favoreciendo actividades cotidianas relativas a un modo de vida sedentario.

Esta tesis aporta nuevos elementos a la discusión sobre el impacto de los cambios socio-ecológicos en los conocimientos ecológicos locales al considerar la importancia de la vida cotidiana de los niños y sus percepciones en un contexto de cambio. Al resaltar la especificidad del sistema de conocimientos ecológicos locales de los niños Baka, los resultados de este trabajo enfatizan la importancia de desarrollar herramientas metodológicas adaptadas a la investigación con niños. Esta tesis también resalta la alta autonomía e independencia de los niños baka y como sus comportamientos parecen estar formados más por los modelos culturales de la comunidad en general que por los comportamientos específicos de sus padres. Dado que la niñez es un periodo clave para la adquisición de conocimientos culturales, los resultados de esta tesis ponen en evidencia la necesidad de una investigación de carácter más global, que se enfoque en el impacto potencial de actividades de reciente aparición (escuela, agricultura, televisión) en la adquisición de los conocimientos ecológicos locales. Finalmente, este trabajo resalta la importancia de evaluar los cambios socio-ecológicos no solamente mirando a los diferentes tipos de conocimientos y los diferentes grupos sociales, sino también a un contexto social más amplio y considerando lo que los individuos hacen y cómo perciben su propia realidad.

Résumé

L'importance des savoirs locaux est de plus en plus reconnue au travers le monde, que ce soit pour la subsistance locale tout comme pour la conservation de la biodiversité. Compte tenu des pressions grandissantes sur les sociétés de petite échelle, les chercheurs se sont penchés sur les impacts des changements socio-écologiques sur les systèmes de savoirs locaux. Cependant, au sein de ces études, peu ont considéré la nature dynamique de ces systèmes, de même que les savoirs des enfants.

Cette thèse de doctorat a pour but d'analyser les processus d'acquisition des savoirs écologiques locaux par les enfants (âgés de cinq à seize ans) d'une société de chasseurs-cueilleurs faisant face à des rapides changements socio-écologiques: les Baka du Sud-Est Cameroun. J'ai porté une attention particulière au contexte dans lequel a lieu l'acquisition des savoirs et comment celui-ci est actuellement modifié. Dans ses cinq chapitre empiriques, cette thèse étudie : a) les savoirs écologiques locaux possédés par les enfants ; b) le contexte dans lequel les enfants acquièrent leurs savoirs (par leur implication dans leurs activités quotidiennes) ; c) l'organisation sociale des enfants durant leurs activités de subsistance; d) la relation entre les stratégies de vie des parents et les activités quotidiennes des enfants ; e) les perceptions des enfants et des adultes sur leurs activités quotidienne et leur mode de vie.

Les résultats de ce travail montrent que les savoirs écologiques des enfants varient selon le sexe et l'âge, et qu'ils possèdent des savoirs qui leur sont propres, c'est-à-dire différents de ceux des adultes. Mes résultats rapportent également que les enfants s'engagent fréquemment dans des activités de subsistance, soulignant la place centrale que jouent ces activités pour l'acquisition des savoirs écologiques locaux durant l'enfance. Je montre également que ces activités réalisées par les enfants varient en fonction du sexe, et ce dès un très jeune âge. De plus, le choix des activités fait par les enfants change selon leur âge, avec une participation plus importante dans des activités nouvellement introduites (telles qu'écouter de la musique moderne ou jouer au football) lorsque les enfants grandissent. De plus, mes résultats fournissent l'évidence de la présence de multiples schémas d'organisation sociale des enfants Baka durant leurs activités de subsistance, soulignant la diversité des processus d'acquisition des savoirs écologiques locaux durant l'enfance. D'autre part, les résultats de ce travail montrent que

les stratégies de vies adoptées par les parents, considérées ici comme indicateurs de changements sociaux, ne sont pas liées à la manière dont les enfants investissent leur temps dans leurs activités quotidiennes, suggérant que les changements sociaux doivent être plutôt évalués à l'échelle de la communauté. Enfin, j'ai pu trouver que les attentes individuelles quant au mode de vie adulte diffèrent selon les générations, où les enfants tendent à valoriser les activités quotidiennes liées à un mode de vie sédentaire.

Cette thèse amène de nouveaux éléments au sein de la discussion relative aux impacts des changements socio-écologiques sur les savoirs écologiques locaux par la prise en considération de la vie quotidienne des enfants et de leurs perceptions dans un contexte de changement. En démontrant la spécificité d'un système de savoirs écologiques locaux propre aux enfants, mes résultats soulignent l'importance de développer des outils méthodologiques adaptés à la recherche centrée sur les enfants. Cette thèse confirme la grande autonomie et l'indépendance des enfants Baka et souligne que leurs comportements semblent plus influencés par un contexte général propre à la communauté plutôt qu'aux comportements spécifiques de leurs parents. Etant donné que l'enfance constitue une période clef pour l'acquisition des savoirs culturels, les résultats de cette thèse appellent à une recherche plus approfondie sur les impacts potentiels des nouvelles activités (telles que l'école, l'agriculture et la télévision) sur l'acquisition des savoirs écologiques locaux. Enfin, ce travail souligne l'importance d'aborder les processus de changements socio-écologiques non seulement en les évaluant par rapport à différents domaines de savoirs et au sein de différents groupes sociaux, mais également à un contexte social plus ample, et considérant à la fois ce que les individus font et comment ils perçoivent leur propre réalité.

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Like a seed...which gradually sprouted, developed some leaves, some flowers... and then a fruit, that can now be opened to disperse its seeds to other horizons...

Just like this fruit, which would not exist without the energy found in its environment from the sun, the water, the wind, and all the beings surrounding it, this dissertation would not have been possible without the presence of so many people, from diverse backgrounds and diverse horizons in life.

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Languages do not matter, customs do not matter, cultures do not matter:

"We are all part of the same and unique heart."

Foreword

I report local names in phonetic typography, using as reference the dictionary made by Robert Brisson (2010). Baka terms appear in NL3 font. The following tables present the different sounds in the Baka language (Fitzgerald, 2011).

Table 1 - Baka consonants

	Bilabial	Dental alveolar	Palatal	Velar	Labio-velar	Pharyngeal	Glottal
Nasal	m	n	ɲ	ŋ			
Plosive	b	t d		k g	kp gb		'
Fricative	ɸ	w s	J			h ²³	
Affricative			dz				
Prenasalized	mb	nd ndz		ng	ŋgb		
Lateral							
Trill		(r) ²⁴					
Implosive	ɓ	ɗ					

Table 2 - Baka vowels

	Front	Central	Back
Closed	i		u
Half closed	e		o
Half open	ɛ		ɔ
Open		a	

Baka language owns three different tones: the high tone: é; the low tone: è; and the mid tone: ē (left e in the text).

Main acronyms and abbreviations

ASBAK	Association Baka
CEB	Centre d'Education de Base
CED	Centre pour l'Environnement et le Développement
CIFOR	Centre for International Forestry Research
FPIC	Free, Prior, and Informed Consent
IK	Indigenous Knowledge
IPBES	Intergovernmental Platform on Biodiversity & Ecosystem Services
IRD	Institut pour la Recherche et le Développement
JICA	Japan International Cooperation Agency
JST	Japan Science and Technology Agency
LEK	Local Ecological Knowledge
MINEDUB	Ministère de l'Education de Base
NGO	Non Governmental Organization
ORA	Observer, Réfléchir, Agir
SNV	Stichting Nederlandse Vrijwilligers
TEK	Traditional Ecological Knowledge
WEIRD	Western, Educated, Industrialized, Rich and Democratic
WIPO	World Intellectual Property Organization

Part I

Chapter I

Introduction

1. Motivation and aims

1.1. Background and motivation

Local ecological knowledge, defined here as the corpus of knowledge, practices and beliefs held by a society about their surrounding environment, is an essential component of human adaptive strategy (Reyes-García, 2015; Richerson & Boyd, 2005). Nowadays, bodies of local ecological knowledge (LEK) continue to be essential for the subsistence of many people living in small-scale societies around the world (Posey & Dutfield, 1996). Over the last two decades, and more specifically since the approval of the Article 8-J of the 1992 Convention of Biological Diversity, the importance of LEK has been growingly acknowledged, with international policies recognizing that LEK systems might provide opportunities to enhance natural resources management and conservation (Hernández-Morcillo et al., 2014; Reyes-García, 2015).

Given the potential of LEK for natural resources management, the study of these knowledge systems has captured researchers attention, with several authors centering in studying the impacts of social and ecological changes on local knowledge systems (Case, Pauli, & Soejarto, 2005; Gómez-Baggethun & Reyes-García, 2013; G. D. Stone, 2007; Wolff & Medin, 2001; Zent, 2001, 2013). This previous research has highlighted that the many challenges faced nowadays by small-scale societies, and most notably the increasing pressure of external agents into their lands and their consequent diminished access to natural resources, directly impact the livelihoods of small-scale societies. Moreover, such changes, researchers have argued, might lead to the loss of their local knowledge systems (Gómez-Baggethun, Mingorria et al., 2010; Gómez-Baggethun & Reyes-García, 2013; Ohmagari & Berkes, 1997; Reyes-García, Luz, et al., 2013).

An important flaw in research on the study of how social-ecological changes might impact local knowledge systems relates to the type of data being used. Most studies on the topic have generally focused on the actual level of knowledge hold by individuals at the moment of the interview, without considering that some of the important factors shaping change in knowledge systems relate to the process of knowledge acquisition. In doing so, such research has largely neglected the dynamic nature of knowledge (Gómez-Baggethun & Reyes-García, 2013; Zent, 2013).

Given that cultures are continuously changing, LEK systems are better understood as dynamic bodies of knowledge (Gómez-Baggethun & Reyes-García, 2013; Zent, 2013). Looking at the dynamic nature of local knowledge systems might help us understand how the current knowledge hold by a society might evolve in parallel to concomitant social changes. Indeed, cultural evolution theories have already highlighted that the acquisition and transmission of culture occurs through many processes, and that each of them has a different effect on the maintenance or the erosion

of culture (Hewlett & Cavalli-Sforza, 1986). For instance, researchers suggest that knowledge that is transmitted from parents to offspring experiences less changes than knowledge that is transmitted among individuals from the same age group, which is therefore more likely to carry innovations (McElreath & Strimling, 2008). Therefore, such research findings suggest that looking at the processes of LEK acquisition might be a good predictor for assessing how LEK might evolve.

In this thesis, I propose to shift the approach from the study of the impacts of social-ecological changes on the content of LEK systems, to the study of the impacts of social changes on the process of knowledge acquisition. I propose to do so by describing the context in which children from a hunter-gatherer society, the Baka from Southeastern Cameroon, acquire local knowledge, and how the current social and ecological changes faced by their society potentially affect the process of local knowledge acquisition.

I chose to focus on children's acquisition of local knowledge for several reasons. First, the few studies focusing on the acquisition of local knowledge among small-scale societies have reported children's precocity in knowledge acquisition: in small-scale societies children acquire large amounts of knowledge early in life, sometimes even before the age of 10 (Hewlett et al., 2011; Hunn, 2002; Zarger, 2002). Second, despite this evidence, childhood has been largely under-considered in anthropological research (Delalande, 2009; Hirschfeld, 2002), including among scientists working among hunter-gatherer societies (Barry S. Hewlett, 2014a). And lastly, the study of children's knowledge is important to understand knowledge acquisition, not only because children are the building blocks of their future society (Lenclud, 2003), but also because children seem to hold a corpus of knowledge, practices and representations specific to them and not shared with adults (Hewlett & Lamb, 2005; Hirschfeld, 2002; Lenclud, 2003), or

what researchers have referred to as "children's culture" (W. A. Corsaro, 2012; Johanson, 2010).

The scant research on knowledge transmission among small-scale societies has generally focused on one particular domain of LEK, with a special emphasis on ethnobotanical knowledge (Ellen, 2011) and hunting knowledge (MacDonald, 2007). From this research we have a better understanding of the process involved in the transmission of cultural knowledge, although we lack specific information of the potential variability of knowledge acquisition processes according to the different domains of knowledge (Ellen, 2011; Reyes-García, Luz, et al., 2013). In that sense, and in order to get an overview of the processes of LEK acquisition among the Baka, I chose to study different domains of LEK, but all related to subsistence activities: hunting, gathering, fishing, and agriculture.

Another particular aspect of this dissertation is the focus on children's daily routines, or *habitus* (Bourdieu, 1986; Rogoff et al., 2007; Zarger, 2010). In that sense, my approach contrasts to previous research largely focusing on declarative knowledge. Indeed, most studies focusing on the process of acquisition of local knowledge have used data collected through interviews, in which researchers typically ask informants questions such as "*from whom did you learn?*". Although results provided by such methodological approach have improved our understanding of the cultural transmission processes, scholars nowadays are aware of their limitations (Aunger, 2000). For instance, data collected with this type of interviews tend to overestimate the role of the first teacher, while underestimating the role played by other members of the society (Reyes-García, Broesch, et al., 2009). Departing from that approach, in this work I study the context of knowledge acquisition by looking at children's actual behavior. In that sense, I chose to focus on the study of children's involvement in daily activities,

drawing on previous research suggesting that knowledge acquisition is intimately embedded in children's daily life and experiences (Gaskins & Paradise, 2010; Rogoff et al., 2007; Zarger, 2010). Because trade off exist between time involved in different activities and the domain of knowledge children would acquire (Morelli, Rogoff, & Angelillo, 2003; Sternberg et al., 2001; Zarger, 2010), analyzing the involvement of children in their daily activities potentiality inform us on the process of LEK acquisition.

Moreover, I also focus on the people who accompany children during their activities because, far from being an endless individual trial-and-error process, cultural learning is a social process, in which people surrounding the individual likely affect the process of knowledge acquisition (Aoki & Feldman, 2014; Nakahashi, Wakano, & Henrich, 2012; Paradise & De Haan, 2009). In that sense, previous research has already highlighted the importance of looking at the social networks for understanding the flow of information within a group (Calvet-Mir, Calvet-Mir, Molina, & Reyes-García, 2012; Hamilton, Milne, Walker, Burger, & Brown, 2007; Hopkins, 2011). Specifically, in this work I analyze children's group composition during daily activities related to subsistence to assess whether differences in how social network are structured for different activities might help explain the process of knowledge acquisition among different domains of LEK.

A final singular aspect of this thesis is that it explores LEK acquisition during middle childhood and adolescence. The few scholars working on child development among hunter-gatherer societies have mostly focused on infancy and early childhood, so middle childhood and adolescence are largely understudied (Barry S. Hewlett, 2014a). In that sense, and given the general precocity of knowledge acquisition is small-scale

societies (Demps et al., 2012; Hunn, 2002; Schniter et al., 2015), I chose to focus on middle childhood and adolescence, or children aged between five and sixteen years-old.

1.2. Aims

The aim of this PhD research is to explore how the current social and ecological changes the Baka faced might also affect the way Baka children acquire local ecological knowledge. Here, it is worth noticing that the focus of this work is on the context in which LEK acquisition occurs, and not specifically on the content of LEK that might be acquired. In that sense, my goal is not to assess which knowledge is being learned, but rather to understand the context in which knowledge is acquired. To reach this goal, I set five main objectives:

- To describe Baka children's local ecological knowledge related to animals, and wild edibles, and to explore the variation between children and adults' LEK, but also according to the age and the sex of the children (Chapter IV).
- To describe Baka children's engagement in different daily activities, focusing on the potential variation among boys and girls and children of different ages. The focus on daily activities draws from research suggesting that the way in which children invest their time might condition the type of knowledge they acquire (Chapter V).
- To analyze the composition of the social networks of children during their activities in order to identify how different social network structures might result in differentiated knowledge acquisition (Chapter VI).
- To identify the potential impacts of social changes on the process of LEK acquisition by analyzing how parental household strategies might relate to children's daily activities (Chapter VII).

- To identify the potential impacts of social changes on children's knowledge acquisition by looking at adult's and children's perceptions of their daily activities and their culture (Chapter VIII).

2. Study Context and overall methodological approach

2.1. Study context

This PhD work was part of the research project “*The adaptive nature of culture: A cross-cultural analysis of the returns of Local Environmental Knowledge in three indigenous societies*” led by Victoria Reyes-García and funded by an ERC Starting Grant (FP-7-261791-LEK) (see <http://icta.uab.cat/Etnoecologia/lek/>). Consequently, in parallel to the work performed for this PhD, during fieldwork I also collected project's data. I have also been involved in other additional tasks such as data entry, data analysis, and co-writing with others members of the team. For the framework project I had to collect information to provide an extended overview of the local livelihoods, a situation that has helped me to expand my understanding of the Baka way of living, thus contributing to the interpretation of my results. Teaming up with another researcher, Romain Duda, and two native research assistants/translators, data were collected in team. One of the research assistants was a Bantu-speaker and the other was a Baka. Two additional Baka translators were occasionally employed.

The research results presented here draw in extensive period of fieldwork of 18 months between February 2012 and May 2014. Fieldwork was divided in three different stays. During the first stay that lasted four months, from February to May 2012, I

identified the studied communities and collected background data. The second and longer stay, lasting 13 months from July 2012 to August 2013, was dedicated to the collection of systematic data, both qualitative and quantitative. Finally, the third and last stay lasted one month between March and April 2014 and was dedicated to return results to the communities, to verify interpretation of results and to complete them with further qualitative data.

Since the beginning of the fieldwork, I worked in close collaboration with local people, local authorities, and local and international institutions working in the area, especially with members of IRD (Institut pour la Recherche et le Développement), CIFOR (Center for International Forestry Research), and ASBAK (Association Baka), a local Baka NGO settled in Lomié. These institutions helped with logistical issues for the implementation of the research in the area. Some of our preliminary results were presented to those institutions during the last period of fieldwork.

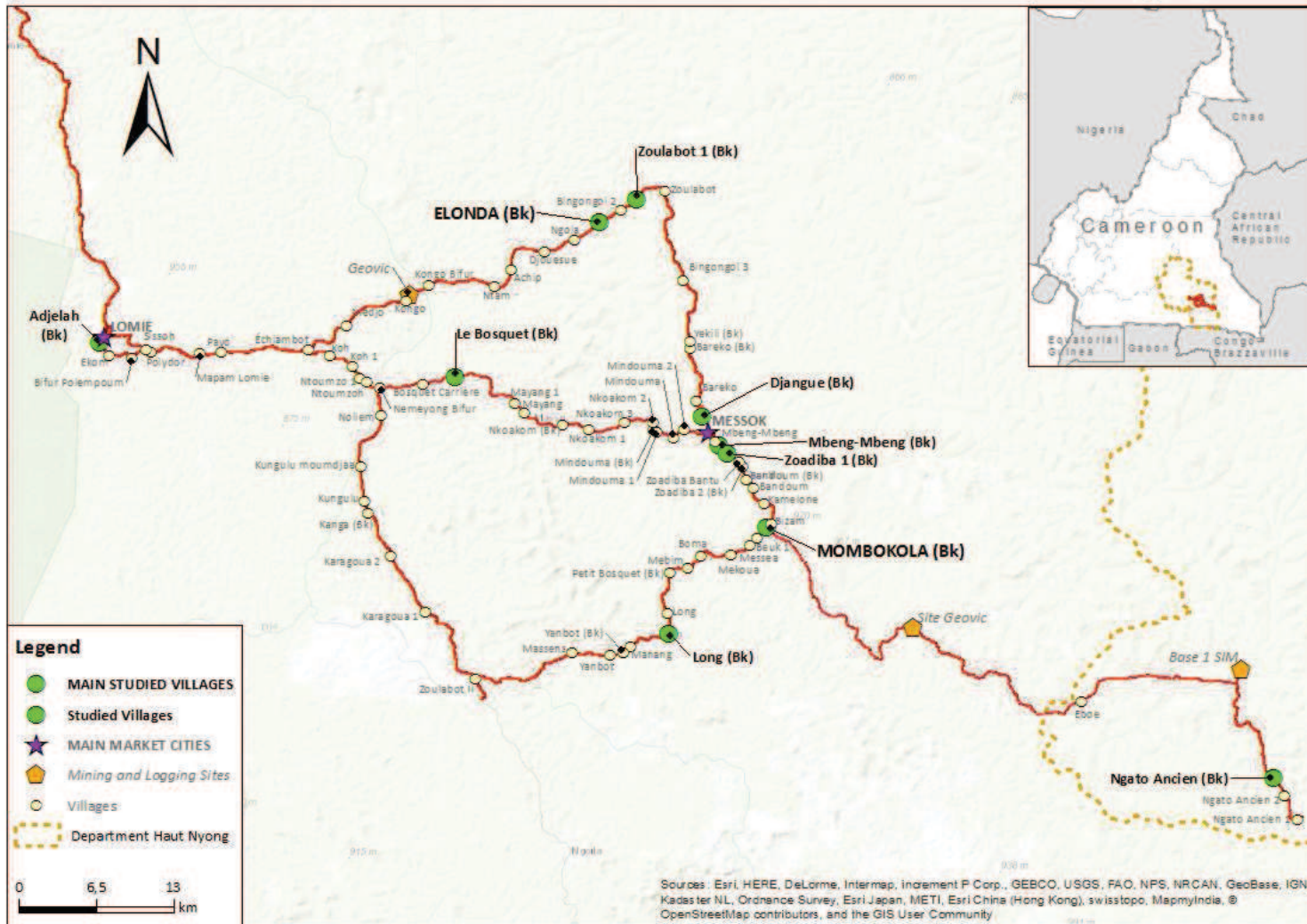
2.2. Localization

I conducted fieldwork in the south part of the Haut-Nyong Department, in the East Province of Cameroon. The East Province of Cameroon is deserved by two main roads: one axis goes from Yaoundé to the Republic of Congo, through Yokadouma and Moloundou, and another axis goes from Yaoundé, Abong-Mbang to the Haut Nyong Department, joining the cities of Lomie and Messok. Whereas a paved road joins Yaoundé with Abong-Mbang, a dirt road, opened and mostly used by the largest logging company operating in the area, joins Abong-Mbang with Mindourou, Lomié and Messok.

The Haut-Nyong Department counted in 2010 almost 218,000 inhabitants, in an area of 36,384 km²(Institut National de la Statistique, 2010) mostly covered by tropical moist broadleaf Congolian forest. Three main fluvial axes cross the area: the Dja, the Boumba and the Sangha rivers. The principal ethnic groups living in the area are the Baka, and different Bantu-speaking groups, such as the Maka, the Nzime, the Njem, the Kanabem and the Badjue. The Nzime were the principal ethnic group present in both districts of Lomie and Messok.

Although during fieldwork I interacted with and interviewed local authorities, local institutions working with the Baka, and local representatives of the Ministry of Education (MINEDUB) settled in the cities of Lomié and Messok, most of my fieldwork was conducted in Baka communities in the districts of Lomié, Messok, Mindourou and Ngatto Ancien. I worked with a dozen of villages where I conducted open-ended interviews and pilot tested protocols I later implemented in the two villages focus of this research (see Figure I-1 showing the studied villages, except for two additional villages, Djebe and Menzoh, located on the road between Lomié and Mindourou).

Figure I - 1 Map of the studied area with the principal studied villages.



To identify the two villages where the project focused, we first visited several Baka communities in the districts of Lomié and Messok. After this first visit, we identified two potential villages and, in a village-meeting, we requested permission to work. I elaborated a Free, Prior, and Informed Consent (FPIC) protocol that was discussed (and later accepted) both at the village and the individual levels (Lewis, 2012). We also obtained FPIC from several villages where we sporadically conducted research or tested protocols. This study adheres to the Code of Ethics of the International Society of Ethnobiology and received the approval of the ethics committee of the Universitat Autònoma de Barcelona (CEEAH-04102010).

3. Methodological approach

In February 2012, I established myself in the village of Elonda, and my colleague settled in Mombokola, where we made houses with local materials. In order to get a better understanding of potential differences between villages, I spent about ten days each two months in the village of Mombokola. During our time in the villages, we visited the closest town (Lomié or Messok) once a month, both to conduct interviews with local institutions and NGO working in the area and to buy groceries. Once each two months we visited the capital city (Yaoundé) to communicate with the rest of the team, to conduct interviews with national institutions, and to buy more diverse food and material.

Although we had installed a solar panel in the villages to recharge electronic devices, most of the data entry, data analysis and writing have been done during my stay in the cities or after returning from the field, principally in June and July 2012, between September 2013 and February 2014, and since May 2014 to date.

3.1. General overview of data collection

In this section, I provide a brief overall view of the context in which data were collected. All the methodological details corresponding to how data were collected and analyzed are included in each of the empirical chapters (Chapters V to VIII), except those used for the elaboration of the ethnographic section (Chapter III), which are described here.

3.1.1. Ethnographical exploration

To be able to contextualize the topic developed in this PhD work, at the beginning of the fieldwork I collected ethnographic information, which was later completed and updated over the entire period of fieldwork. Specifically, because the lack of previous information related to Baka childhood and to the type of knowledge hold by children, I first had to gain enough understanding regarding the practices and the knowledge of interest to my work. The first ethnographic explorations were oriented to understand local livelihoods, the context of the villages (the history of their settlements, the proximity to administrative centers, and the frequency of outsiders' visit) and their social organization (norms of sharing, marriage, kinship, household rules), as well as childhood and cultural learning. I collected this contextual information using several methodological tools such as semi-structured interviews, focus groups, and free-listing, but also participatory observation, tale and song recordings, and informal spontaneous talks. An important part of this first ethnographic exploration was also devoted to understand the relation of Baka people with their environment (by their practices, knowledge and believes).

More specifically, to assess the relation of Baka people with their environment through their daily uses to skills, knowledge, beliefs, and myths, I conducted open ended interviews and informal talks with as most informants as possible, for both sexes and from different ages (see Davis & Wagner (2003)).

I also conducted focus groups to capture the variation on the following topics: game and hunting, wild edibles and gathering, medicinal plants and health, agriculture, and climatology. In each village, we also organized two focus groups to elaborate a seasonal calendar (one focus group with male and another with female participants), focusing specifically on subsistence activities and the availability of natural resources.

During fieldwork I participated in village life as much as possible. To be able to immerse myself in Baka life, I studied Baka language, with the precious help of the French-Baka dictionary (Brisson, 2010) and thought numerous exchanges with our translators and with French-speaking Baka informants. Initially, during the first months of fieldwork, most interviews were performed with a local translator of Nzime origin. Eventually, I gained a level of mastery in Baka language that allowed a more direct and intimate communication with people in the villages. I also tried to follow, as much as possible, local norms of conduct. Thus, living directly in the village, in a hamlet of an extended family (7 households), I had many opportunities to participate in community life, such as joining women and children who washed in the river, to cook, to prepare and share food, and to take care of children. Although I had a more intimate relation with families in the area around my house, I also interacted and got a close relation with all the other households of the village, something that was possible because my extensive fieldwork.

Finally, I also had several opportunities to participate to daily activities of both adults and children, what provided me with a general overview of all the context in which Baka perform different activities, from hunting, gathering, agricultural work and fishing, domestic work, to traditional and new leisure, such as traditional songs and rituals and dancing in informal bars.

3.2. Systematic data collection on Baka demography and livelihood

3.2.1. Census

During the first months of research, I collected census data for every individual of every household present in the village. As some people have temporary residencies in forest camps, I interviewed them upon their return to the village. For each individual, I collected both Baka and French names, sex, relation of the person with the head of the household, clan and age. As most Baka do not have birth cards and generally do not remember their birth-date, I estimated the age of almost all the population. To do so, I used contextual information and mostly kinship data, i.e. order of birth, birth interval among sibling (including miscarriage and dead children). Kinship information was completed asking people about the group of peers who were growing up and living together. Such data were used to draw family trees and to elaborate a kinship charts (using Community Express for Windows). The census survey also included data on schooling (i.e., attendance, higher school grade completed), and evaluated literacy in national and Baka language, as well as numeracy (using a test based on four questions: addition, subtraction, multiplication and division).

3.2.2. Adult's livelihood

To evaluate Baka livelihood, I collected data on the daily activities performed by adults in both villages. To do so, I used self-reported interviews on the main activity performed during the two days before the interview (during day time). Between August 2012 and August 2013, we visited every household in the sample every week and conducted interviews with all the adults present in the household. These activities were grouped into 17 different categories of activities. I estimated the individual's involvement in an activity as the ratio between the number of times the activity was mentioned by the respondent and the total number of days reported in interviews. Therefore, the variable that captures an individual's involvement in an activity took a value between 0 and 1, where the sum of the involvement in the 17 activities equals to 1. During such interviews, we also asked them about the different products they brought home: forest products, game and agricultural. A total of 4447 observations were conducted with 272 individuals (114 men, 158 women). Results from these data are shown in the Chapter III.

4. Structure of the thesis

This dissertation is a hybrid between a monographic review and a compilation of articles, and it is structured in two parts. The first part includes general aspects, such as the overall context and the methodological approach used during this research (presented above) as well as the theoretical foundations of this work (Chapter II) and the ethnographic settings of this research (Chapter III). In the second part of this dissertation, I present the results of my study, which are structured in five empirical chapters, each of them corresponding to a journal article or book chapter. Four of the

articles in the second part have been submitted to peer-reviewed journals (Chapter IV, V, VIII) or as a chapter in an edited book (Chapter VII); and the last one (Chapter VI) will be submitted soon to a peer-reviewed journal. I chose to include these last five chapters in the format they have been sent for publication. In that sense, each chapter of this second part contains an introduction, a case study and a methodological section, with some overlap between chapters, and also with Chapters II and III of this thesis.

In Chapter IV I describe the ontogeny of LEK related to game and wild edibles among the Baka children. I look at the pattern of variation according to the sex and the age of the children. I then analyze the variation between children's and adults' LEK, so to highlight the specificity of children's LEK, and the existence of a children's culture among the Baka. This chapter has been submitted in October 2015 to the *Journal of the Royal Anthropological Institute* with the title "Evidence of 'children's culture': the case of the Local Ecological Knowledge system among the Baka".

In the next two chapters, I discuss issues related to the process of LEK acquisition. Specifically, in Chapter V I analyze children's daily activities. The intuition behind this chapter is that understanding how children allocate their time would help us understand the context in which Baka children acquire LEK. Specifically, I analyze the frequency with which Baka children engage in activities with different potential for the acquisition of LEK. By describing the involvement in daily activities during middle childhood and adolescence, this chapter highlights the variation on children's engagement in daily activities according to their sex and age. In the final part of the article, I discuss the relation between children's involvement in daily activities and the potentiality of LEK acquisition. The chapter corresponds to an article titled 'Children's daily activities and Local Ecological Knowledge acquisition. A case study among the Baka from southeastern Cameroon', submitted to the *Journal of Ethnobiology and*

Ethnoecology in October 2015. First preliminary results of this section had been presented during the CHaGS 10 in Liverpool in June 2013.

In Chapter VI, I analyze the structure of the social network in which children are embedded during their daily activities to explore the role that different actors in the network might have in the process of LEK acquisition. I analyze the composition of children's social groups according to the sex and the age of the children, looking at four main subsistence activities: hunting, gathering, fishing, and agriculture. I discuss the results of such analysis in the light of cultural transmission, exploring the multiplicity of strategies of knowledge acquisition present during children's daily activities.

The following chapter, Chapter VII, addresses the issue of how social changes might affect LEK acquisition dynamics. Specifically, as a proxy to assess social changes, I look at the variation in parental indicators of social changes, related to their use of time, their income and their education. Then I look at how such variation in parental livelihood relates to children's activities. This chapter corresponds to the chapter titled " 'Like Father, Like Son'? Children ethnoecological learning in a context of social changes: A case study among the Baka from southeastern Cameroon", submitted as a contribution for a book titled "*Hunter-gatherers in a changing world*", edited by A. Pyhälä and V. Reyes-García.

The last empirical chapter of this thesis, Chapter VIII, focuses on the potential impact of social changes on children's LEK acquisition by looking at adult's and children's perception of their livelihood activities and culture. I analyze the variation of children's and adults' representations according to their age and the sex, and discuss results focusing on how hunter-gatherer characteristics might explain the difference between children's behaviors and perceptions and their parental household profile and

on how new trends affect both adults and children daily life. This chapter corresponds to the article submitted in July of 2015 to the journal *Childhood*; with the title: "Do changes in parental livelihood strategies affect children's daily activities? A case study among the Baka from southeastern Cameroon". Most of the results developed in this section were presented during CHaGS11 in Wien, September 2015.

The dissertation ends with a concluding chapter, Chapter IX, which provides a comprehensive discussion of the results presented in previous chapters. I thus outline the main theoretical and methodological implications of this research, the main caveats and limitations, and suggest potential areas for further study.

In addition to these chapters, this thesis includes three annexes. The two first annexes present complementary information to the results analyzed for the first empirical chapter of this thesis (Chapter IV). The first one details the results of the free-listing performed with adults and children with the scientific correspondences of these species. The second annex presents the surveys realized to assess children's and adult's LEK. Finally, I present in the third annex a list of publications complementary to this PhD research.

Chapter II

Theoretical Background

“Change is the only constant in life.” Heraclitus

The study of the dynamics of local ecological knowledge systems in a hunter-gatherer society requires an interdisciplinary approach, as addressing such a topic involves the mobilization of concepts from different and complementary disciplines including ecology, cultural anthropology, cognitive anthropology, psychology, anthropology of childhood and education, and -of course- ethnoecology. Therefore, it seems important to provide a summary account of the essential concepts that form the theoretical framework of this study.

1. Culture and cultural evolution

In this section, I aim to define briefly the concept of culture and to provide an outline of how the meaning of the term and the way it has been approached has changed within the discipline of anthropology, and more specifically within cognitive anthropology. I then focus on describing the various processes resulting in cultural transmission and how these processes can affect cultural evolution.

1.1. The definition of "culture" and the study of "cultural evolution"

The concept of culture is concomitant to the birth of the discipline of anthropology (Blount, 2011). However, despite many attempts to provide a definition, the term "culture" continues to be fuzzy, as it is differently defined in each discipline and even within the same discipline (Mesoudi, 2011). However, from the very first definition coined by E. B. Tylor during the nineteenth century, a commonality among the many definitions proposed is the link of the term "culture" to cognition. Culture was defined by Tylor as "*a complex-whole which includes knowledge, beliefs, art, law, morals, custom, and any other capabilities and habits acquired by a man as member of a society.*" (1871:1 in Blount, 2011: p.13), where "*capabilities*", refers "*to the ability of people to acquire and produce knowledge, beliefs, etc. In contemporary terms, ability would include cognition*" (Blount, 2011: p.13).

Later on, the idea of culture was also approached from an evolutionary perspective, as some cultural anthropologists began to borrow biological concepts. Such definitions, however, continued to put cognition at the center, as illustrated by Richerson and Boyd's (2005) definition of culture as "*information capable of affecting individuals' behavior that they acquire from members of their species through teaching, imitation, and other forms of social transmission.*" (Richerson & Boyd, 2005: p.5), where the term of "information" relates to knowledge, beliefs and conscious or unconscious attitudes . In line with this definition, a considerable amount of effort has been devoted to understanding how culture is shaped, spreads and evolves, with many contemporary works dealing with the concept of cultural evolution (Laland & Brown, 2002). For instance, some cultural anthropologists have tried to analyze culture using biological theories, namely Darwinian and Neo-Darwinian approaches (Mesoudi, 2011).

Thus, in an attempt to explain cultural evolution, researchers have borrowed the three main postulates of Darwinian theory to explain biological evolution: variation (i.e., characteristics vary between individuals), competition (for resources); and heritability (i.e., descendants acquire the characteristics of their parents by heredity). According to the proponents of such approach, the use of biological concepts to try to explain culture is justified in several ways. Firstly, as is true of any biological system, culture also exhibits variation, the variation existing between cultural traits. Secondly, there is competition between cultural traits, even if it is not directly related to survival (at least for most of the time). And thirdly, there is heredity of these cultural traits occurring through the different processes of cultural transmission. However, in contrast with genetic heredity, culture can be transmitted in many ways (Laland & Brown, 2011; Mesoudi, 2011).

Other anthropologists have also attempted to apply Neo-Darwinian theories to cultural evolution (see Mesoudi (2011)). In biology, Neo-Darwinian theories postulate that, beyond the three Darwinian processes, other forces affect evolution. Among them, scholars have been wondering whether cultural transmission was particulate, meaning that it occurs through the transmission of discrete units, in the same way gene are the discrete units of biological transmission. Even if this concept has been discredited for several reasons (Buskes, 2013), it is worth noticing the main influence of Dawkin's work and the notion of "meme" (Dawkins, 2006), leading to other theories such as the Dennett's theory of mind evolution (see Dennett, 1995). Some scholars have also questioned whether cultural evolution was or not Lamarckian; and whether cultural evolution was or not blind (Mesoudi, 2011). Following these different intellectual traditions, some researchers have focused on the evolutionary processes at the micro and macro level to try and model cultural evolution. Whereas the macro-evolutionary

approach aims to assess cultural evolution through a holistic approach and looking at the phenomena at a large-scale level, the micro-evolutionary approach focuses on the sources of cultural variation, the form of cultural selection, and the details of the processes responsible of transmitting cultural traits from a generation to another. Such processes of cultural evolution are thus shaped by the modes of cultural transmission and the way cultural selection acts (that is cultural drift), but also by natural selection and migration processes (Mesoudi, 2011).

1.2. Cultural Transmission

Researchers adopting the cultural evolution approach have devoted much research effort to understand the modes through which cultural transmission operates. As the study of processes that occur through time is challenging, much of this research has been based on theoretical and mathematical models (Cavalli-Sforza, Feldman, Chen, & Dornbusch, 1982; McElreath & Strimling, 2008; Richerson & Boyd, 2005). Such models emphasize three main paths of cultural transmission that reflect variations in generational differences and social relations between the “learner” and the “teacher”: vertical, horizontal, and oblique (Cavalli-Sforza et al., 1982; McElreath & Strimling, 2008). Following genetic transmission models, vertical transmission, i.e. the transmission of information from parents to their offspring, is the most "conservative" mode of transmission, as it limits innovations and enhances cultural continuity (Cavalli-Sforza et al., 1982; McElreath & Strimling, 2008). By contrast, horizontal transmission, i.e. the transmission of information between several individuals from the same generation, might lead to a faster diffusion of new cultural traits, especially if contact with transmitters is frequent (Cavalli-Sforza et al., 1982). The same trend has been related to oblique transmission, i.e. the flow of information following the

intergenerational path but without being necessarily linked to kinship relations. Horizontal and oblique transmissions, both based on epidemiological disease transmission models, tend to be less conservative when interactions are frequent. Furthermore, those modes of transmission are highly adaptive in rapidly changing environments. Indeed, results from several ethnographic studies and theoretical models indicate that innovations are frequently spread through horizontal and oblique transmissions (Barry S. Hewlett & Cavalli-Sforza, 1986; Barry S. Hewlett et al., 2011; Reyes-García, Broesch, et al., 2009).

Two perspectives have thereafter derived from the study of those three pathways of cultural transmission. From a cultural evolution approach, the first perspective, several researchers have focused on the effectiveness of the modes of cultural transmission, analyzing how the different transmission pathways might be depending on or be shaped by environmental conditions. In that sense, it has been argued that vertical transmission might be favored when the environment is stable, the selection is strong, or when the cultural traits affect fertility; in turn oblique transmission might be favored when the environment is variable, the selection is weak, or the cultural traits affect adult's survival (McElreath & Strimling, 2008). Some anthropologists have also tried to weight one pathway against the others. Whereas the importance of vertical transmission has been highlighted in ethnographic studies among several societies (Hewlett & Cavalli-Sforza, 1986; Lozada et al., 2006; Ohmagari & Berkes, 1997), researchers have also showed that both horizontal and oblique transmission might be more important for specific types of knowledge (Kline, Boyd, & Henrich, 2012; Zarger, 2002) or at different learning ages (Aunger, 2000; Demps et al., 2012; Barry S. Hewlett et al., 2011). A recent comparative work proposes that cultural transmission should be analyzed as a dynamic process entailing the combination of several transmission

pathways at different moments of the life-cycle, or a “multi-stage learning model” (see Reyes-García, Demps, & Gallois (2016)).

The second perspective departs a little further to propose that the transmission of cultural knowledge can follow pathways which do not necessarily resemble those identified for genetic transmission. Thus, researchers have also proposed that other strategies, complementary to the three pathways described above, might be involved in cultural transmission. Such strategies fall into what is known as social learning or the “*general capacity to acquire information from others, regardless of the nature of the information, its function, or the sensory modality involved*” (Laland et al., 2000: p.141). Thus, researchers have suggested that cultural transmission might be biased by two main types of biases: context and content biases (Broesch, Barrett, & Henrich, 2014). Content biases refer to the “*intrinsic attractiveness of an idea, belief, or practice*” (Mesoudi, 2011: p.65) independently to the frequency with which this cultural trait occurs among the population. In other words, content biases cause the “*preferential transmission and retention of certain types of information over others as a function of what is being transmitted*” (Broesch et al., 2014: p.182). In turn, context biases refer to the likelihood and saliency of transmission of cultural traits due to the distribution of such traits in the population. For example, the frequency-dependent biases (or conformist-biases) imply that “*a learner is disproportionately more likely to adopt the most common trait in the population, relative to simply copying at random*” (Mesoudi, 2011: p.72)(McElreath & Strimling, 2008; Perreault, Moya, & Boyd, 2012; Richerson & Boyd, 2005). Context biases might also be due to model-based biases, referring to the characteristics of the model who owns the cultural trait. The learner would be more likely to copy in order to adopt cultural traits from a model who shows similarities with him (same age, gender, or social group) (Acerbi & Bentley, 2014; Henrich & Gil-White,

2001; Wood, Kendal, & Flynn, 2013). Preferential transmission through context biases might also occur from a model culturally considered as prestigious. The prestige-biased transmission involves preferential social learning from models seen by the population as experts and who receive conferred deference from other members of the community (Chudek et al., 2012; Henrich & McElreath, 2003; Richerson & Boyd, 2005a).

It is thus worth noticing that, although different models of cultural transmission have been proposed, they all consider knowledge, values, beliefs and practices as defining parts of culture. In the following section, I explore the definition of knowledge, and discuss how the concept will be used in this study, particularly referring to cultural knowledge related to the local environment, or what is commonly known as local ecological knowledge (LEK).

2. Local ecological knowledge

I start this section by presenting the academic discipline which studies local ecological knowledge: ethnoecology. Then, after a brief historical overview of the use of the concept, I discuss some of its most common definitions and explain the rationale for the selection of the particular definition used in this work. I finish the section discussing the importance of studying Local Ecological Knowledge.

2.1. Ethnoecology

The term ethnoecology refers to the study of the relation between human societies and the environment they inhabit. Ethnoecological studies aim to describe, understand, and analyze how human societies can perceive, name, identify, conceptualize and use their environment. With a strong interdisciplinary component, ethnoecological studies draw on several methodologies coming from both social (such as sociology, anthropology, psychology) and natural (such as ecology, biology, agronomy) sciences. As highlighted by Nazarea (1999), "*conceptually and methodologically, ethnoecology offers great promise for linking anthropology meaningfully with other fields of investigation and discourse*" (Nazarea, 1999: p.vii).

The discipline of ethnoecology draws from two, initially separated, approaches. On the one side, during the 1960s' several anthropologists from the USA studied folk classifications and vernacular taxonomies aiming to highlight universal classification principles. On the other side, the French anthropologists approached the study of human relations with the environment from a more ethnographic approach, and based on the transdisciplinary teaching of A.-G. Haudricourt (Bahuchet, 2012). Both approaches converged during the International Congress of Ethnobiology in Belem (1988), when

the International Society of Ethnobiology was created. The creation of this society represented, not only the consolidation of ethnobiology as a new discipline, but also the public engagement of some researchers to protect local communities from the overexploitation of their resources and their knowledge (Bahuchet, 2012).

In the decades that followed, the number of studies on ethnobiology and ethnoecology has grown. One of the most influential authors in this tradition, V. Toledo, summarized the object of study of ethnoecology arguing that "*the connections between corpus (the whole repertory of symbols, concepts and perceptions on nature) and praxis (the set of practical operations through which take place the material appropriation of nature) in the concrete process of production should be the starting point of any ethnoecological research.*" (Toledo 1992: p.9, in Bahuchet, 2012).

In that sense, ethnoecology aims to transcend the dichotomous approach that places cognition in one side and behavior in the other, by focusing on the relation between both aspects embedded in a whole cultural system (Bahuchet, 2012). In other words, ethnoecology aims to understand the relations between societies and the world surrounding them through the study of society's dynamics, social organization, and cultural specificities in relation with their environment. One important aspect of this discipline relates on the study of cultural knowledge, and specifically local ecological knowledge.

2.2. Historical overview to the study of LEK

Prior to the mid-1980s, the study of local knowledge systems mostly relied in qualitative techniques, aiming at providing ethnographic descriptive reports of elements of local knowledge and developing theory in ethnobiology. As pioneer in ethnoecology, H. Conklin conducted his PhD research on the study of ethnobotanical knowledge

among the Hanunoo from the Philippines (Conklin, 1954). Additional studies after this first one were mostly devoted to analyzing the linguistic, cognitive and biological domains of local environmental knowledge. Such research has helped in our understanding of the empirical perspicacity and the ecological rationality of traditional knowledge systems. Mostly, the purpose of those studies was "*identifying universal or evolutionary principles of the human apprehension of the biological world*" (Zent & Maffi, 2011: p. 15).

More recently, researchers have conducted ethnoecological studies using quantitative techniques, a methodological shift somehow aiming to establish the dialog with other disciplines through methodological convergence (Zent & Maffi, 2011). Such studies have used replicable procedures of data collection and have analyzed such data to empirically test hypotheses derived from theory, using several statistical measures, approaches, and mathematical models. Results of such studies have let to the understanding of many cultural phenomena, the way local populations depend on natural resources, or the ecological impact of local uses (Zent & Maffi, 2009). Results of these studies have also been applied in biodiversity conservation and sustainable development programs (see Zent & Maffi (2011) for more details). Although some authors have criticized the use of quantitative techniques in ethnobiology, as this methodological approach tend to convert all the complexity of cultural traits and knowledge into numbers, it should be acknowledged that results from this research have provide important insights for scientists and practitioners and have enhanced the interdisciplinary dialog between social and environmental sciences.

As the discipline of ethnoecology continues to grow, new fields of enquiry appear. Thus, in addition to work on local ecological knowledge systems, nowadays ethnoecological research also studies the relations between cultural and biological

diversity (Maffi, 2005); the contributions of local systems to natural resources management (Reyes-García & Marti Sanz, 2007); or social resilience (Gómez-Baggethun & Reyes-García, 2013; Reyes-García et al., 2014).

2.3. Definition of LEK

Researchers have used many terms to refer to the knowledge of local societies in relation to their environment, the most common ones being folk knowledge, indigenous ecological knowledge, traditional ecological knowledge, local ecological knowledge, or local environmental knowledge. As Ellen highlighted, the use of one or another word is not insignificant, since "*whether we use indigenous knowledge (IK), [...] local knowledge, [...] traditional environmental (or ecological) knowledge (TEK), [...] says something about the direction from which we approach the subject and the assumptions we make about it*" (Ellen & Harris, 2000: p.2). It is, therefore, important to clarify the selection of the term.

From the several terms that can be found in the literature, in this work, I use the term 'local ecological knowledge' for several reasons. Using the term 'indigenous' did not seem relevant in my study, as the notion of indigenusness or autochthony might be ambiguous and has been contested in the African context (Geschiere, 2009; Pelican, 2009). I chose not to use the term 'traditional' either, as even if the body of knowledge I analyze is embodied in history and social memory, the term 'traditional' has been often opposed to the term 'modern', in a binary approach of the world that will deem this knowledge as opposed to modern scientific knowledge, or even simple, primitive or irrational (Agrawal & Bouamrane, 1995; Ellen & Harris, 2000; Roué, 2012). Moreover, the term 'traditional' might contribute to give a static notion of knowledge (Zent & Maffi, 2009), disregarding its dynamic nature (for an example, see Gilchrist, Mallory, &

Merkel (2005)). Therefore, I choose to use the term 'local' to highlight the place-attachment nature of the knowledge system studied.

Additionally, I chose to use 'ecological' rather than 'environmental' because the term 'environment' refers to all the elements surrounding an entity (an organism, a group, or a society) including the cultural, social, physical and ecological elements. As this definition is very vague, I rather prefer to use the narrower term 'ecological', which reflects better the fact that the knowledge system studied in this work only refers to the biological and physical environment.

To provide a specific definition of the term local ecological knowledge, I first refer to the definition of traditional ecological knowledge proposed by F. Berkes and colleagues, as "*a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment*" (Berkes, Colding, & Folke, 2000: p.1252). I, however, complement this definition with insights from other researchers. Thus, following R.K. Puri (2013), I consider LEK as a knowledge system that includes the notion of "knowing things (*facts*), as well as knowing how to use those facts" (Puri, 2013:p.268) and which "*is also intimately related to other cultural domains, such as religious and medical belief systems, social structures and linguistic forms and expressions.*" (Puri, 2013: p.268).

As Zent and Maffi (2009) have argued, acknowledging the multi-dimensional and interconnected nature of LEK systems, poses important methodological problems: "*Due to its multi-dimensional and interconnected nature, the demarcation of environmental knowledge from other kinds of cultural-based knowledge is somewhat ambiguous and arbitrary, and in many societies implies a conceptual imposition that has no meaning for local members*" (Zent and Maffi, 2009: p.15).

An additional point to take into consideration in studying local knowledge is that knowledge is not limited to the individual and its mind. Indeed, it is worth highlighting that local ecological knowledge systems are mostly perceptual and unconscious (Medin & Atran, 2004), intimately embodied (Marchand, 2010), and not necessarily verbalized (Bloch, 1991). Such characteristics imply that LEK might be implicit and internalized, rather than consciously acquired and "*interdependent with the collective memory formed by history of a specific group*" (Haselmair et al., 2014: p.2). Indeed, knowledge rather than being an individual attribute is collectively shared (Ellen, 2011), as it is, for instance, located "*both inside the individual and in relation between teacher and learner*", and "*encoded inside the brain but it is also in material object, living things and spoken word*" (Wyndham, 2002, p. 551).

Due to the complexity of local knowledge systems, I had to limit my approach to some aspects of LEK. Therefore, this study mainly focuses on some domains of LEK, mainly related to domains of activities and to individuals' skills, such as the identification of natural species, knowledge about their ecology and their ethology, and skills related to subsistence activities. However, aware of the limitation of such approach, I try to consider such complexities in the interpretation of my results. Therefore, even if empirical results from this work mostly relate to knowledge expressed in tangible ways (verbalized, practiced), in discussing those results, I try to bring insights considering the intangible and frequently unconscious aspects of the knowledge system analyzed.

2.4. The importance of Local Ecological Knowledge

Local ecological knowledge systems have been an essential component of human societies. From alpine tundra, and tropical forests to deserts human populations managed to adapt to the constraints and the advantages of their environment by developing specific knowledge and practices in a myriad of ways, such as pastoralism, horticulture or foraging strategies (Reyes-García, 2015). It has been acknowledged that these knowledge systems are intimately related to environmental management and sustainability of biodiversity through the social and cultural systems where this knowledge and practices embedded (Becker, 2003; Brondízio et al., 2010; Virginia D. Nazarea, 2006). Indeed, several researches have documented systems in which resources have been the sustainable managed not only through the use of particular techniques, but also through following socio-cultural norms, including restrained access to some areas, prohibition rules, or taboos, that regulate the use of such techniques (Puri & Vogl, 2005).

Although local knowledge systems were largely discredited by many scientists in the past, the potential contributions of such knowledge systems are now more largely acknowledged, both in academic and social circles. Indeed, worldwide, and in parallel to the increase of the movement for rights of indigenous people, the status of local ecological knowledge started to change in the 1980s. Researchers argue that such interest lies in the growing consideration of traditional knowledge systems among academic realms and in the potential value of local ecological knowledge for the management and conservation of biodiversity (Reyes-García, 2015).

Thus, we see a growth in the political interest in local knowledge systems. The interest was first manifested in 1992, with the Convention of Biological Diversity, in

which the importance and the potential role of Traditional Ecological Knowledge -TEK- in biodiversity conservation were acknowledged (see article 8-J). The same interest was manifested in the Convention for the Safeguarding of Intangible Cultural Heritage, which aims at the protection of TEK (UNESCO, 2003). TEK also entered in the policies of the World Intellectual Property Organization -WIPO-(WIPO, 2004). Finally, the recognition of TEK was reinforced during the Conference of the Parties in Nagoya in 2010. In parallel, some international policies such as the Millenium Ecosystem Assesment (2005), the Economics of Ecosystems of Biodiversity (TEEB 2010), and the Intergovernmental Platform on Biodiversity & Ecosystem Services (IPBES) have recognized the importance of TEK integrating the term into their texts.

It is worth noticing, however, that -overall- local knowledge systems continue to be important for local populations. For many people around the world, LEK continues to be the main source of information to take everyday decisions related to -for example- local productive systems, health or nutrition (Reyes-García, 2015). In this changing world, the maintenance of local knowledge system is essential for local populations to access to their resources rights (Posey & Dutfield, 1996). *"By maintaining their traditional knowledge and technologies, people give themselves more options, greater control over their lives, and greater leverage with which to negotiate the process of development and change more on their own term."* (Zent & Maffi, 2009: p.4). In that sense, LEK *"constitutes a powerful tool for self-determination and political empowerment"* (Zent & Maffi, 2009: p.4) which requires that local knowledge systems conserve their dynamic nature, where *"local knowledge serve as a bridge for absorbing new knowledge elements, such as useful techniques and technologies stemming from global science."* (Zent & Maffi, 2009: p.4).

2.5. Review on studies on the dynamic nature of LEK

“...the normal state of local knowledge is change, [...] but change is not everywhere uniform or unidirectional”.

(Zent, 2013: p. 215)

Only in the last two decades, researchers have started to analyze the dynamic nature of local ecological knowledge systems (see Zent (2013) for more details), with a main focus on the potential impacts that current social and ecological changes might have in local knowledge systems. This body of research has been dominated by the study of the phenomenon known as knowledge erosion, or knowledge loss (Gómez-Baggethun & Reyes-García, 2013).

Authors have identified several drivers for the loss of LEK, including: a) language shift, or the process of replacing local language with a national language, generally concomitant with schooling (Maffi, 2005; McCarter & Gavin, 2011; Reyes-García, 2013); b) the expansion of market economy, affecting local people's livelihood strategies (Godoy et al., 2005; Reyes-García et al., 2005); and c) the accessibility to Western medicine and medical technology leading, to the disinterest of people towards their own medicine (Case et al., 2005; Phillips & Gentry, 1993; Plotkin, 1988; Vandebroek et al., 2004), d) the loss of access to resources through conservation programs and other management regulations (Gomez-Baggethun et al., 2010; Ruiz-Mallén & Corbera, 2013); e) development aid work and mechanization (G. D. Stone, 2007); and f) climate change (Eakin, 2000; Morton, 2007). Wolf and Medin (2001) further highlight two overarching elements with an important role in LEK erosion: the

lack of contact with nature and the lack of cultural support, the last related to "*the degree to which a society promotes a particular set of knowledge*" (Wolff & Medin, 2001: p.3).

Finally, even if LEK erosion has been reported worldwide among several societies (Reyes-García, 2015), there is "*considerable variation and inconsistency across different biocultural settings*" (Zent, 2013: p. 224), and "*drivers to the current erosion of TEK are complex and multifaceted*" (Reyes-García, 2015: p. 286). In other words, authors continue to debate the extent and rate of loss of local knowledge systems. Indeed, despite numerous works reporting loss of local knowledge systems (Gomez-Baggethun et al., 2010; Ohmagari & Berkes, 1997; Reyes-García et al., 2013), some authors have reported that social changes do not always and necessarily affect LEK (Gómez-Baggethun & Reyes-García, 2013; Zarger & Stepp, 2004), and some others have even shown that, in specific contexts, such changes might help increase LEK (Byg & Balslev, 2004; Guest, 2002).

Recent work highlights theoretical and methodological limitations in studies on the loss of local knowledge systems (Gómez-Baggethun & Reyes-García, 2013; Zent, 2013). At the theoretical level, studies on LEK erosion typically consider a single domain of knowledge, most of them ethnobotanical knowledge (Ellen, 2011). Disaggregating such a large domain of knowledge into some of its constituents might hide the variations between different bodies of knowledge, both regarding the tendency and the rate of knowledge change (Ellen, 2011; Reyes-García, Luz, et al., 2013). At the methodological level, it is not accurate to compare studies using different methodologies and focusing on different domains of knowledge to reach general conclusions on any phenomenon. However, to date, there is a lack of methodological universality which might hinder reaching general conclusions on the worldwide loss of

local knowledge systems (Reyes-García, Martí, McDade, Tanner, & Vadez, 2007; Zent, 2013).

Furthermore, it has been argued that narrowing the research only to the process of LEK erosion and its drivers generally occults the dynamic nature of knowledge. Indeed, to assess change in LEK it is necessary to consider its dynamic nature, in other words the "*mechanisms that allow societies to generate, regenerate, transmit, and apply knowledge*" (Gómez-Baggethun & Reyes-García, 2013: p.643). However, to date, there is no study focusing on the impact of such changes on the pathways through which knowledge is transmitted, transferred, and acquired.

Addressing the dynamics of LEK implies that, rather than focusing the attention in the erosion process, other processes should also be considered. In other words, it might be worth considering the maintenance or continuity of knowledge, defined here as the slow accumulation of information with a large temporal extension, where knowledge go through time with a continuity, despite some changes. In that sense, going beyond the loss/maintenance duality, it is worth considering also other processes, such as the diffusion, the hybridization, the migration and the innovation in local knowledge dynamic (Zent, 2013). Diffusion might be understood as the transfer of cultural elements, knowledge, practices, or beliefs, from a cultural and environmental context to a different one. Diffusion of information has been largely observed throughout human history, as several researchers have reported the diffusion of food preparation technologies among different societies (Dole, 1969), or the spread of plants' and animals' names (Brücher, 1990; D. Stone, 1984; Yen, 1991). The concept of hybridization refers to the integration of knowledge coming from both the global and the local level, and has generally been used in the case of concepts driven by scientific community to local societies. In this context, hybrid knowledge would "*display a*

complex blend of concepts and practices of diverse origins that may be differentially distributed within a society according to social or economic statuses as well as personal experience.” (Zent 2013: p. 235). In a study about the local knowledge of Iberian gardeners, Reyes-García and colleagues (2014) showed how hybrid knowledge, i.e. the coexistence of traditional and modern agricultural knowledge, might be the witness of social-ecological resilience among the Iberian gardeners. Then, another important process to consider in the study of the dynamic nature of knowledge is migration, or the movement of a population from one environment to another. When arriving to a new environment, people might have to adapt, evaluating what knowledge to maintain, modify or abandon in their new context. To focus on the changes occurring to the corpus of LEK hold by migrant populations might give us keys for understanding of how such populations are integrating themselves in their new environment, but also of the dynamic nature of LEK (see for instance the work of Ceuterick et al. (2011); Medeiros et al. (2012); Pieroni & Vandebroek (2007); Pirker et al. (2012)). Finally, LEK dynamic also involves processes of innovation (Mesoudi, 2005; Zent, 2013). Innovation refers to the *“creation of new knowledge or the novel application of old knowledge that leads to new ways of doing things”* (Spielman et al., 2008, in Zent, 2013: p. 240). Innovation is generally under-considered because the independency from outsiders influences into an individual or a society is hard to establish and because most scientists considered that *“people were culturally programmed to follow traditional customs without deviating from ‘the way it has always been done’”* (Zent 2013: p. 238). However, despite this limitation in attribution, researchers have already highlighted the existence of processes of innovations among local knowledge, specifically among agricultural knowledge and practices, as well as knowledge related to commercial or subsistence activities (Zent, 2013).

Therefore, studying the dynamic nature of LEK implies taking into consideration a myriad of notions and phenomena, although, up to date, such study has been shadowed by the main preoccupation of studying knowledge erosion. In this thesis, I have tried to highlight the dynamic nature of local knowledge systems, never static, always with indeterminate and changing knowledge among space and time.

3. LEK among small-scale societies

3.1. Defining hunter-gatherer societies

Most studies focusing on local ecological knowledge have been realized among small-scale societies, especially among hunter-gatherers. In this work, I use the term “small-scale society” to refer to societies which share some common characteristics, either social or ecological, which "*maintain political autonomy at the level of one or few local communities and, hence, number a few hundred to a few thousand inhabitants*" (Smith & Wishnie, 2000: p.493), and which show a high dependence with their environment, as subsistence is largely based on the use of natural resources. Consequently, the term small-scale societies can be used to refer to ethnic groups such hunter-gatherer, but also societies of pastoralists and farmers. Although the term and the definition of hunter-gatherers are debated in the literature (Arcand, 1988; Panter-Brick et al., 2001; Reyes-García & Pyhälä, n.d.), in this work, I use it to differentiate groups whose livelihood mostly rely on activities that do not transform the natural environment surrounding them from other groups whose livelihood does transform the surrounding environment, such as farmers and pastoralists.

It is worth noticing that a consequence of the fact that hunter-gatherer societies do not modify their surrounding environment is that they have then to adapt their social organization to the environment. Such characteristics results then in a considerable adaptability to face spatiotemporal variability of resources, typically manifested in a high mobility in an extended territory to follow the natural resources' availability (both animal and vegetal), which in turns results in a reduced possession of material goods to facilitate mobility.

The first attempts to define the term hunter-gatherers date from the anthropology congress "*Man the Hunter*" in 1968, since when other attempts to define the term followed. In general, hunter-gatherer groups have been defined through three main aspects related to their mode of subsistence, their social organization, and their cosmology. A common characteristic attributed to hunter-gatherer groups was that their subsistence was dependant on hunting, fishing, and gathering, without cultivation nor domestication, except dogs. Living in bands, i.e. small groups of people, the social and political organization of hunter-gatherers has been generally based on sharing, cooperation, and egalitarian regime (Richard B Lee, 1980). In this line, sharing, and particularly food sharing, is not limited to the household sphere, but rather it involves other members of the community; cooperation relates not only in relation to activities oriented to the acquisition of food, but also to other activities such as child care, the construction and maintenance of living spaces, and the provision of public goods on a daily basis (Hill et al., 2011). Hunter-gatherer groups generally respect an egalitarian regime, with a respect for the autonomy of all the individuals, and without designating any chief. In that sense, and reinforced by the absence of the concept of private property, resources are communally accessed generally in an equal way by all the members of the community based on cultural regulations and norms (Richard B Lee, 1980; Winterhalder, 2001). Finally, contemporary hunter-gatherer are also known to conceive the world as multilayered, seeing nature as animated with moral and mystical forces, and that the land is their spiritual home or "giving environment" (Richard B Lee & Daly, 1999).

However, beyond these common characteristics shared between hunter-gatherer groups, researchers have also highlighted the large diversity found in contemporary hunter-gatherer societies (see for instance Johnson (2014)), arguing that as important as

finding an encompassing definition of the term is to explain variations in the hunter-gatherer livelihoods (Stiles, 2001). Recently, considering this high diversity of hunter-gatherer groups, T. Widlock proposed during the CHaGS11 (Conference on Hunting and Gathering Societies) international congress, to add the use of "hunter-gatherers *situation*" to refer to characteristics, conditions and situations of hunting and gathering, which are present in several different small-scale societies. In that sense, rather than trying to find a common definition for so diverse societies, this term might be applied as a characteristic present in several groups.

3.2. Intracultural variation of LEK among small-scale societies

Considering the reduced number of studies conducted among small-scale societies, and the large variation they show, it might not be appropriate to generalize on the variations of LEK present among such societies. However, a commonality among the different studies is that LEK is not equally spread within a society and that its distribution varies according to several individual characteristics, such as sex (Pfeiffer & Butz, 2005), social status (Reyes-García & Gallois, 2014), and age (Demps et al., 2012; Gurven, Kaplan, & Gutierrez, 2006; Soengas López, 2010).

Although gendered-orientated approaches to the study of LEK have been long under-considered, it is now acknowledged that the sex of the individual is on the first factors affecting the distribution of LEK within a society (Pfeiffer & Butz, 2005). Differences in LEK between men and women exist for several reasons. First, men and women are typically not involved in the same activities. Their different involvement in subsistence activities, the different techniques used while engaging in the same activities, and their differentiated access to natural resources shape the distribution of LEK. In that sense, the sexual division of labor and their different access to the

environment results in differentiated knowledge. However, as highlighted by Pfeiffer and Butz (2005), LEK variation might not be assessed only by the sexual division of labor (Pfeiffer & Butz, 2005). In that sense, these authors advocate for a "*multifactorial analysis of cultural variation*", including other variables that affect the gendered division of LEK, such as different social networks of women and men; gender-specific modes of knowledge transmission; the gender-cultural roles and spiritual taboos; but also the variation in the access of men and women regarding formal and external knowledge (Pfeiffer & Butz, 2005).

Social status also plays an important role in the distribution of LEK within a society. Social status relates to the special position of an individual in the society recognized by the member of the society. The attribution of a higher social status varies according to the cultures, as well as the individual's characteristics which affect social status (Reyes-García, Molina, et al., 2009; Vonrueden, Gurven, & Kaplan, 2008). A research realized among the Tsimane' showed that prestigious people, defined as people considered 'important', had more traditional knowledge (Reyes-García, Molina, et al., 2009). As the definition of social status depends on both researchers approach and cultural norms, another aspect of social status relates on the possession of certain kind of LEK. It is for instance the case of knowledge hold by specialists, such as traditional healers, who precisely derive their status from holding this specialized knowledge (Reyes-García & Gallois, 2014).

Another variable that has also been largely studied in relation to the intracultural variation of LEK is age. Thus, whereas there is a common assumption that the stock of LEK hold by an individual changes across her lifespan, there is still a debate on how that knowledge evolves and changes. For example, some authors have highlighted that LEK increases with age over the lifespan of an individual, so elders would always be

more knowledgeable (Ladio & Lozada, 2004; Reyes-García et al., 2005; Wester & Yongvanit, 1995). However, some other studies have reported that the acquisition of some knowledge shows a different pattern, with larger stocks of knowledge being accumulated at younger age, constituting what has been named as “embodied capital” (Kaplan, Lancaster, & Robson, 2003). According to such studies, the actual proficiency of skills was not positively correlated with age, and the accumulation of LEK would peak during people’s mid 30s (Dempis et al., 2012; Gurven et al., 2006; Kaplan et al., 2003; Zent, 1999). In sum, the idea behind these studies is that childhood is a critical period for the acquisition of LEK.

4. Small-scale and hunter-gatherer childhood

4.1. Key notions on childhood

Human beings are the species with longest juvenile period, i.e. the period between weaning and first reproduction -from 14 years of age- (Blurton Jones & Marlowe, 2002). This also corresponds to an extensive cognitive development that lasts almost 18-20 years, whereas the longer period known among other mammals is around eight years for chimpanzees (Kaplan et al., 2003). This extensive period, characterized by a high dependency towards adults, is mainly explained by to the long period of brain development, as humans have the biggest brain of all primates. As formulated by Kaplan and colleagues under the embodied capital theory, human large brain has coevolved with a long lifespan through the use of nutrient-dense resources (Kaplan et al., 2003). In that sense, it has been suggested that the exploitation of such resources has been allowed by complex techniques of extraction which requires a long period of learning. This delayed maturation among humans, devoted to the acquisition of

knowledge necessary for being a proficient adult, can also be explained, as formulated by Gurven and colleagues (2006), by a) the intragroup level social competition, which implies the necessity for individuals "*to develop social competency*" (Gurven et al., 2006: p.454); b) the risk-aversion theory, or the idea that this long period of juvenility "*serves to reduce the risk of dying due to fluctuations in food supply*" (Gurven et al., 2006: p.454); and c) the trade-offs between growth and reproduction, that stipulates that delaying the age of reproduction avoids risk of dying.

Although extended childhood is a universal human characteristic, the perception of childhood drastically varies cross-culturally. Indeed, despite the biologist explanations, taking a more cultural point of view some authors have argued that the notion of childhood can be considered as much culturally as biologically built (Lancy, 2008: p.7). For instance, through his work on the painting in Western European societies, Ariès showed that the childhood was not represented differently from adulthood in paintings before the 15th century (Ariès, 1962). From this, the author suggested that the idea of childhood was not considered as a special moment before the 15th century and that the idea of childhood as a distinct period of life only emerged and was created in modern epoch. A similar view on the cultural variation of the understanding of childhood is presented by Shweder, who stated that "*Childhood can be said to be fabricated, invented or constructed in the sense that ideas and practices associated with positive child development are not the same around the world or even within a single society*" (Shweder, 2009, in Waldren & Kaminski, 2012: p.1). In that sense, the way children live and develop also depend on parental goals and ideas on childhood (Harkness & Super, 1992, 1994; LeVine, Miller, & West, 1988; LeVine, 1977), as whatever perception adults have of children, children are a "*key notion in [...] people's own culture*" (Bird-David, 2005: p.93). For example, according to Chin, in our

society “*Implicitly or explicitly, children are generally portrayed (when portrayed at all) in ways that are based on contemporary, Western notions: They are nonproductive, social beings in progress, in need of care and attention but not able to provide things to others*” (Chin, 2001: p.131).

Given the large share of the population that children represent worldwide -in 2014, children’s population was almost 31% of the global human population, with almost 2.2 billion individuals under 18 years old (UNICEF)- and the importance of childhood in human development, it is surprising that children have long been ignored or under-considered in anthropological research (Delalande, 2009). Furthermore, within anthropological studies, children have often been considered as adults-to-be, rather than as humans of interest on their own, thus downplaying the idea that children have the capacity to own and create their specific cultural environment (Delalande, 2009). From a diachronic point of view, a child today can be considered as the cognitive parent of tomorrow’s children, and in that sense, the future social actors (Lenclud, 2003). It follows that the study of today’s children, their interest and development, might provide insights on societies’ future trends and developments. However, from a synchronic point of view, children are not only in the process to become adults, a kind of adult-in-training, but they are also of interest on their own, as “*their cultural production or expressions are as valid and interesting as those of adults*” (Johanson, 2010: p.389). Children are human beings who act and interact with others, and who think, interpret, and act on the world around them. In that sense, children can be the focus of social research, and it is worth to assess their own culture, semi-autonomous and partially detached from adulthood (Hewlett & Lamb, 2005; Hirschfeld, 2003; Kamei, 2005; Lenclud, 2003).

Anthropologists' interest on childhood can be traced back to the 1870's, with the work of British researchers E. Tylor (1871) and J. Lubbock (1870) who studied children with an evolutionist approach, considering them at the lowest stage of human evolution, and C. S. Wake (1878) who studied childhood development stages. However, it is only in the 1930's that the anthropological interest in childhood grew, with the pioneered child-focused research of Margaret Mead, who opened the field, inspiring subsequent studies in anthropology, education sciences, and psychology (Montgomery, 2008). Since then, the focus on children has evolved, and nowadays children are considered in anthropological research as key elements for understanding culture. For instance, in recent work among Tsimane' children, Aiello showed how children self-reported interviews on health were much more accurate than mothers' reports, thus highlighting the importance of recognizing children as valid research participants (Aiello, 2013).

One of the main topics in research focusing on childhood has been child development, including psychological, biological, social and physical development. As research on child development is abundant, here I limit myself to briefly review the main findings of such body on drivers of child development related to the learning process. In that sense, I have chosen not to discuss the psychological, physical and biological aspects of child development, as the main focus of this work is on social aspects related to the acquisition of LEK.

Several scholars from a variety of disciplines have focused on child behaviour and development, trying to assess both its universal and specific traits. In such line, the works of Beatrice and John Whiting had highly contributed to our understanding of the topic (Whiting, 1980). Whiting and their colleagues adopted a cross-cultural approach to child development and child rearing among several societies. Their study was conducted within the project "Six Cultures" in which they developed a similar

methodological approach to collect information among six different societies to assess children's roles, characteristics, and behaviors . Important insights on child development and on the understanding of childhood have emerged from their work. Importantly, John and Beatrice Whiting (1975) brought to anthropological studies of childhood the concept of cultural learning environment, or the idea that culture, and primarily maintenance systems, is essential to understand the patterns of children behavior and the physical setting where behavior occurs, both essential to understand knowledge acquisition. How children spend their time during the day is largely dependent upon/constrained by the needs of parents to do particular subsistence tasks; so children learn from those culturally established settings (Whiting, 1980).

This main contribution opened the door for posterior numerous theories (Pope Edwards & Bloch 2010; Weisner 2015). For example, following the concept of cultural learning environment, researchers have highlighted that what children do is shaped by different factors including cultural, social, and environmental factors. Researchers have also argued that child development might be assessed through the physical, social and emotional settings in which children live (Harkness & Super, 1992, 1996; LeVine et al., 1988; Whiting & Whiting, 1975; Whiting, 1980). For instance, Harkness & Super elaborated the concept of "*developmental niche*", highlighting the relation between the individual and his environment and analysing three main factors shaping children's behaviour and development: a) the social and physical context wherein children live; b) the cultural practices and rules that guide children's education; and c) the parental psychology towards education and child development, also referred as parental ethnotheories(Super & Harkness, 1986).

Following this last line of inquiry, in recent work comparing information from two societies living in the same environment but whose cultures are totally different: the

Aka hunter-gatherer and the Ngandu farmers from Central African Republic, Boyette has shown the importance of cultural norms in shaping the way children develop and how they spend their time (Boyette, 2013). Similarly, Hollos reported that among the Pare from Tanzania, children's use of time varies according to the type of household they live in, showing that "*children in small, so-called 'partnership' families work little, play a lot, rest a bit and study. (...) Children in larger, so-called 'lineage-based' families work a lot, play little and rest and study even less*" (Hollos, 2002: p. 187).

4.2. Specificities of hunter-gatherer childhood

Given that the notion of childhood varies among cultures and that the attachment-forming processes of human infants evolved in a hunting and gathering context, as proposed by Bowlby (1958, 1969), anthropologists have paid some attention to the study of hunter-gatherers' childhood (Hewlett, 2005). Pioneer work in this line dates back to the 60's, with the child-focused works of M. Konner (1972; 1976; 1973); P. Draper (1972; 1973; 1976); N. Blurton Jones (1972; 1973; 1974), highlighting how childhood among hunter-gatherers is different from childhood in Western societies, but also from childhood in geographically closed farmer societies.

Considerable insights on hunter-gatherer childhood have been brought by the work of Barry Hewlett, who mainly works with the Aka in Central African Republic. For example, using data from the Aka, Hewlett has investigated the role of father in child development, showing in his PhD work (1991) that Aka children's attachment to their fathers was not due to vigorous interaction with their children, as stipulated by Lamb's hypothesis (1981), but because they intimately knew their infants through their extensive care (Barry S. Hewlett, 1991). In that sense, Hewlett highlights the important place of fathers in Aka society, mainly through their important role in childcare. In his

recent book, B. Hewlett summarizes similarities in hunter-gatherer childhoods, with a special attention on African hunter-gatherers (Hewlett, 2014a). He does so using the notion of 'foundational schema' proposed by Shore (1998) which describes the common features among different groups as "*ways of thinking and feeling that pervade and cut across many domains of socio-emotional life*"(Hewlett, 2014a: p. 247). Shared by African groups, but also many other hunter-gatherer societies, these common 'foundational schema' of hunter-gatherer are egalitarianism, autonomy and giving/sharing. To identify and analyze such concepts is essential to understand any cultural specific pattern as these concepts "*shape people's perspectives on their social relations, interactions, and values, as well as their perception of and interactions with the world around them*" (Berl & Hewlett, 2015: p.14).

Focusing on childhood, Barry Hewlett emphasizes several schema shared by different African hunter-gatherer childhoods. Five main features of habitus and demography contexts referring to childhood can be highlighted : a) physical and emotional intimacy, as for instance the considerable amount of time infants are held or the physical proximity between children and adolescent, as during co-sleeping; b) autonomy, i.e. the freedom children witness from adult control during their daily activities; c) presence of mixed-age groups, both adult-child groups and mixed-age child groups; d) predominance of play, an activity that decreases as children grow up; and e) early acquisition of knowledge, enhanced by their peculiar way of learning the environment (Barry S. Hewlett, 2014a).

Several studies on African hunter-gatherer childhoods have focused on the difference between children hunter-gatherer groups and their farmer neighbors. For example, several studies realized in the Congo Basin showed that although both groups share the same environment and show similar biological patterns, as the same fertility

and mortality rates, as well as similar level of exposure to infectious diseases and parasites, their foundational patterns drastically differ (Barry S. Hewlett, 2014a). In contrast with hunter-gatherers, the socio-emotional life of farmers is regulated by a gender and age hierarchy, a high value of communalism, i.e. the individual has to serve the interest of the clan; and finally a perception that interpersonal relations have material and economic components (Barry S. Hewlett, 2014a).

Describing these common patterns shared between hunter-gatherer childhoods according to the age category, Hewlett underlined that during infancy and early childhood, hunter-gatherers shared the giving and responsiveness, i.e. the reactivity and the indulgence of parents towards their children; and a considerable proportion of allomaternal care. From their earliest age, children are involved in domestic and productive tasks. Among middle childhood, Hewlett reported the absence of gender-bias for caregiving. Finally, hunter-gatherer adolescents share the common male and female initiation. These patterns of hunter-gatherer childhoods vary between and within groups, with a kind of specificity among African groups for a more extended allomaternal care. (Barry S. Hewlett, 2014a).

Despite the important advances from those studies, an important gap in our understanding of hunter-gatherers childhood relates to the middle childhood and adolescence periods. Thus, most previous studies analyzed here have focused on infancy and early childhood (Hewlett, 2005), but there are less studies which have focused on middle childhood and even less among adolescence of hunter-gatherer societies (see for exception the works of Bonnie Hewlett on Ethiopian and Aka adolescents (Hewlett & Hewlett, 2012). However, several authors already reported the importance of both periods of the lifespan, as for instance highlighted by Konner suggesting that "*middle childhood is a phase of calm and active acquisition of many*

domains of culture, from subsistence and rules of emotional expression to ritual and faith" (Konner, 2010: p.638).

5. LEK acquisition among small-scale societies

5.1 Acquisition vs transmission

Looking at the processes of cultural transmission, and specifically to the transmission of LEK, I chose to refer to those processes using the term 'acquisition' rather than 'transmission', as the former term captures better the processes through which culture is evolving and the way people gain knowledge (see Tim Ingold, 2010; and the corpus of articles compiled in the Special Issue of the *Journal of the Royal Anthropological Institute*, 2010). Indeed, contrarily to the term 'transmission' which emphasizes the role of the teacher who transmits the knowledge, the term 'acquisition' emphasizes the role played by the learner and therefore the learner active participation in this processes of cultural evolution. As stated by Ingold & Lucas (2007), "*novices are not passive recipients whose mental capacities are waiting to be 'filled up' with content peculiar to their tradition, but are rather active participants in a process in which knowledge is forever being created and discovered anew*" (Ingold & Lucas, 2007: p. 288). Moreover, the use of the term 'acquisition' acknowledges and highlights the role played by other entities different to human beings from which an individual might learn and acquire LEK (Tuck-Po, 2002; Zarger, 2010).

5.2 LEK acquisition during childhood

With the exception of some pioneering work (see for example Stross (1969) or Katz (1989)), most studies focusing on children's ecological knowledge have appeared during the past fifteen years, and have been the focus of researchers working on ethnoecology, on life history of human evolution and social learning theories

(MacDonald, 2007). Therefore, research on LEK acquisition is still scarce (Zarger, 2010; Zent, 2009).

Such research is based on the idea that the pre-reproductive period, i.e. infancy, childhood and adolescence, is the period during which most knowledge is acquired, and that knowledge increases with age of the individuals over the course of her lifespan. In that sense, many empirical studies have reported that large amounts of ecological knowledge are acquired before adolescence (Bliege Bird & Bird, 2002; Blurton Jones & Marlowe, 2002; Bock, 2002; Folke et al., 2002). This is, for example, the case of the ethnobotanical knowledge among the Mexican Tzeltal children (Zarger & Stepp, 2004) and the knowledge related to honey-collection of the Jeru Kuruba in India (Dempsey et al., 2012). Some studies even reported that the acquisition of most knowledge an individual would require for subsistence might have occurred as early as at 10 years-of age (Hunn, 2002). Although most studies on ecological knowledge acquisition have focused on productive and foraging skills. In that sense, it is worth noticing the recent contribution of Schniter and colleagues who focused on the age of acquisition of 77 different skills among the Tsimane' from Bolivia, related not only to food production, but also to childcare and reproduction, household chores and craft production. Results of this study show that most of the productive and non-productive skills were acquired by late adolescence, prior to the initiation of reproduction (Schniter et al., 2015). Most authors also agree that this initial accumulation is then followed by the progressive acquisition of much more complex knowledge and skills during adolescence and maturity (Dempsey et al., 2012; Gurven et al., 2006; Hewlett & Cavalli-Sforza, 1986; Reyes-Garcia et al., n.d.). Indeed, as underlined by Bock (2002), the learning of certain knowledge and skills depends on the growth and the strength of the individual, so some skills and

knowledge can just not be learned before a certain age, proposes that skills and knowledge learning is a process involving a punctuated development of key skills.

A considerable amount of the researches on LEK acquisition among small-scale societies has focused on hunting-related knowledge (see MacDonald (2007) for a review). Such research has highlighted that "*some important activities do require periods of skill acquisition in order to reach proficiency*" (Walker et al., 2002: p. 641), as it is the case for hunting skills and other complex techniques such as honey collection. In that sense, it is also the case among the Tsimane' for the skills "*perceived as difficult to learn and perform*" (Schniter et al., 2015: p. 13), such as honey collecting and household crafts, which were acquired at least a decade after a person entered adulthood.

It is worth noticing that the scant research among children have neglected at least two important factors. First, such research has rarely addressed the intracultural variation according to the sex of the child, (see Soengas López (2010) for an exception). Second, such research has only recently started to pay attention to the fact that, depending on the domain of LEK, such corps of knowledge would be transmitted through different pathways and following different social and individual learning strategies (Demps et al., 2012; Schniter et al., 2015).

From such researchers, it might be worth noting that LEK acquisition might be assessed as a process of social learning which depends on a) individual learning processes, such as observation and imitation b) the context of the daily life of the child, and c) the social-ecological environment of the child.

5.3 Individual processes of LEK acquisition

Studies on social learning among hunter-gatherers have highlighted the prevalence of observation and imitation during childhood (Barry S. Hewlett et al., 2011). Observation might be defined as the act of focusing the attention, by one of the senses (listening, watching, feeling, or smelling), on something or someone, either outside or inside the individual's body. Children, during their daily activities, observe the social and ecological environment around them and learn from it (Gaskins & Paradise, 2010; Zarger, 2010). This prevalence of observation as an important pathway for knowledge acquisition is possible because children from hunter-gatherer societies are not isolated from the adult's daily activities (Niskac, 2013), but rather they typically participate in adults' lives on a daily basis. For instance, in his study among the Aka, Boyette reported that observation was a really common activity among children between 4 and 18 years-old. He also reported that the amount of time children were observing and imitating decreased with age, where imitation refers to the "*focus by the observer on the reproduction of form of modeled actions rather than the results or goal of those actions*" (Berl & Hewlett, 2015: p.2). Children would thus repeat their model and integrate new practices. Scholars already reported the importance of other processes for the process of knowledge acquisition, such as overimitation and emulation, concepts I would not develop here (for more detail see the work of Berl & Hewlett (2015)). Finally, once a skill has been observed and already imitated, the acquisition of knowledge would also require the performance of such knowledge (Boyette, 2013). In this sense, when considering that learning occurs in a long-term, performance or the repetition of a previously observed and imitated behavior or task, might be seen as one of the basis of the acquisition of knowledge through embodiment.

5.4. LEK acquisition in the context of daily life

"It is not of no little importance what sort of habits we form from an early age - it makes a vast difference, or rather all the difference in the world"

(Aristotle 1976 :p. 32) in Ochs & Izquierdo, 2009).

For children to be able to observe, imitate, and perform, they need to be involved in a social and ecological environment where they would find different models from whom to learn (Rogoff et al., 2007; Zarger, 2010). Several researchers reported that such knowledge acquisition is tied to daily life through both play and work (Lancy, 1996; Zarger, 2010; Zent, 2009). Several researchers have suggested that children's activities and the way children spend their time may provide important insights into the nature of LEK acquisition. Intimately linked with the eco-cultural settings in which children grow (Gallimore, Goldenberg, & Weisner, 1993; Whiting & Whiting, 1975) children's knowledge acquisition is shaped by their activities, the location of those activities, and the people accompanying them during such activities.

Because the acquisition of knowledge reflects the complexity of interactions of various factors which occur "*both within and without the individual, and of the spatial and temporal arrangements in which these interact*" (Marchand, 2010: p.S5), and wherein both the mind and the body are involved (Downey, 2010), the analysis of the context of the process of knowledge acquisition is of great importance. Thus, the analysis of children's involvement in different activities can help us understand the importance of context in the acquisition of LEK through embodiment and through the actual –passive or active- engagement of the learner in the activity (Bliege Bird & Bird, 2002; Demps et al., 2012; Gurven & Kaplan, 2006; Haselmair et al., 2014). Because

there are trade-offs in the acquisition of different types of knowledge, either related to the environment or not (Boyette, 2010; Morelli et al., 2003), the amount of time spent in each particular activity might be useful for understanding LEK acquisition. Moreover, the way in which children invest their time might be critical to understanding preferences for the acquisition of different types of knowledge (Morelli et al., 2003; Sternberg et al., 2001), and therefore potentially predict changes in the transmission of such knowledge systems.

5.5. Social context of LEK acquisition

To understand children's knowledge acquisition, in addition to studying children's daily activity, it is essential to study the social context in which activities occur, as people surrounding children can have a direct impact on what and how children learn. To date, most of the studies focusing on LEK acquisition have devoted their analyses through the pathways of cultural transmission.

Researchers looking at the pathways of cultural transmission among small-scale societies debate the importance of different pathways for the transmission of knowledge to children. Previous studies on social learning among hunter-gatherers groups reported the prevalence of vertical transmission, especially during early childhood, before 5 years-old (see Hewlett, 2014). For example, Hewlett and Cavalli-Sforza showed that in 80% of the cases, the Aka reported that they learned subsistence knowledge, sharing and cultural norms from their parents, with a predominance of the same-sex parent. More recently, reviewing 40 hunter-gatherer groups from the Standard Cross-Cultural Sample, Hewlett showed that parents were quoted as first transmitters by 70% of the boys and 80% of the girls interviewed (Barry S. Hewlett et al., 2011). In the same line, parents were also highly reported as the main source of knowledge in other cultural

groups, such as the Ituri (Aunger, 2000), the Cree (Ohmagari & Berkes, 1997) and the Baka (Hattori, n.d.). Ohmagari showed that 72% of their informants were taught by their parents. However, some other empirical researches showed that although parents were quoted as main teachers, there was not a correlation between parents and children LEK, which suggest the importance of other modes of transmission (Reyes-García, Broesch, et al., 2009). In fact, several authors argue that findings indicating the prevalence of vertical transmission might result from the existence of normative biases, such as highlighted by the work of Aunger(2000), reporting that "*adolescents continue to rate parents as significant influences, even after association patterns become peer-dominated*" (Aunger 2000: p. 18), or in Boyette's study in which children tended to cite their parents as first sources of cultural knowledge, because "*naming parents as teachers may be a typical response because parents were their first teachers or the most salient of many*" (Boyette, 2013: p. 38).

The debate on the importance of the vertical transmission process has led to a debate, both within cultural anthropology (see for instance Lancy (2012)) and cognitive sciences (see for instance Strauss, 2005), on the presence of teaching among hunter-gatherer societies (see B. S. Hewlett (2013)). Following the definition provided by Caro and Hauser (1992), here I highlight three aspects that help define teaching. First, for teaching to occur, a knowledgeable person has to modify her behavior for entering in the process of transmitting knowledge. Second, in so doing, this knowledgeable person does not get immediate benefit of its behavior. Finally, the learner would not have acquired such knowledge without the presence of the knowledgeable person. In that sense, teaching might be considered as key element for cultural acquisition among hunter-gatherers: researchers defending the existence of teaching in hunter-gatherer societies have argued that teaching is often diminishes because it is difficult to spot, as

in this societies teaching is often low cost, i.e. subtle and quick, opportunistic and, strategic (Barry S. Hewlett, 2013).

Whereas the role of vertical transmission during early childhood can arguably be important, although varying depending on the social and cultural context, once children get older, they also rely on other modes of cultural transmission for the acquisition of knowledge. Indeed, Some scholars have argued that non-parental models are as important as parental models for cultural transmission (Moya, Boyd, & Henrich, n.d.). In that sense, Boyette also reported that some knowledge related to sharing norms, essential in cultural settings of hunter-gatherers, while first learned by same-sex parents, *"adults other than a child's parents play a role throughout development—perhaps more so after early childhood"* (Boyette, 2013: p. 116). Hewlett reported that among the 40 different hunter-gatherer groups, uncles, aunts and peers were reported as transmitters in 20-30% of the cases. Research on hunter-gatherers also reported that oblique and horizontal transmission might occur more frequently during middle childhood and adolescence, specially between and 12 years-old (Barry S. Hewlett et al., 2011). In that sense, Henrich and colleagues (Henrich & Broesch, 2011) two-stage learning model suggests that the process of learning follows two main stages. At an early stage of development, novice learners would acquire knowledge from their closest environment, i.e. from their own family. Later on, more experienced learners would be able to enhance their knowledge and skill by other more specialized models out of their family (Henrich, Boyd, & Richerson, 2008). Going beyond, Reyes-García and colleagues suggested that the pathways of cultural acquisition would also vary according to the age and the domain of knowledge, proposing a process of multiple-stage learning pattern (Reyes-García et al., 2016). Despite those works, studies in small-scale societies are still too few to assess the complexity of processes of cultural transmission, especially those

occurring during middle childhood and adolescence (Barry S. Hewlett, 2014a). However, some scholars reported that "*During adolescence and young adulthood, when remaining life time seems unlimited, information acquisition goals are relatively more prevalent compared with other life periods. People focus on gathering knowledge and information from diverse relationships and sources, which is achieved best in large networks with diverse relationship partners.*"(Wrzus et al., 2012: p. 56).

Adolescents show a considerable set of knowledge we could consider as 'basic' knowledge, such as recognizing, naming and conceptualize their environment. It is during this stage that much more complex tasks and skills would begin to be acquired. This includes understanding and knowledge on supernatural beliefs, a type of knowledge that is not likely acquired during childhood, as children's brain is still on process of development (Lewis 2008, p299, in Hewlett & Hewlett (2013)). Moreover, as they approach the age to establish a new household, adolescents perform higher productivity tasks, as reported in other hunter-gatherer (see Hewlett & Hewlett, 2013). However, the acquisition of knowledge might last much more time, depending on the domain, the kind of knowledge, and might be acquired only late during adulthood (Gurven et al., 2006; Reyes-García et al., 2016).

Given the diversity of pathways involved in knowledge transmission and the multi-stage learning strategies potentially used, analyzing only cultural transmission pathways might hide the global social structure involved in knowledge transmission. In that sense, researchers have recently started to use tools such as social network analysis to assess the processes through which different aspects of culture (i.e., information, practices, tools) are transmitted within a given social structure (Phelps, Heidl, & Wadhwa, 2012). For example, pioneering work on how social structures shape the flow

of non-written knowledge has highlighted that aspects such as the size of the group, or the position of the individual in the social structure are critical to understand cultural transmission processes (Calvet-Mir et al., 2012; Hamilton et al., 2007; Hopkins, 2011).

Finally, another important aspect to consider when looking at knowledge acquisition during childhood relates to the expectations children and adults hold towards the domain of knowledge an individual should acquire, and the activities they are expected to perform (Gaskins, 2000). In this line, parental expectations might play an important role in the way children behave during the day, as well as parental psychology towards education and child development in the domain of LEK more likely to be acquired (Harkness & Super, 1996). In that sense, to understand LEK acquisition, in addition to studying children's activities, and their social network during those activities, one should also assess children and adult's perception and expectations towards the domains of knowledge likely to be acquired and, in general, to their own culture.

Chapter III

Case study

In this chapter, I first present a general bibliographical overview of research conducted among the Baka and the main insights of such bibliography in relation to Baka social organization and the current changes they are facing. Then, I devote the second part of the chapter to present current Baka livelihood and a brief description of their Local Ecological Knowledge, based on the data collected during this PhD fieldwork.

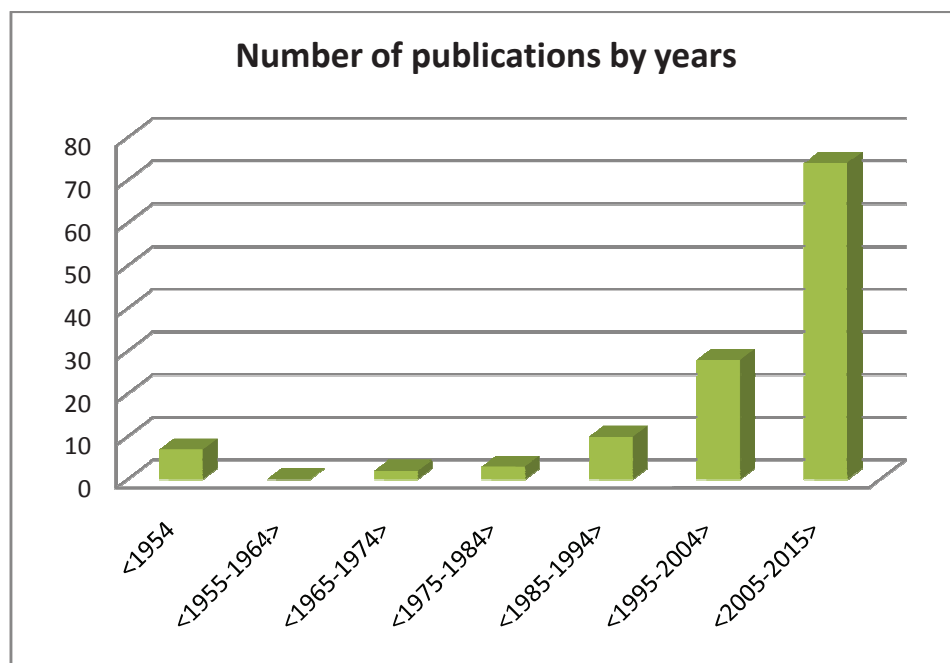
1. Baka literature: a general overview

The first reported contact with the Baka dates back only to 1888, when the French explorer P. Crampel (Crampel, 1890) provides information about them. Not much later, other reports of contact with the Baka appeared, in this case coming from the French expedition delimiting the border between French Gabon and German Kamerun led by Captain Cottés in 1905-1908 (Cottés, 1911) and soon after from the German explorer Koch in Moloundou in Southeastern Cameroon (Koch, 1913). Reports and literature on the Baka continued to be scarce and of unequal quality until the 1980's. Until then, most information about the Baka came from missionaries (Bertaut, 1943; Dhellemes & Macaigne, 1985; Ternay, 1948; Verhille, 1949) whose works, despite providing interesting information, cannot be characterised for their ethnographic accuracy; and from observations of the French anthropologist Vallois (Vallois & Marquer, 1954, 1976; Vallois, 1935, 1948, 1970). The Baka became the object of

ethnographers' interest in the 1970's, and since then considerable and precise work has been done in relation to Baka's society, religion (Dodd, 1980; Higgins, n.d.), music (including the publication of audio discs (Arom & Renaud, 1977; Sallée, n.d.), and language and oral tradition (Brisson & Boursier, 1979; Brisson, 1984a). Such work lead, among others, to the publication of the French-Baka and Baka-French dictionaries (Brisson, 1984b, 2010).

After the 90s, the number of publications about the Baka has largely increased. Such publications include reports for governmental and nongovernmental organizations, master and PhD thesis (most of them difficult to access), and scientific publications in national and international journals, books, and other medias. Figure III-1 presents this evolution in a graphical way.

Figure III - 1 Publications referring to the Baka through time.



From the 129 publications about the Baka referenced since the beginning of the last century that I have compiled during this research (restrained here to books and scientific literature), most belong to research conducted by French and Japanese

researchers. Thus, the leading authors of the research considered here include 26 French, 20 Japanese, 14 Cameroonian researchers, 3 North American, 1 South American, and 8 other European (UK, Germany, Netherlands, and Belgium). Such authors have covered a high diversity of locations in the countries where the Baka are found. In Southeastern Cameroon we find the works of Dounias, C. Leclerc and S. Fürniss (mostly in Messea); J. Lewis (in Ngola); F. Ramirez-Rossi and A. Froment (in Le Bosquet and Lomié), R. Brisson (in Djoum); S. Hattori, M. Ichikawa, and Yasuoka (in the Boumba Ngoko department: Malea Ancien, Gripe; Zoulabot Ancien). In the south border of Cameroon we find the works of T. Oishi, K. Kitanishi, D. Kimura, H. Sato, K. Hayashi, V. D. Joiris (in Ndongo, and Moloundou), M. Robillard (in the Yokadouma area), P. Paulin and D. Weig (in North Gabon), and A. Köhler (in the North of the Republic of Congo). We could only locate one publication on the Baka from Central African Republic (Pedersen et al., 1991). In that sense, as highlighted by Weig (2015), most studies realized among the Baka from such different regions give us the potential diversity of situations Baka are living but not a comparative or synthetic view of Baka people.

Given the extent of recent literature on the Baka, in this section I only provide an outline of the historical review of the main references. Then, I focus the rest of the chapter in the presentation of topics directly related to my study.

1.1. Thematic evolution on Baka literature

Authors from different disciplines and interested in a variety of topics have conducted research among the Baka. A large body of the literature has been devoted to understand and analyze Baka's way of life, their modes of production, and their relation with the environment, especially looking at their hunting and gathering techniques and

at their use of medicinal plants. An important amount of work has also focused on their language, their music and their rituals as well as other socio-cultural characteristics.

As mentioned, the first studies conducted among the Baka focused on their language and oral tradition. Following the considerable work of R. Brisson and D. Boursier, who elaborated the Baka dictionary, R. Letouzey studied the vernacular names of plants (Letouzey, 1964, 1976; Letouzey, 1966), and C. Killian-Hatz (1989) the Baka tales. This line of research was continued by the work of Serge Bahuchet, who conducted an extensive comparative study on ethnoecological terminologies between Aka and Baka societies. With such work, S. Bahuchet could trace back Baka and Aka history and highlighted the common ancestor of both populations - called the *Baakaa* (see Bahuchet (1992, 2006)) - who despite common ancestry do not speak inter-understandable languages anymore (Bahuchet 1989, 1992, 1993, Cavalli-Sforza 1986).

During the last decades of the 20th century, research among the Baka was more focused on their way of life and subsistence (Bahuchet, 1992; Sato, 1992, 1998), with extensive work on the ritual systems of hunting realized by V. D. Joiris during her PhD research (Joiris, 1998). In parallel, following the first work made by Arom and Renaud (1977) on Baka music, subsequent research has aimed to describe and understand the specificities of Baka music and rituals systems (Bundo, 2001; Fitzgerald, 2011; Fürniss, 2005, 2012; Joiris, Fürniss, & Joiris, 2011; Olivier & Fürniss, 1999; Tsuru, 1998, 2001).

At the same time, ethnoecological approach emerged in the study of Baka's subsistence systems, as the work conducted by Letouzey, who studied Baka uses of plants, or the ethnoecological approach of Baka societies done by the study of S. Bahuchet. In the same line we find the work of E. Dounias on ethnobotany and uses of natural resources, specifically on the paracultivation of wild yams (Dounias, 1993,

1995, 1996). Other works in this line are the study of Sato, focusing on Baka spatial repartition and ethnomedicine (Sato, 1998). Overall, the interest in hunter-gatherer societies subsistence strategies has mobilized a large amount of scientists, who have often adopted a human ecology approach, especially the Japanese researchers (Hayashi, 2000; Kitanishi, 2003; Sato, 2001; Yasuoka, 2004). Indeed, although scientific interest on Baka people started to expand out of the French borders in the last part of the 20th century, Japanese research has largely contributed to expand this literature after the turn of the century.

During the last two decades, and concomitant with the increasing pressure faced by forest societies worldwide, researchers working among the Baka have also addressed the topic of social changes and local adaptation. Such issues, although already highlighted by Althabe in 1965 (Althabe, 1965), have been more extensively addressed during the last 15 years (Kitanishi, 2006; Köhler, 2005; Rupp, 2003). An example of this line of research is the extensive work of Leclerc. Both in his original PhD work (2001) and in the reviewed version published in 2012, C. Leclerc accurately describes, using a longitudinal approach, the different patterns of Baka way of life, subsistence and mobility, with a special focus on the social changes associated to the process of sedentarization and the adoption of agriculture. He also highlights the importance of the social aspects of Baka spatial organization for their use of natural resources (Leclerc, 1999). The last decade has also seen a growing interest on scientific questions related to the sustainability of cultural practices and conservation issues (Ichikawa, 2006; Lewis & Nelson, 2006; Lewis, 2007; Yasuoka & Monographs, 2006). This, for example, has been the topic of the PhD work of M. Robillard (Robillard, 2010), who reported the considerable complexities of the implementation of conservation policies into local realities of Southeastern Cameroon.

In parallel, a number of publications written by Cameroonians have also appeared, mostly published by official governmental institutions or NGOs (such as Centre pour l'Environnement et le Développement - CED, Stichting Nederlandse Vrijwilligers -SNV). It is only during the last decade that Cameroonians scholars began to publish, with for instance the work on ethnobotany and ethnopharmacology of J. L. Betti (Betti, 2004; Betti & Lejoly, 2009; Betti et al., 2013).

About half of the publications on the Baka documented through my work have appeared since 2010 (Figure III 1), in most cases authored by French and Japanese researchers. This recent literature focuses on the adaptation and the diversity of Baka way of life, both in relation to forest uses, and agriculture, but also about their adaptation to change (Hattori, 2014; Oishi & Hayashi, 2014; Sato, 2014; Weig, 2015). There is, however, some diversity in recent research, such as D. Weig PhD research questioning the concept of mobility among Baka people and Fitzgerald's PhD work (2011) questioning and describing the multiples roles of Baka songs, especially songs performed during the tales (*bè na likanɔ*).

At the moment of writing this thesis, there are three ongoing research projects being conducted among the Baka. A French research team is working on the determinants of biological characteristics of the Baka (Froment and Ramirez Rossi); Japanese researchers are involved in two different projects, one organized by the Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA) titled "*Sustainable Project in the Forest-Savanna of Cameroon*" and the other titled "*A Study of Human Learning Behavior Based on Fieldwork among Hunter-Gatherers*" looking at learning strategies and brain development of among Baka societies as part of their project of Scientific Research on Innovative Areas entitled "*Replacement of Neanderthals by Modern Humans*".

In sum, the Baka have been the focus of numerous researches, mostly over the last three decades. Researchers have approached the Baka from different perspectives: language, ethnoecology, ethnobotany, ethnomusicology, anthropology, and psychology. As highlighted by the doctoral research of Paulin in Gabon, all these studies reported the regional and international diversity within the same cultural group (Paulin, 2010). Indeed, although Baka people are all living in the tropical forest of the Congo Basin, their livelihoods might vary across places, depending on the country and its governmental policies, but also within the same country, depending on the localization of their settlement. Meanwhile some Baka are settled in villages along paved roads, such as the Yaoundé-Bertoua axis, where there is a high circulation of people and therefore the levels of market access are high. Other Baka are settled along dirt roads, and are less exposed to such circulation, as most of the traveller are logging trucks and traders. In such villages, the population might reach several hundreds of people. Baka livelihoods in both cases are still in sharp contrast with the ones who are mostly settled in small forest camps (between 25-50 people), where their access to market is low . In that sense, it is important to highlight that there is still heterogeneity within Baka livelihoods, which has direct effect on their social organization and their daily life.

In sum, given the large geographical range where the Baka live, and that researchers have studied in different fields sites, we still lack a global overview of the whole ethnic group. Moreover, to date no research has focused on Baka's ethnoecology in a longitudinal and exhaustive way. Thus, except the listing of vernacular names and scientific correspondences available in diverse publications (such as Brisson (2011), Hattori (2005, 2006), Hayashi (2008), Letouzey (1964) and the work of Dounias (Dounias, 1993, 1996, 2001) describing specific techniques for wild yams uses, there is not any general ethnoecological publication on the Baka.

Moreover, this review of Baka literature also made evident that, with few exceptions, Baka children have been largely ignored. The few works focusing on Baka children include the cognitive approach made by Avis and Harris (1991) on child development; the work of Kamei on play and his description of schooling; and the work made by Hirasawa on infant care (Hirasawa, 2005; Kamei, 2001, 2005). Two Japanese researchers have also worked on Baka childhood (mostly PhD researches of K. Sonoda and I. Hagino), but their results are not accessible yet.

In that sense, although the work presented here does not aim to be a monographic synthesis, neither a detailed study on children, it is the first to compile an ethnoecological analysis of knowledge and practices and the first to focus on knowledge acquisition in a transversal way among the different corpus of ethnoecological knowledge. In this line, in the following section of this chapter I provide a description of the ecological, cultural and social characteristics of the Baka, as well as their main cultural knowledge and practices related to the environment.

1.2. Brief review

The Baka, also known as Babinga, Bayaka, Bibayaka, Bebayaga, Bibaya and Bangombe, live in the rainforest of the Congo Basin, on a territory estimated at 100,000km², administratively divided among four different countries (Leclerc, 2000). Some Baka live in the southwest of the Central African Republic (in the prefecture of Sangha Mbaere), others in the north of Gabon (province of Woleu-Ntem), and still others in the northeast of Republic of Congo (regions of Sangha and Likouala). Most Baka, however, live in Cameroon (in the East Province). Estimations of the total Baka population are very imprecise and range from 30,000 to 70,000 individuals, depending on the source and the time of the survey. Using information from the more exhaustive census conducted in Cameroon at the beginning of the 80's, I. Dhellemmes estimated that Baka people might have been more than 26,000 individuals spread in 410 villages (Leclerc, 2012). However, because this number mainly considered the Baka settled along the logging roads, researchers generally consider the actual population of the Baka in Cameroon to be larger, between 25,000 and 30,000 individuals (Ichikawa, 2006).

The Baka were known for being a highly mobile population, largely dependent on wild resources. Until the middle of the last century, they lived in small groups, formed by 30-40 people (Bahuchet, 1992), in temporary forest camps made of *mongulu*, their traditional huts made with the leaves of a Maranthaceae species. Their subsistence was based on a foraging strategy relying on the combination of hunting, gathering, fishing, “paracultivation” of wild yams (Dounias, 2001), and the acquisition of cultivated products by barter (Bahuchet, McKey, & Garine, 1991; Bailey et al., 1989; Yasuoka, 2010, 2013).

1.2.1. Social organization and inter-ethnic relations

Several scholars have studied Baka social organization, highlighting that: 1) the family nuclei is embedded in band organization (Joiris, 1998; Leclerc, 1999), 2) interethnic relations with farmer neighbors are embedded in Baka culture (Joiris, 1998; Rupp, 2003), 3) division of labor is sex-oriented (Joiris, 1998; Leclerc, 1999), and 4) levels of egalitarianism and sharing are high, following an acephalous organization (Joiris, 1998).

Social organization

As for other hunter-gatherer groups worldwide (Hamilton et al., 2007), the familiar unit is at the center of Baka social organization. The entanglement between kinship and social organization is best exemplified by the fact that the terminology used for biological familial relations is also used for other people in the group or clan. For example, Baka would call –and consider- *nyùà* "father" all the brothers of their biological father and *nyíè* "mother" all the sisters of their wives. Mother's sister is called Father's sister is called *kàa*- "aunt", but mother's sister are also called "mothers". The husband of the mother's sisters is then considered as the "mother's husband" (Leclerc, 2012). The lineage is thus principally shaped by patrilineal norm (Paulin, 2010).

Although the family unit might be considered as the basic social unit, the social organization of Baka livelihoods relates to a group, generally composed by households from the same extended family, and directly linked with the people belonging to the same clan (Joiris, 1998; Leclerc, 1999). In that sense, beyond the familial nuclei, every individual belongs to a clan, following a patrilineal system of inheritance. All the descendants would acquire their father's clan. In previous work in the area, more than

thirty different clans have been reported (Leclerc, 2012). Own and other family member's clan pertinence shapes the relation one would have with members of others clans, specifically in relation to marriage, sharing and hospitality. Baka are not allowed to marry a member of his father's or mother's clan. Moreover, other norms apply according to the individual's clan. A person would be considered as mother if he belongs to the same clan as the ego's mother, and as brother/sister if it is the same as ego. In that sense, considered as "family", the ego would be able to behave as if he was in family's house, asking for bed and food sharing. Finally, if the person's clan is the same than ego's husband/wife clan, and thus than ego's family in law clan, this person would be considered as parents or children in law, and then, the social expectations and norms, particularly regarding sharing, would follow the same norms as if it were real. In general, children in law would be expected -once adults- to procure parents in law with food. In that sense, such social norms shaped at the clan level allow children to get a network of people extended out of their own biological family.

Inter-ethnic relations

The Oubanguian-speakers Baka have deeply embedded relations with Bantu-speaking ethnic groups, including other groups of hunter-gatherers and groups of farmers.

Baka sedentary neighbors are many, with several ethnolinguistic groups within. For example, in the region East of Cameroon, the Bantu-speakers villagers belong to almost twenty main different groups (Leclerc, 2012). The relation between Baka people and their neighbors has been studied and extensively reported by researchers, journalists, Indigenous Rights institutions and other NGOs. Such studies have used the notion of "clientage", "ownership", or even "slavery" to refer to the relation between

the Baka and their Bantu-speaking people neighbors (see Joiris (2003), Robillard & Bahuchet (2013)) for more details on the terminology and its limitation). This aspect of the social relation of Baka with other groups has received so much attention because, for many authors it questions the notion of human rights.

However, some other authors have argued that depicting the relation between Baka and Bantu's speaking people merely as one of subordination somehow hides the complexity of the relations that those peoples establish between themselves (Joiris, 2003). Considering the ambivalence of this relationship, it is important to remind that *“even though Pygmies [Baka] are described as being feared denigrated, abused and exploited, relationships between the two communities continue in spite of important changes that could have led to their separation”* (Joiris, 2003: p.68). According to Joiris, the relations between both groups also involve a social dimension that has been defined through three main types of alliances i) pseudo-kinship, ii) “friendship”, and iii) solidarity bonds (or those acquired through initiation) (Joiris 2003). Links between families in both groups also involve a dimension of sacred “blood alliance” through which the members of both families are linked from one generation to the next. In sum, inter-ethnic relations and the interdependence of both groups might be explained through ideological, economic and ecological interpretations.

Finally, it is worth noticing that today, the prevalent interest that the Baka generate in NGOs and local institutions has created a certain imbalance in Baka relations with other groups (Robillard, 2010). Now, many Bantu-speaking villagers complain about the exclusive interest of development workers and scientists on the Baka, as –in their opinion- they live in the same environment and face similar challenges.

1.2.2. Childhood and learning

To our knowledge, research on Baka childhood and cultural learning is scant. Avis and Harris (1991) were the first authors to lead a child-focused study among the Baka, with a psychological approach to the conception of belief-desire reasoning among middle childhood (Avis & Harris, 1991). More recently, Hirasawa conducted a research on Baka early childhood (Hirasawa, 2005), showing the importance of infant allomaternal care, by looking at the time the infant are hold by the different members of the family.

Most of what we know about knowledge acquisition during childhood has been done by Fűrnis, Joiris, Kamei and Hattori (Fűrnis, 2005; Hattori, 2006; Joiris, 1998; Kamei, 2005) and more recently by Sonoda (Sonoda, 2014). Those authors reported the importance of vertical transmission for medicinal plants uses (Hattori, n.d.), the importance of play (Kamei, 2005), the autonomy of children during cultural learning (Sonoda, 2014), and the role tales and songs play in the construction of gender identity (Fűrnis, 2005). Indeed, Hattori reported that girls were learning medicinal plants uses from their mothers in 80% of the cases and from their fathers in an additional 15%. In his recent work on social learning among Baka children through face to face interaction, Sonoda highlighted the self-motivation of the learner and the autonomy and independence it is given to him (Sonoda, 2014). Such research illustrates how Baka children acquire knowledge during daily activities performed in mixed-age group of children. Fűrnis detailed the way songs and dances become pathways of cultural transmission for girls, as through song and dances they learn women's responsibilities, both regarding sexuality and motherhood. According to this author, games—such as *solo a yande*, and songs, such as *bè na solo*, which are generally performed at night

by 7 to 14 years-old girls, are indeed training girls' bodies to sexual act, reproduction and maternity. Girls are learning through dances and songs what it is still hidden to them: sexuality, seduction, reproduction and maternity. They sing them through explicit verbs and stimulate parts of their bodies not solicited during their daily life. Probably not totally conscious of the exact meaning of the lyrics and the gesticulations, girls are learning and training themselves through their principal aim and interest which is above all playing (Fürniss, 2005).

Except from some insights reported by these three authors, few else is known about Baka childhood and cultural learning.

1.2.3. Recent changes

Over the last 50 years, the Baka from Cameroon have faced several important social and ecological changes including 1) a push for sedentarization, 2) the arrival of new actors to the area, and 3) schooling.

First, the combination of national policies, such as the extensive sedentarization program instituted in Cameroon since the 1950s, the influence of missionaries promoting development programs, and the reduction of wild game, have led many Baka to reduce their mobility and gradually establish themselves in somehow permanent villages (Althabe, 1965b; Bahuchet, 1991; Bailey, Bahuchet, & Hewlett, 1992; Barry S. Hewlett, 2000; Leclerc, 2012). In the Haut-Nyong department, the village of "Le Bosquet", located in the district of Lomié, is one of the most relevant examples of missionaries' work in this region. First established as a health centre for the Baka, the population of this village might currently reach 2,000 individuals, and is locally dubbed "the Baka city". There are, however many other smaller villages, and as a result,

nowadays, most Baka settlements are found along logging roads, some of them in proximity to the Bantu-speaking villagers.

Second, during the same period, new outsiders arrived to the territory occupied by the Baka. Such actors include poachers, missionaries, but also logging and mining companies (Lewis & Nelson, 2006; Lewis & Nkuintchua, 2012). Logging activities began in the region during the 1970' and increased drastically during the 1990', largely driven by the establishment of the governmental National Zoning Plan, which conferred large area of the land used by local people to outsider companies (Lewis & Nkuintchua, 2012). Ichikawa reported that in 1994, from their field research station they could observe "*more than a hundred trucks a day hauled trees from Yokadouma and its vicinities*" (Ichikawa 2006). Today, the exploitation of timber products has not stopped and might be one of the main factors affecting biodiversity and forest resources in the area. In response, international organizations representing conservationists' interests have also show a growing interest in the area. Cameroon nowadays holds around 7 millions hectares of areas protected for wildlife conservation (Chupezzi & Betti, 2008). However, the management of such protected areas, and therefore biodiversity conservation, faces considerable social-cultural challenges and witnesses several limitations, such as the restrictions of access to natural resources by local people. The problematic around biodiversity conservation has been, and still is, the focus of several researchers (see for instance Ichikawa (2001), Robillard (2010), Yasuoka & Ichikawa (2006)). While interests vary from actor to actor, overall the arrival of new actors to the area has resulted, for the Baka, in a gradual reduction in access to forest resources in general and to game and wild edibles in particular.

The above mentioned factors have led many Baka to spend more time in settlements, where they have started to engage in agricultural work, both by opening

their own plots and by providing casual labor to neighboring Bantu-speaking villagers (Kitanishi, 2006; Leclerc, 2012). The creation of such villages, much bigger than forest camps, has also affected Baka health. In contrast to their a nomadic way of life, sedentarization among the Baka has facilitated the propagation rate of several diseases, such as parasitism, infectious diseases, malaria and yaws (akin of syphilis) (Dounias & Froment, 2006). Finally, sedentarization has also affected Baka social organization and well-being through, for instance the increasing of jealousies regarding game (see Leclerc (2010)).

A third important change relates to the increase of school attendance facilitated by sedentarization. Schooling of Baka children and their integration into the national education system was initially promoted by governmental policies, helped by NGOs mainly linked to the missionaries. The aim of these schools was to integrate Baka children within public schools mostly frequented by Bantu-speaking children (Bahuchet, 1991). In parallel, private schools, specifically orientated for Baka children have also been established. The institution called “Frères des Ecoles Chrétiennes” - FEC- developed a project titled "Projet Pygmées", providing a specific school "Centre d'Education de Base" - CEB –covering the first third grades and using an adapted method called ORA ("Observer, Réfléchir, Agir" - Observing, Thinking, Acting) (Kamei, 2001). This initiative has encouraged Baka schooling through a variety of instruments: the reduction of the expenses (which included providing school stationary to children, and school fees registration), the establishment of schools in Baka villages, and the performance of classes in Baka language and with a curriculum adapted to Baka livelihood (Kamei, 2001). However, and despite the efforts of this institution, it continues to be a challenge for Baka children to attend school in the same way that it is a challenge for the education system to be adapted to forest life (Kamei, 2001).

2. Ethnographic settings

2.1. Life in the village: Social and spatial organization

Before I move into assessing the local ecological knowledge acquisition processes among Baka children, I will give a brief overview of the main aspects of the knowledge, practices, and techniques Baka people refer to and use in their daily interaction with their environment.

2.1.1. Demographic settings

The two communities where we mainly worked are settled along the logging road, but they vary in their level of integration into the market society. Elonda is settled about 35 kilometers from the city of Lomié and 2 kilometers away from the Bantu-speaking village of Ngola. The village of Elonda was established almost 50 years ago by representatives of the clan *èmbòkò*, previously living in the northeast of this area (on the road above Zoulabot). They migrated to the area after they reached an agreement with Nzime people who requested them to settle close to them, so to provide wage labor for their fields. About 264 individuals, including 145 children (under 16 years-old) and from 14 different clans live in Elonda (see Figures III - 2, 3). Elonda is established along a logging road and has four main hamlets. Moreover, some close forest camps are present in a 2 kilometers-radius area, where most Baka from Elonda have opened their fields. During the last decade, some development projects have been working in Elonda. One project was oriented to the establishment of cacao fields for commercial purposes. Nowadays, however, most of these fields have been abandoned and the project has been discontinued. Another project, promoted by the local institution

"Les Frères des Ecoles Chrétiennes", settled in Lomié, established a private school. The closest health center is located in Zoulabot, around 8 kilometers from the village, where a nurse provides basic medicines. More specialized medical services are provided in Le Bosquet, at half-a-day walk through the forest. The administrative center is Lomié, which can be reached by motorbike in a 1-hour drive, an expensive trip for most Baka in Elonda.

Mombokola is a bigger village than Elonda, with the highest population estimated at 410 individuals (208 children) divided in 12 clans (see Figures III-2, 3). Mombokola is located at the intersection of two main axis, the Messok-Ngoyla road and the Messok-Yokadouma road. The houses are settled along these two main road-axes. Mombokola is situated directly in the prolongation of the Nzime village of Bizam, both being separated by a soccer field and the public school. However, in contrast with the village of Elonda, households are highly dispersed, and several households are considered part of the village even if they do not have a permanent house in the village, but mostly live in forest camps several walking hours away from the village. These forest camps are settled about 1-2 kilometers far from the center of the village. Mombokola is located at about 12 kilometers from Messok, where some administrative and health centers are found. Consequently, people from Mombokola are closer to health and administrative services than people from Elonda. They can also reach the village of "Le Bosquet" and its health services in two hours.

Figure III - 2 Population pyramids, by village, collected in 2014.

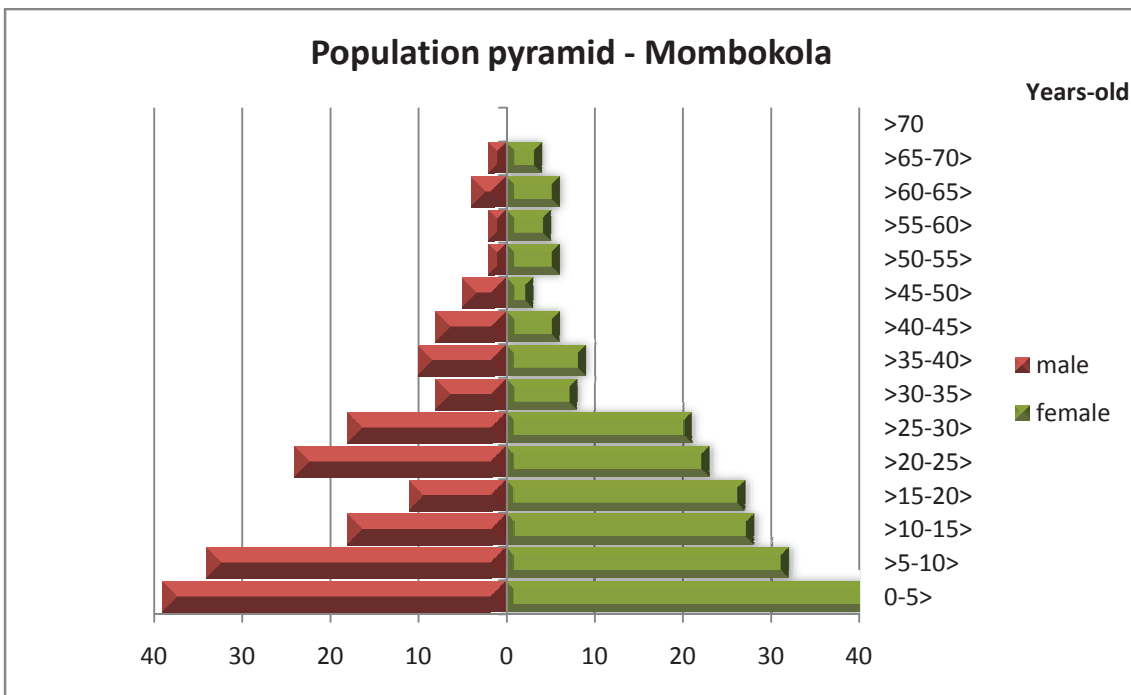
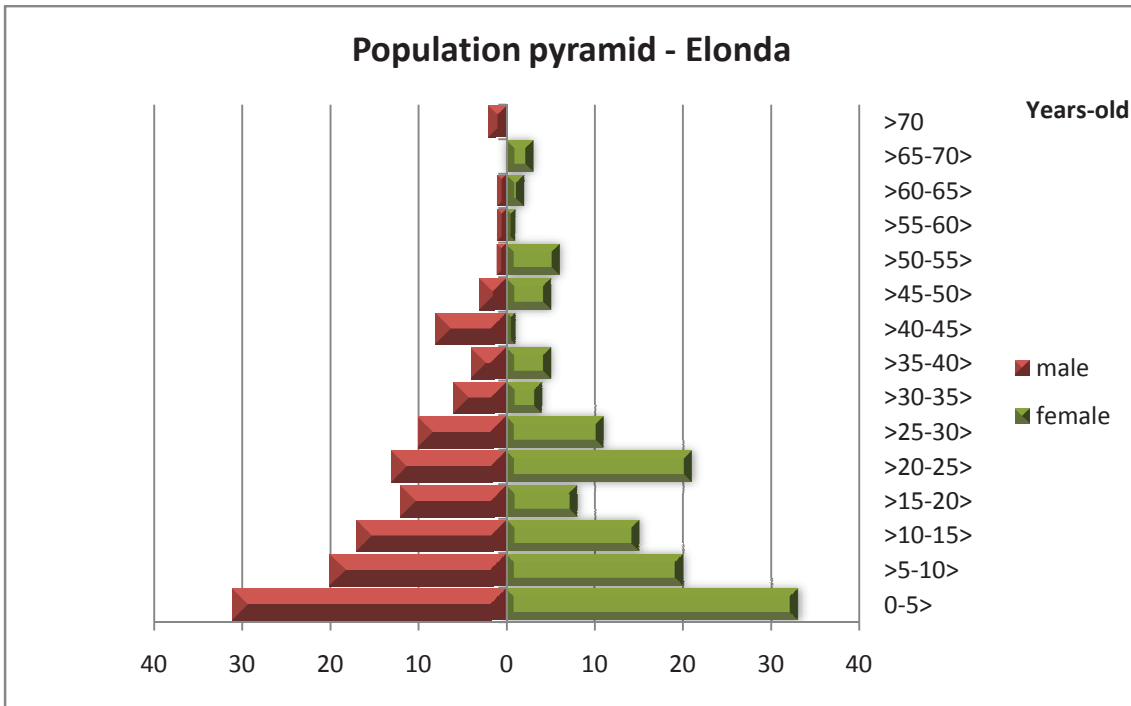
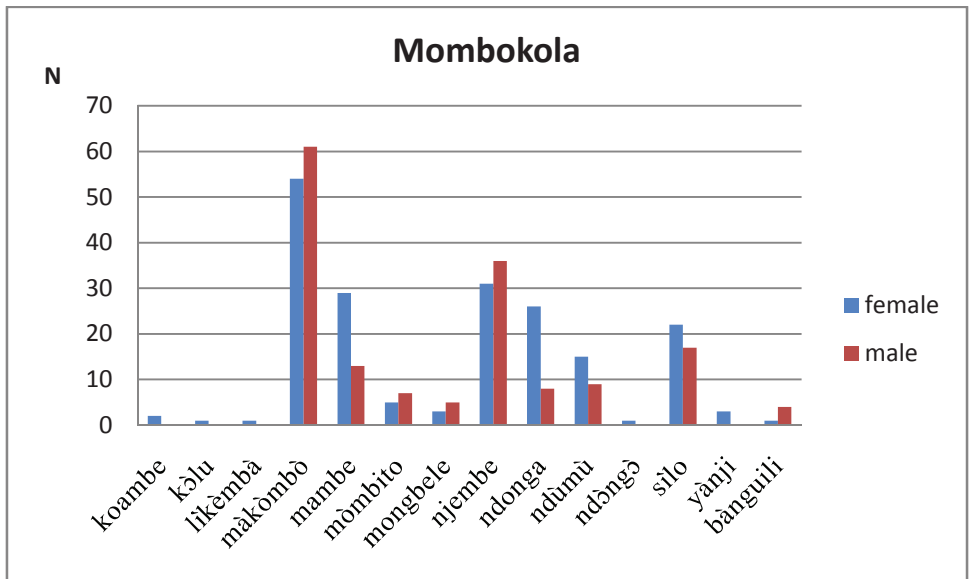
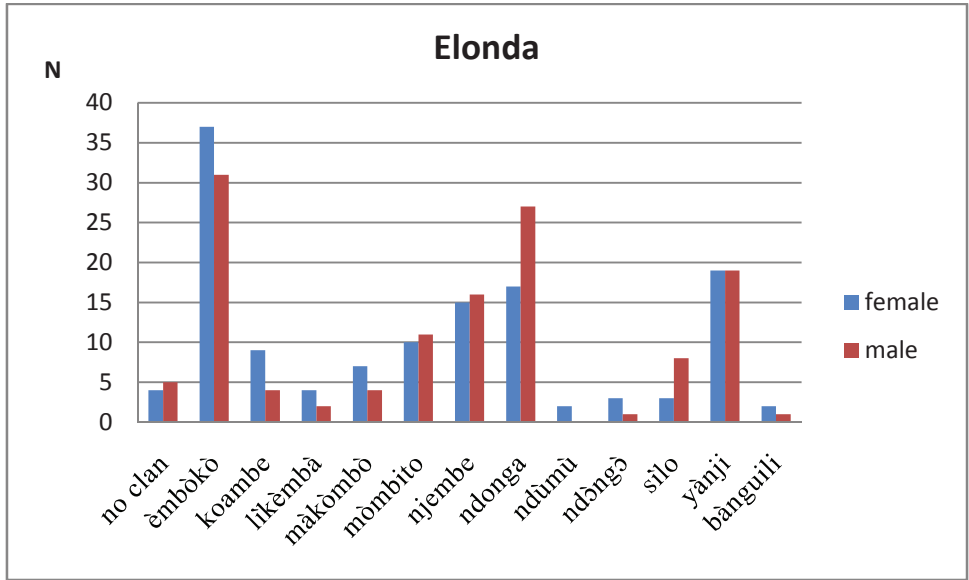


Figure III - 3 Number of individuals per clan, data from 2014 (no clan refers to children born from a mixed Nzime-Baka marriage).



2.1.2. Village organization

At a first look, Baka villages by the road look very similar to the villages of their agriculturalist neighbors, although they are generally smaller in size and with smaller houses. In contrast with settlements from other hunter-gatherers or from Baka camps in the forest, typically composed by 25-50 people, the villages selected for this study were considerably larger.

Most houses in the two studied communities had mud and wood walls and palm leaves roofs. However, some families continued to live in houses made with palm leaves only, and some also live in *móngulu*, the traditional hemispherical huts made from Marantheceae leaves. Both types of habitats are mostly used in permanent or temporary forest camps. Villages are generally organized in clusters of houses from the same family, who live in little hamlets. However, we observed that village's spatial organization changed quickly over the course of the year. Some houses are destroyed and others are built, depending on the harmony or argument between households. The arrival of people having traveled or the creation of new households also contributes to change the villages. In some cases, households –generally from the same large family– exchange their houses.

In general, material possessions are very limited among Baka households. In general, beds are made with weaved mat, and only some people own wooden bed matrices, made out of logging residues. Most common possessions are tools (machete, flatware and cable for snare), cooking and small household utensils (pots, plates, petrol lamp, torch). The wealthier people own radios, mattresses, and sometimes chicken.

2.2. Baka subsistence system

Although most Baka live in permanent villages, they are still highly mobile (Leclerc, 2012). Mobility is mostly organized around the agricultural calendar and the extraction of Non Timber Forest Products (NTFP), which varies considerably between seasons. Figure III-4 presents the periods of major investment in different Baka subsistence activities.

At the beginning of the dry season (*yaka*), in December, most Baka live in their forest camps, where they gather a common forest fruit: the *mbalaka* (*Pentaclethra macrophylla*). Later in the season, they move back to the village where they spend most of their time opening new agricultural plots. The Baka mostly rely on slash-and-burn agriculture, in which men cut the big trees, with the axe with a narrow blade (*kopa*), while women and adolescents cut brushes with machete. The main crops, plantain and cassava, are planted just after or just before burning the plot. *Yaka* is also the fishing season, for which several techniques are used: collective bailing fishing, hook fishing and fishing with ichthyotoxics. As the villages of Elonda and Mombokola do not have any big river in their surroundings, Baka people in the studied communities do not have access to big fishes. Although both, men and women, are involved in fishing, it is more commonly a woman's activity. Women reported having fishing almost 10% of their time during the dry season (Figure III-5a).

The first rains typically arrive in the month of March, starting the minor rainy season, locally known as *elanga*. This season is essential for agriculture. Due to their importance, the arrival of the first rains is largely ritualized: for instance, during our stay, Baka people accused Nzime people to provoke them, in order for their groundnuts seeds recently planted to have water. For the Baka, the beginning of this season is a

period of high investment in agricultural activities, both in their own fields and in Nzime's fields, especially for women, who reported having spent during this season almost 31% of their time in Nzime's fields and 23% of their time in their own plot (Figures III-5). Thus, at this time of the year, Nzime's people generally arrive early the morning to the Baka village to look for the Baka who would work in their fields. The beginning of the minor rainy season is also a period with high investment of Baka people in their own plots, and it was common to see Baka people going to their plot rather than accepting Nzime's job. Once the plots are planted, later in the season, the investment in agricultural work decreases, and it mostly consists on weeding the plots. The minor rainy season is also an important moment for hunting and for the gathering of forest fruits such as the well known wild mango: *payo* (*Irvingia excelsa*) and *pekè* (*Irvingia gabonensis*).

Mid-June is the beginning of the second part of *elanga*: the minor dry season, which lasts until the end of August. The most important agricultural activity of this season is the harvesting of groundnuts, mostly in Nzime's fields. As this is also a very intense agricultural period for Nzime, a main Baka occupation during this period is to work in Nzime's plots. Whereas agricultural work in their own plots was based principally on weeding in the last part of the previous season, this new dry season presents the opportunity to open new little plots. At this period, as during *Yaka*, the rivers are low, so fishing is easier, and the *mbalaka* are generally fructifying again. During this season, the caterpillars, another common wild edible especially appreciated by Baka children, are also available .

Sokodunga, the major rainy season, typically arrives in September. This season marks the beginning of the big long-term hunting expeditions, the fructification of many NTFP, honey and mushrooms collection. In that sense, it is the second main period of

high mobility among the Baka, who might spend several weeks in their forest camps. During this season, the agricultural work mostly consists on planting new crops, and weeding.

Despite the importance of seasonality, several wild edibles and animals are present and gathered all year around. It is the case of *gbè*, the Emin's pouched rat (*Cricetomys emini*), larvas, and the leaves of the common liana *kɔkɔ* (*Gnetum africanum*).

Figure III - 4 Seasonal Calendar.

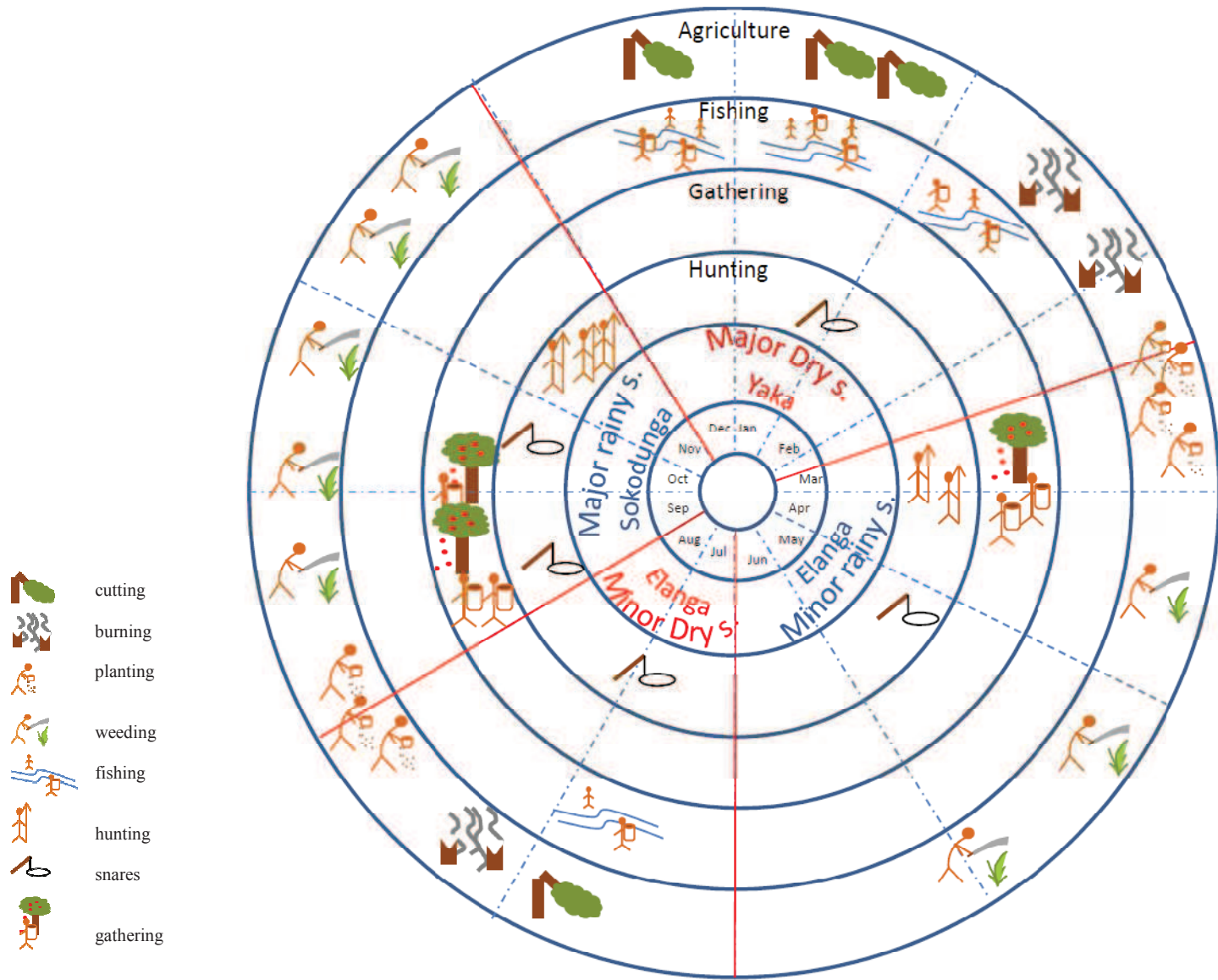
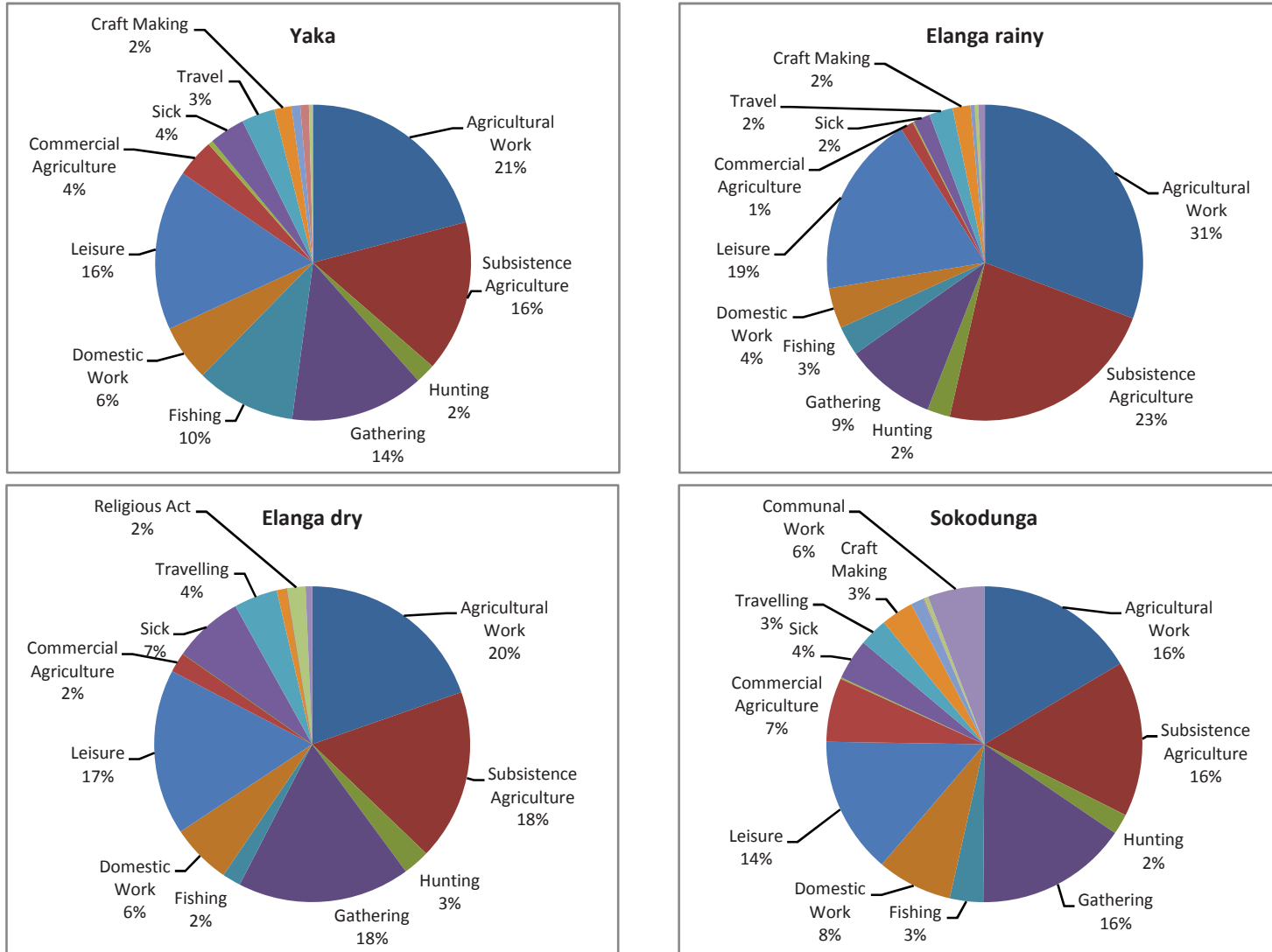
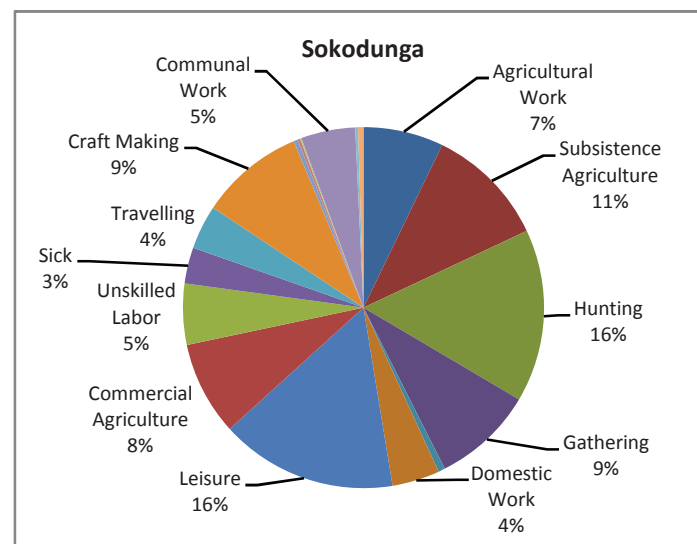
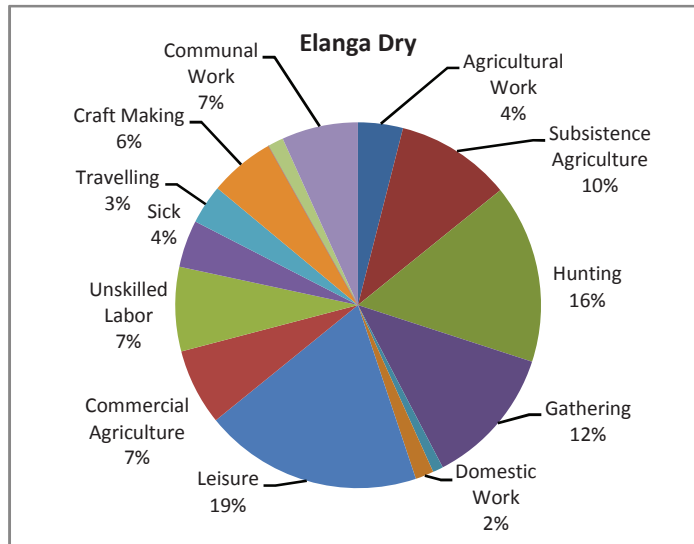
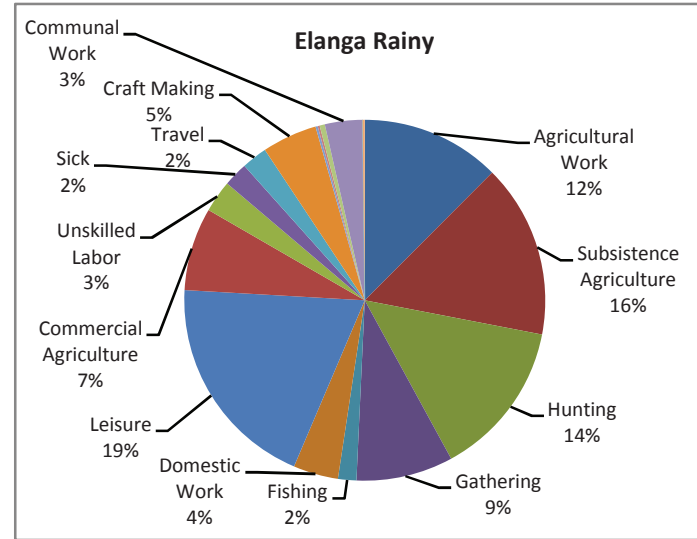
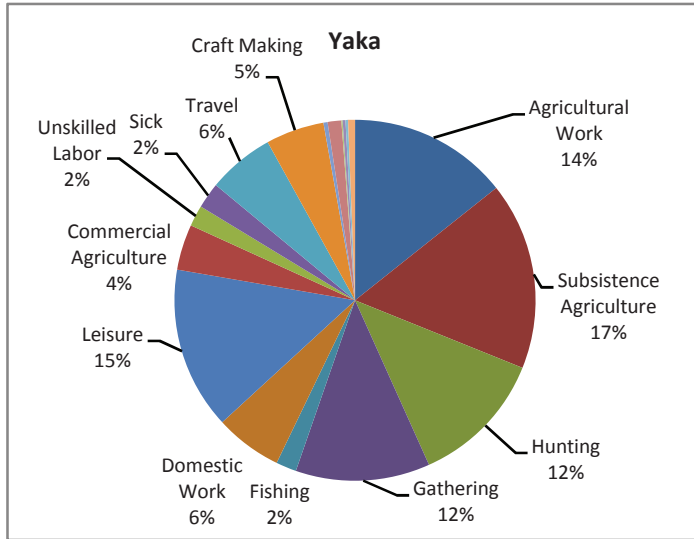


Figure III - 5 Adult's main daily activities, by sex and season.

a) Women



b) Men



2.3. Ecological Uses and Practices

Holders of a detailed and intimate knowledge of their environment, the Baka are acknowledged beyond their territory for their talent as forest's experts. The Baka have always been valuable guides for foreigners who wanted to access to the natural resources present in the forest (ivory, game, ebony) (Köhler, 2012). Baka knowledge system, which is essential for their subsistence, includes theoretical knowledge (species recognition, behavioral and ecological processes), as well as practical techniques and adapted gestures to the daily needs of subsistence. They demonstrate complex techniques adapted to specific situations, species, season, places and social rules.

In the following sections I will describe some of the Baka ecological uses and practices, using categories of activities to ease the presentation.

2.3.1. Hunting

Most Baka hunt using snare traps made with iron cables. Whereas most traps are located in the forest in pathways of game previously identified by the hunters, some traps are also built around the plots, a technique that has the dual purpose of hunting and avoiding that rodents and other animals damage the crops. Traps, therefore, can be found in areas relatively close to the village or to the forest camps, where Baka typically open their plots. Other common hunting techniques are the spear, or the machete, techniques that are used with or without the help of dogs. In general, Baka use spears and machete for opportunistic hunting, as such weapons are taken by the hunters mostly for protection from the potential dangers during their forest visits. Shotguns are used by a minority of individuals, and very few Baka in our sample owned fusil.

Hunting is mostly performed by men, who reported hunting in almost 15% of the self-reported interviews performed in both villages during 12 months. While women also hunt (reported almost 2% of their reports on main daily activities survey- see Figure III 5a), they do not typically hunt alone, but rather accompany their husbands to visit or set the traps, or go in group with other women. Women's most common hunting techniques are the machete; they also hunt unearthing rodents with smoke. Even if hunting, as most Baka daily activities, is gendered, this gender boundary is never impermeable. Some women also know how to hunt with spear and how to set a snare.

In our studied area, the game most commonly caught are the Emin's pouched rat *-gbè* (*Cricetomys emini*) and the Blue duiker *-dèngbè* (*Philantomba monticola*). Other species commonly hunted include the Brush-tailed porcupine *-mbòke* (*Atherurus africanus*) and different monkeys (Duda et al., *under review*).

2.3.2. Fishing

The Baka claim that fishing is "women's hunting." Bailing fishing is largely the most common fishing strategy in use. It is performed collectively, in little streams, by groups composed by several adult women, adolescent girls, and children. Differently from hunting, whose main aim is the acquisition of meat, valued for its nutritional and symbolic aspects (Joiris, 1998), the importance of bailing fishing seems to lie on its social role, rather than on its productivity. In this sense, this female-oriented activity creates a specific space, far from the household sphere, and especially from the men, allowing women to share between themselves and thus, in a way, to maintain the social cohesion within the village. When the group of women and children reaches the river, the first step of the bailing fishing begins. They build the first main dam which would retain the upstream water of the river. To do so, women and children put dead trunks

and branches on the river, and fill the holes with cubes of mud extracted from the riverbanks. The solidity and the impermeability of this dam would regulate the time the expedition would last. Once finished, women and children would organize in little groups of 2-6 people, and would go down the river elevate in a spot two new little dams with the same technique as above. Then, they begin to extract the water present between these two dams, using a bucket, a pot, or some Maranthaceae's leaves. Once the water is almost fully extracted, they gather fishes and shellfishes manually or with the machete. Once all the fishes gathered, the group would be going down the river and look for another spot. In general, this activities ends when the main dam is broken, and the upstream water flows again putting a stop to the fishing activities.

On their side, Baka men's involvement in fishing varies according to the specific ecological setting of the village. In the case of the men from both studied settlements, they reported fishing over the year not more than 2% of their time (see Figure III - 5b). When men fish, they mostly fish alone, and use hooks bought in local stores in the Nzime's village. Finally, Baka also fish using ichthyotoxics (made mostly with barks of *fòlòngo -Fagara heittzii*), what allow them to gathering the fishes downstream the river once they are asphyxiated by the poison. This activity is usually done in couple or in little groups.

Over the course of the year, Baka people reported having fished twenty different fish species. On these, the most common fishes and shellfishes caught were *ndéngé* (indeterminate), *mbòsè* (*Myomyrus macrodon*, or *macrops*), and *ntia* (Siluridae), *ngbààkà* (*Haplochilus sexfacuiatus*), *kálá* (crabs) and *káànji* (shrimps).

2.3.3. Gathering

All year around, Baka people gather wild plants (leaves, tubers, fruits and nuts), mushrooms, honey and insects for daily food. This activity is performed both by men and by women, with a higher engagement of women than of men (see Figure III - 5a). Moreover, there seems to be a pattern in which women gather food for daily consumption and men are more involved in gathering commercial products. This distinction might be seen in the seasonal use of time of men, who reported having invested more time in gathering during the major and the minor dry seasons (reported almost 12% of their time), when commercial NTFP were fructifying, than during the rainy seasons (reported 9% of their time).

Whereas the gathering for daily consumption is generally completed in some hours, or one day trip, the gathering of commercial products might involve several days to several weeks living into the forest. Indeed, several Baka have reported that the pressure for some commercial products is so high, that they have to go increasingly further into the forest to find them.

More than 100 wild edible items have been reported by the Baka, but we counted a total of 62 different species which have actually been gathered during the 12 months of systematic data collection in both villages. The product most commonly gathered are the leaves of *kɔkɔ* (*Gnetum africanum*), which is consumed very often. With cassava's leaves (*djàbùkà*), *kɔkɔ*'s leaves are the main accompaniment of the tubers of cassava), *langa* (*Colocasia esculenta*), or the fruits of plantain. Three species of wild yams were gathered very often: *sapà* (*Dioscorea praehensilis*), *ba* (*Dioscorea* sp.), and *keke* (*Dioscorea burkilliana*). *Payo* (*Irvingia excelsa*) , *pekè* (*Irvingia gabonensis*) , *mabɛ* (moabi - *Baillonella toxisperma*), *kanà* (*Panda oleosa*) and

mbalaka were also gathered in important quantities. Both *Irvingia spp*, locally called the "wild mangos" and the moabi's nuts are really appreciated for their oil. Another important fruit gathered for making oil is the fruit of the palm *mbilà* (*Elaeis guineensis*), which growth both in plots and in the forest.

The Baka also gather honey. Whereas the most appreciated honey, *pɔki*, considered by the Baka as "the true honey" is made by bees (*Apis mellifera*), more than 13 other varieties of honey are known and consumed. Those other varieties of honey are made mostly by *Trigona* stingless bees (from the Meliponini tribe). *pɔki* is certainly one of the most valued forest product and its gathering implies climbing trees sometimes at really high elevations. For climbing and collecting honey, Baka used cords and a vegetal belt that they tie to the tree to climb. The collection is realized once the bees are dazed by the smoke the Baka bring with them in a special vegetal basket. Then afterwards, the *pɔki* is sent down using a specific basket. As this technique is delicate and complex, nowadays people commonly prefer to cut the trees, particularly if they are not too big, rather than climbing.

Another common wild edible, less dangerous as they are gathered once they fell down, are the caterpillars. More than 10 different caterpillars are consumed by Baka people. Most of their names are in relation with the tree where they grow. The most common are *kàngà*, growing in the *kàngà* tree (*Entandrophragma candollei*).

Finally, Baka people also commonly gather mushrooms. On the almost 30 different mushrooms known by the Baka, the most commonly consumed over the course of the systematic data collection year were *mòboli*, *mòndùngùle*, *musele*, *tokpoli*, and *ndɔbɔlɔbɔ*.

Natural resources are also used for construction and handicraft production. The most commonly used vegetal species for making basket and mats are the *pèke* (*Raphia laurentii*), and the *pombɔ* (indeterminate liana). Maranthacea's leaves are largely used for many domestic purposes (making small containers, as spoon, as cooking pot), and for the construction of the *mongulu*. Finally, another appreciated wild plant is the wood of *bòyo* (sapelli - *Entandrophragma cylindricum*), generally used for domestic tools such as mortars.

2.3.4. Agriculture

Baka people engage in agricultural activities both in the Nzime's plots and in their own. The most common crops in the area are plantain (*Musa spp*), cassava (*Manihot esculenta*), cocoyam (*Xanthosoma sagittifolium*), and domesticated yams (*Dioscorea spp*). Groundnuts and maize are also planted, but to a lower extend. In my work in two villages, I was able to report 18 different varieties of crops planted by Baka people including several varieties of banana and plantains. While both Baka men and women engage in agricultural work, there is a sexual division of labor: men are more involved during the opening of new plots, when they have to cut the trees, whereas women perform agricultural work all year round. Women participate in the opening of plots, in weeding and harvesting crops. In addition to subsistence plots, some Baka also own cacao fields. Such fields have been established with the help of NGO's programs working in the area, although the number of cacao fields in Lomié and Messok does not seem as large as in other areas (see Oishi (2012) for a comparison). Furthermore, as in other neighboring regions, most cacao fields have been abandoned few years after being opened (Leclerc, 2012).

Most agricultural work is done with the help of a machete and, in the case of men, also with a type of axes, called *kɔpa*, which is used for cutting trees. Very rarely Baka own small hoe, a tool more common among the Nzime. An extended description of agricultural activities can be found in Leclerc (2012).

2.3.5. Medicine

Baka cultural way of healing might be divided in two: the daily and popular medicine, which contain knowledge and practices for common health problem and known by a large part of the population, and the specialized medicine, which refers to knowledge and practices held by a reduced part of the community, such as by specialists and recognized healers.

Baka medicine is extensively based on the use of plants and Baka have different ways to prepare them. Commonly, the barks of some plants are boiled and drunk. The leaves of other plants are crushed and the resulting mass applied on wounds. Another common way of administering medicines is through scarifications (Betti & Lejoly, 2009; Betti, 2004; Hattori, 2006; Saotoing et al., 2011). When using cauterization, first the plant is burn, crushed and mixed with ashes and the oil of palm's seed ("black oil"). Then, a precise site is cut, with a razor or a blade, and the mixture is applied on the scarification.

Medicinal plants are also used during pregnancy and on newborn babies, sometimes to strength the baby and protect him from disease. For example, to protect the infant against diseases, or to give him strength, Baka construct a cord from a bark of a tree or liana and tie it to their child. Finally, it is also common to wash the babies or toddlers in maceration of plants.

2.2.6. Cosmology, art and rituals

The relation between Baka people and their environment is embedded in a corpus of beliefs and representations, a cosmology that constitutes the basis of their culture. This is largely mirrored in their complex ritual systems (Joiris, 1998), their taboos, tales, music and dances. The Baka are animists, and have great believe in *komba*, the Creator. Baka mythology and cosmology are really extended and complex and has been the focus of previous studies, including the works of D. Joiris (Joiris et al., 2011; Joiris, 1998, 2015), D. Tsuru (Tsuru, 1998), and Fűrnis (2005), but also through the compilation of different Baka tales made by R. Brisson (1984a) and D. Boursier (1994).

2.4. Recent Local Changes

2.4.1. Local realities shaped by a myriad of actors

As mentioned, the last five decades have brought many changes to Baka livelihoods, mostly in relation to the increasing arrival of external actors into their territories. I chose here to give a first overview of the relation between these new actors and the Baka livelihoods, in the specific context of the studied area.

In the last five decades, the Haut Nyong Department has opened and become more exposed to the globalized exchanges and external cultures. The dirt roads opened from the capital Yaoundé to the East Province which were built at the beginning the nineteenth century by Germans, have been considerably improved these last decades (Joiris, 1998). The axis Abong-Mbang - Lomié, Lomié - Messok, and recently Messok - Ngato Ancien (reaching further Yokadouma Mouloundou axis) has been mostly managed and improved by the main logging companies of the area. Such enhancement of ways of communication considerably increased the number of new actors arriving in the Haut-Nyong department.

While roads allow for the circulation of people and materials, they also facilitate the circulation of ideas, concepts and representations. For example, extractive companies arriving to the area during the 1970s (Joiris, 1998) brought the idea that it was possible to earn money by selling precious species, even if they were culturally important. It is the example of the moabi (*Baillonella toxisperma*), largely exploited by logging companies and illegal loggers, whose fruits are highly valued and used by Baka for making nut oil and for several medicinal purposes. As some young Baka might not

acknowledge the cultural value of those trees, they accept jobs to guide private loggers to access to their communal forest and cut them.

Monetarization has not only reached timber products. The improvement of the roads has also increased pressure on wildlife diversity and abundance through overhunting. The East Province of Cameroon is the main source of bushmeat for the national market and one of the main providers for the international market. As the bushmeat demand by urban centers increased considerably these last decades due to their demographic expansion, the local pressure on such resources also increased. Locally, it has confused the providing network by increasing the number of people asking for buying then reselling bushmeat, hunted mostly by Baka people. Whereas Baka moved to villages partly because of the rarefaction of big mammals fifty years ago, this increasing pressure on such game have lead Baka to change their practices. Notably, young Baka men are shifting to new more efficient techniques, and selling parts or all the animal hunted -rather than sharing and consuming it with the family.

The Haut Nyong Department has also witnessed the arrival of NTFP traders coming mostly from western and north Cameroon. These traders generally settle some months during the major harvesting season in the area, sometimes in Baka villages. For instance, in Mombokola there were three foreigners settled in the village acting as traders, and many migrant traders were visiting both villages during the higher fructifying season. They buy the fruits of *ngimbà* (*Afrostryrax lepidophyllus*), *mbalaka* (*Pentaclethra macrophylla*), *ma6ε* (*Baillonella toxisperma*), *tóndo* (*Aframomum dalzeilii*), *payo* (*Irvingia excelsa*) and *pekè* (*Irvingia gabonensis*), but also mushrooms as *kutu* (indeterminate). Once the season is finished, they generally go back to the urban center to sell the products. When settled in the area, they ask Baka people to go to the forest to gather products. Such way of commercializing has increased the pressure over

forest resources, as the Baka, rather than gathering fruits directly on the ground as they use to do, they now use more intensive harvesting methods to get more fruits, such as climbing, cutting some branches or even the entire tree.

In such context, natural resources conservation policies have started to be implemented in the area during these last decades. In our studied area, localized in the lowland forest region of the Congo Basin, there are still representatives of mega fauna, such as gorilla (*Gorilla gorilla*), elephants (*Loxodonta cyclotis*), and chimpanzees (*Pan troglodytes*). Three protected areas have been created: the Boumba-Bek and the Nki national Parks, and the Dja Biosphere Reserve. The creation of reserves and national parks has resulted in a reduction of Baka access to land and to natural resources, affecting their cultural practices.

One of the most debatable issue related to conservation policies is the big mammals hunting, especially elephant hunt, a traditionally important cultural practice. Prohibited by conservation policies, elephant hunts are promoted by the high price of ivory in the black market. Due to the current pressure and controls made by conservation agents, Baka people don't engage anymore in elephant hunting on their own, but rather foreigners generally hire Baka people to perform such hunt. The regulation of elephant hunting has also resulted in the decrease of several cultural practices, such as the performance of several rituals and song that involved the participation of several members of the community (Joiris, 1998; Tsuru, 1998). For instance, only one elder woman in the two villages knew how to sing the *yeli*, traditional song performed for accompanying elephant hunting expedition.

In addition to the previously mentioned actors, several NGO have been working with the Baka in this area, and namely NGOs working on human development, human

rights, and sustainable development. Such organizations have promoted the empowerment of local populations, the sustainable use of forest resources, and the promotion of agriculture. In that sense, development work has tried to bring new techniques to the Baka, including agricultural practices and the raising of domestic animals (chicken, rodents...). For instance, in one village, a local NGO helped the Baka to open cacao fields almost twenty years ago. At the moment of the fieldwork, almost all those fields were abandoned. A potential reason for lack of success is that such initiatives faced several difficulties to connect with local realities due to both a cultural misunderstanding between NGO workers and the Baka culture, and the complexity of local realities driven by the above mentioned several actors. For instance, Baka villages are progressively pushed by local NGO to constitute traditional chefferie by electing village leaders in order to better communicate with local authorities. However, despite those initiatives, it remains difficult for the Baka to participate in meetings mostly hold in French and dominated by Nzime villagers and government representatives.

Finally, the arrival of new actors has also resulted in the arrival of new tools and products to the area. The arrival of Chinese products into the area is quite recent. Among other items, the arrival of cheap motorbikes has considerably increased movement in the area; nowadays there is at least one motorbike in every village Bantu village. Many people work as mototaxi drivers, carrying people and all types of products between villages and towns. Easier transportation has also accelerated the spread of other commercial products such as audio equipment. At the same time, unofficial musical bars have appeared in almost all the Nzime's villages - and also in some Baka villages-, where there is a high consumption of alcohol (Oishi & Hayashi, 2014). In both studied villages, there was at least one Nzime settled with his own little store and audio equipment. Indeed, the increase in alcohol consumption is a main issue

of worry for Baka people, and for others external agents working on human development. For example, some Baka told us that the increase in alcohol consumption leads to the decrease of household productivity, the disinterest of household heads- especially men -for taking care of their offspring , and increased conjugal violence. From elder's point of view, alcohol consumption among young adult generations is the major affront for Baka culture and tradition.

The presence of some others actors might be highlighted, such as outsiders visiting Baka villages to find the help and magical remedies of traditional Baka diviners-healers (*nganga*). While the acknowledgement of the expertise of such healers is not new, it seems to have grown recently, including people from further places, like the capital. What is also recent is the monetarization of such health services, and now most healers asking for money to offer their services, not only to outsiders but even for patients from the same village.

2.4.2. Schooling among the Baka

The district of Lomié counted with around 40 schools for a total 4561 children in 2014 (3731 in public schools and 630 in private schools). From the total number of children in the district, almost one quarter were Baka (981, 453 girls and 528 boys). In both district of Lomié and Messok, private schools were mostly managed by the FEC, except the one settled in Le Bosquet, leaded by a missionary institution. At the same time, a NGO *PLAN Cameroun* was currently working in some villages of both districts on specific programs (in 2014, they were establishing a educative program in 8 different villages), promoting an bi/multilingual education, a education based on Baka's daily life (rather than programs established in cities), and on helping economically for furniture and fees.

For the schooling year 2012 - 2013, only about 56% of the children on age to attend school were actually registered in the schools of the studied villages. Mombokola, holding a public school, presents the lowest attendance where only 44.4% of the children on age to attend school do so, in contrast with Elonda, holding a private school, where almost 74% of the children attended school. However, even if children were registered at school at the beginning of the schooling year, school attendance decreased in the course of the year. Moreover, the attendance to school decreases drastically after the second year; indeed, very few children follow the schooling cycle more than one or two years. Therefore, in general, most Baka children and adults who had attended school only reached the SIL ("Section d'Initiation au Language") level, a pre-curricula level with the aim to familiarize children with French language.

During the data collection, a main reason of this low attendance at school related to teachers absenteeism, especially among the private school. Even if the village teachers were initially motivated and enthusiastic, they generally get demotivated after few months. Several reasons might explain teachers' demotivation. For example, teachers complain of their working conditions. Their discouragement is also related to the low attendance of Baka children. At the individual level, teachers were generally in front of challenges such as dealing with economic issues, due to a low wage/salary, and the general delay for getting paid, and their geographical isolation from their origin place. Therefore, it was really common to find local teachers who began other economic activities, such as selling basic groceries, cigarettes and alcohol, or even investing time and money in bushmeat and NTFP markets.

However, the low school attendance reported in our data is also explained by additional challenges related to the Baka children's daily life, language, Baka livelihood and economic reasons. As first issue concerning Baka attendance to school is linked to

the fact that children are not used to eat first thing in the morning and thus, and thus, late in the morning, when they are already in school, their main preoccupation relates to break the fast. Thus, at school, during the first break of the morning around 10am, most children are going out to look for some food, going generally to hunt some mice or birds, to gather tubers or fruit in the nearby forest. Thus, they rarely go back to school after the break.

The second issue relates to language. In public school, the SIL program aims to facilitate children to speak the national language, so classes are given in French, a language not understood by Baka children. In private school, even if teachers are supposed to speak Baka language, some new teachers, as was the case in Elonda, do not speak Baka. Thus, the language barrier imposed on Baka children do not facilitate children motivation to go to school.

The third issue relates to the importance of seasonality for Baka livelihood. During the school year, many activities punctuate children's daily life. Among them, the collection of NTFP, which generally begins around April and later again during September. Thus, as many households are settled in forest camps during the major dry season from several weeks to several months, these activities do not facilitate children's school attendance. For instance, after the Christmas break many children do not return to school,. However, as some of the trees are continuously fructifying , fruit gathering might occur at different moment of the year, and implies the punctuated absence of children from school.

A last important issue regarding low school attendance among Baka children relate to economy. In the case of public school, the fees of registration and school stationary are one of the hindrances to attend school, as Baka people do not generally

save money, so they typically do not have enough money to pay all the expenses related to school. Thus, the access to school for Baka children who do not have all the school stationery would depend on the mildness of the school director. However, most of the time, children who do not have enough money or material prefer not to go to school because they feel ashamed, feeling which is generally enhanced by Nzime children taunts towards Baka children.

To conclude, even if many efforts have been made by private schools and more recently by public schools, the way in which the national educative system works, both in its daily and annual structure, does not fit with Baka livelihood. Thus, in general, both in public and private school, Baka children quickly loss interest and rarely finish their schooling year. According to various interviews realized with children, they apparently like school, they didn't mention any problem with school, and both adults and children acknowledge the importance of schooling for acquiring literacy and numeracy.

2.5. Baka childhood

In such context, I devote this part to present briefly the main settings shaping Baka children life and development.

2.5.1. Lifespan and development

Figure III-6 briefly summarizes Baka terms used for the different stage of human development, detailing the main characteristics of each stage. The information used to elaborate the figure was obtained from previous literature and focus group interviews with Baka adults conducted during fieldwork.

Infancy, *dindo*, is perceived as a critical period in Baka life and the triangular relation between father-mother-infant is at the heart of Baka culture. Furthermore, this relation seems to shape many daily activities. Even before birth, Baka children receive attention and have a specific position in the household and the village. For example, to ensure the physical and spiritual health of the infant-to-be, both the pregnant woman and her partner have to follow several restrictions, including dietary restrictions on the consumption of wild animals and plants. Parents with infants also restrict some practices during the performance of subsistence activities (hunting, gathering, and fishing). Men are also warned against having sexual relations with other women. Failure to follow such restrictions is believed to cause abortion or newborn illnesses. While most of these restrictions are limited to the pregnancy and the first months of an infant's life, some are prolonged until weaning. Interestingly, weaning represents not only the onset of children's autonomy, a condition that starts as soon as the child begins walking, but also the end of the mentioned children-related social norms that regulate parents' behaviours. For instance, after weaning, food restrictions tend to be related to

very specific activities and not related to children anymore. Once weaned, and concomitant with walk acquisition, children are called *yandé*.

Baka differentiate several stages of child development: middle childhood, or *ngùmà nà bo*, preadolescents –called *lingi* and *sia*- and adolescents, called *ewanjo* for boys and *sia* for girls. Once a person establishes his or her household, and specially after the arrival of the first child, young adults are then considered as "*ko.bo nà bo*", or adults (Figure III - 6). The elder, called *gbekoa bo*, are locally characterized by their low autonomy and their higher dependency towards others.

Few rituals exist among the Baka, but only for boys. The first common ritual, originally performed by Bantu-speaking people, is the boys' circumcision, *bèkà* (Joiris, 2003). This ritual is generally realized around 6 years-old, but might be also performed on boys until early adolescence. Once the boy is circumcised, Baka people say that he is then a "real adult", however, this ritual is not a needed for entering into adulthood. The other boys' ritual embedded in Baka culture relates to their initiation to the *jengi*, the main and most powerful spirit of the forest. Considered as part of entering into the social world of men adults, this initiation confers to the individual aptitudes intimately related to forest skills, especially in relation to hunting.

Figure III - 6 Terminology of the individual development among the lifespan

		Terms	Baka's descriptions
		mε	Fœtus
bimi a bo (Half a human)	}	1-1.5 y.- dindo	From birth to walking (infant)
		2-3 y.-o. libenda	From walking to weaning (toddler)
yandε	}	ngama	Weaned, however, they still need help to accomplish their daily activities (washing, eating...), they don't express clearly their needs and cry often (child)
		5 y.-o. ngùmà nà bo	They are able to perform their activities for their own, they are more independent, and can express their needs (child)
		9 y.-o. lingi/ sia	They are able to perform work (agricultural work for instance) ; girls <i>sia</i> begin to get breast and arrival to menstruation (pre-adolescence)
		13 y.-o. ewanjɔ/ sia *	Their bodies are already more like adult's ones; period just before marriage (adolescence)
ko.bo	}	16 y.-o. mbotaki	
		ko.bo na bo	After first birth / new household (adult)
		gbekoa-bo	They don't have the energy to work, they become like children, since they need other people to feed (elder)
		mε	Dead spirit

* there were some differences between what Brisson and Joiris said about *lingi*, *sia* and *ewanjɔ* and what Baka people reported to me. For Brisson and Joiris (Brisson, 2010; Joiris, 1998), the adolescence stage is called *ewanjɔ* for both gender, however, Baka told me that we talk about *ewanjɔ* only for boys. Also, the term *sia* is the same between pre ado and adolescence, however, Baka I interviewed told me that there is a first stage of *sia*, the youngest *sia* and then the oldest *sia*, without giving me a clear distinction between what Brisson and Joiris consider as preadolescence and adolescence.

2.5.2. Physical and emotional settings for children's learning

Baka generally hold close relations, both physically and emotionally, and children, since infancy, benefit of this intimacy, as it is also the case for many other hunter-gatherer societies (Barry S. Hewlett, 2014a). During infancy, mothers would not leave their infant and would hold them a considerable amount of time, at least when compared with their neighbours farmers (Hirasawa, 2005). Adults quickly answered to infant's demands and do not leave the child crying. Furthermore, in general Baka people are physically very close, for examples houses have a unique bed shared by all the family. Such cosleeping is a common feature among hunter-gatherers from the Congo Basin (Barry S. Hewlett, 2014a). This intimacy is maintained through adolescence, or until children get married and thus, build their own house with their new family.

Another significant characteristic of the physical settings that impact Baka children's daily life comes from the importance of allomaternal care. As shown in various other societies (Weisner et al., 1977; Weisner, 1982), including Western societies until the last century (Lancy, 2008), Baka children might be cared for by older siblings, grand-parents or adults other than the parents. Indeed, Baka children are supposed to take care of their younger sibling, and older children (but as young as 6 years-old) are often asked to accompany their mother to take care of the infant while the mother works. In that sense, they can be considered as the secondary caregivers of the infants (Hirasawa, 2005). Consequently, Baka children seem to witness a high physical

and emotional intimacy also with other members of the group, not only parents (Barry S. Hewlett, 2014a). Thus, although Baka children's education, care, punishment and obligations are primarily the role of parents, numerous other adults also participate in all them.

Differently from Western views of childhood, but similar to how childhood has been described in other small-scale societies (Hewlett et al., 2011; Hewlett, 2014), Baka children are highly autonomous from an early age. Once children are able to walk, they might be called *kobo*, term which mostly refers to adult. In a way, Baka children receive the same independent considerations of adults, even if it is understood that they are in a learning process. For example, Baka children have the freedom to make their own decisions, but they are also considered responsible for the consequences of such decisions.

However, children are appealed to participate to daily household life. For example, children are asked to fetch water, to collect firewood, to share plates between households. However, very few obligations are imposed upon Baka children and if the child doesn't obey, parents would not go to use punishment but would prefer to use another way to achieve their goals. Punishment is very rare and occurs only through specific circumstances, as when an adult has suffered what is considered a grave offence (e.g. steal, wound). Moreover, punishment takes a form not usual for western societies. As in another hunter-gatherer societies, the Baka generally full of good humor, in good mood and laughter (Gray, 2009). In that sense, they use the humor as a tool used to correct the ones "*who are in some way disrupting the peace and violating a rule*" (Gray, 2009: p.490), by ribbing them publically.

Disobedience, however, affects the relations. Nowadays, it is very frequent to hear from elders that none of their children are respectful. Therefore, when children do not complete with their parent's demands, parents might tend to be less interested in transmitting their knowledge.

Finally, another interesting aspect of Baka childhood, again in contrast with our Western view of education, is that Baka typically do not openly judge other people's actions or behaviours. This has important implications for teaching, as it is very rare that an adult provides negative feedback during a child's activity. Rather than interrupting the child, Baka adults would prefer to observe and wait until the child completes the action, and then perform the activity him or herself as a type of demonstration.

Therefore, the setting in which Baka children would be acquiring LEK is one in which physical intimacy, allomaternal care, and child autonomy and independency prevail.

Part II

Chapter IV

Is there a children's local ecological knowledge system?

1. Introduction

“If the goal is to understand how children contribute to making culture, a more appropriate focus would be the arena in which children do most of their culture making: namely, in their lives with other children, what is sometimes called ‘children's culture’”

(Hirschfeld, 2002: p. 614).

During childhood, individuals learn, use, modify, and create games, artefacts, routines, and specific activities that are not necessarily shared with adults. Children also share exclusively with other children certain values, concerns, knowledge and skills. These sets of practices and knowledge produced by children for themselves or for their peers, apart from the adult world, are known as ‘children's culture’ (Corsaro, 2012; Johanson, 2010).

The existence of a ‘children’s culture’ is not only significant for understanding child development, but it might also provide important insights into the study of cultural transmission (Ahn, 2010). Firstly, the existence of a children’s culture implies that there is a body of knowledge of intrinsic value to children but not necessarily to adults (see also (Bird-David (2005) and Hirschfeld (2002)). Is this knowledge created and transmitted by children themselves? Answering this question would improve our understanding of how cultural knowledge is created and transmitted at different stages of the life cycle.

Secondly, as children’s culture overlaps with adult’s culture -at least partially-, understanding children’s culture provides insights “*into how children ‘do’ culture: how they reproduce and reformulate it*” (Johanson, 2010: 389). In other words, children’s culture might play an important role in contributing to cultural production and change, especially in situations where children actively reproduce “*adult’s society through their activities in their own peer cultures*” (Corsaro, 2003: 14).

Thirdly, the analysis of children’s culture might also provide new insights into the study of the pathways through which knowledge is transmitted. For example, some researchers have found that children’s plays, games and songs can be transmitted between children alone, that is, without the help or intervention of adults. Games and songs transmitted in this manner have shown an impressive persistence (Morin, 2010). Using a selection of Gargantua’s plays, Morin (2010) shows that plays performed only by adults persisted, on average, for ten generations of adults, whereas plays performed by children persisted for fifty five generations of children, despite the more limited duration of children’s generations. Such findings are important because they challenge the supposed low stability of knowledge transmitted horizontally (Hewlett & Cavalli-Sforza, 1986). According to Morin, the high fidelity of children’s plays is a consequence

of a) the high frequency of performance which allows for continual recall of the rules and b) the ease with which these games are learned and repeated, in contrast with adult's more complex plays or practices.

Despite the theoretical importance of 'children's culture' in the transmission of cultural knowledge, there is limited research on the topic (Ahn, 2010). Furthermore, most research has focused on the leisure activities, i.e. games and plays, of children living in what anthropologists know as WEIRD (Western, Educated, Industrialized, Rich and Democratic) societies (Henrich, Heine, & Norenzayan, 2010). To the best of our knowledge, no research has analysed whether 'children's cultures' also exist in relation to productive activities or in non-WEIRD societies.

Here, we pioneer such research. Specifically, we analyse children's culture in relation to subsistence related knowledge and focus on a small-scale society of foragers, the Baka in southeastern Cameroon. The choice of topic and setting go hand in hand, as in small-scale societies like the one studied here, knowledge related to the local environment guides subsistence activities (Reyes-García, Guèze, et al., n.d.). Previous research in such settings suggests that childhood is a critical period for the acquisition of Local Ecological Knowledge –LEK¹- (Demps, 2012; Gurven et al., 2006; Reyes-García, Broesch, et al., 2009; Ruiz-Mallén, Morsello, Reyes-García, & Marcondes de Faria, 2013; Zarger & Stepp, 2004), for which studying children's culture in relation to LEK could enable us to understand how, in reproducing aspects of adult's knowledge, children might acquire or re-create cultural knowledge.

2. Methodology

2.1. The Baka

This study took place among the Baka, a hunter-gatherer group of about 30,000 individuals living in Cameroon, Gabon, Democratic Republic of Congo and Central African Republic (Joiris, 2003). Detailed ethnographic information of the Baka can be found in Leclerc (2012) and Joiris (1998).

Until recently, the Baka lived in small, semi-nomadic groups, depending both on forest and agricultural products they obtained by bartering with sedentary Bantu-speaking farmers. For the last 50 years, the Baka living in Cameroon have faced several changes mostly driven by the defaunation of the forest where they live and the extensive settlement program conducted by the national government (Leclerc, 2012). As a result, nowadays, most Baka live in villages located along logging roads, practice agriculture, and engage in wage labour (Leclerc, 2012). Compared to only three decades ago, Baka's mobility has been largely reduced and, nowadays, forest incursions are generally organized around the agricultural seasons and the gathering of commercial wild edibles.

Similar to children in other hunter-gatherer societies (Hewlett, 2014), Baka children are very autonomous and independent from an early age. They engage in subsistence activities, including hunting small mammals and birds and gathering wild edible plants, often without adult presence. Moreover, due to the adults' prolonged absences during the day, identifying and catching or gathering animals and plants are essential skills for the Baka children, as they partially feed on those.

2.2. Methods of data collection

Data were collected from the Baka communities in southeastern Cameroon, in the Haut-Nyong region, specifically in the districts of Lomié and Messok. The two first authors spent 18 months, from February 2012 to April 2014, living in two Baka villages. The studied villages had a population of 119 and 187 adults (defined here as people above 16 years of age, as this is the age at which Baka typically create new households) and 145 and 206 children (31 and 86 were under 5 years of age). The sample of people varied for the different methods of data collection (see below, and Table IV-1).

We firstly obtained Free Prior and Informed Consent in both villages and with every individual participating in this study. For children, we asked for parental consent. This study adheres to the Code of Ethics of the International Society of Ethnobiology and received the approval of the ethics committee of the Universitat Autònoma de Barcelona (CEEAH-04102010).

During the first six months of fieldwork, we learned the basics of the local language, Baka, and the local socio-cultural norms (e.g. on sharing), which helped us to be accepted in the villages. We also collected ethnographic information using spontaneous conversations, semi-structured interviews, and participant observation in daily activities (e.g. joining fishing or hunting trips and honey collection expeditions, or working on agricultural plots). Two trained local assistants and interpreters helped with data collection. By the end of the initial period, we had collected a census with demographic (i.e. name, sex, and level of schooling) and genealogical data (i.e. kinship charts) of all the people living in the two villages. As the Baka do not have birth cards, we estimated participant's age using kinship information.

Over the following 12 months, we used different systematic protocols to assess individuals' LEK in two domains: game and wild edibles (i.e. plants, mushrooms, insects, and honey). Specifically, we assessed their abilities 1) to name the animals and plants using a free-listing task, 2) to identify items in specific domains of LEK using a test of visual and auditory identification, and 3) to conceptualize etho-ecological knowledge through a structured survey (the questionnaires are presented in Annex 2).

Free-listings: We asked informants to enumerate all the animals and wild edibles they knew (Puri & Vogl, 2005). Ethnographic observations suggested that children and adults engage differently in activities related to the two domains of knowledge selected (game and other wild edibles). Consequently, we conducted a set of free-listings that would potentially cover both children's and adults' expertise. Thus, to capture game, we asked informants to list a) game (without further specification), and then b) mice, c) birds, and d) fishes. To capture wild edibles, we asked informants to list a) wild edibles (without further specification), and then b) fruits, c) caterpillars, and d) mushrooms.

For each free list we obtained data for about 45 individuals, including adults and children (see Table IV-1 for details). Some informants responded to more than one free-listing. All the entries in our lists were reviewed with one of our translators, a Baka man. Furthermore, once we had completed the data collection with free-listings, we asked adult informants to review the list of items listed by children, identifying any item unknown to them. We used items reported by at least two informants in the 'game' and 'wild edibles' free-listings to elaborate the other tests.

Common identification test: We used the Smith's Saliency Index derived from free-listing (Puri & Vogl, 2005) to categorize items listed in the 'game' and 'wild

edibles' lists into three groups: high, medium, and low saliency (see Annex 1). Then, we randomly selected five items in each group, from which –after testing- we kept nine game and eight wild edibles. The *common identification test* consisted of a series of stimuli, including pictures and recordings for the selected game (i.e. a monkey's call) and dry specimens, pictures, and plant parts (i.e. barks) for the selected wild edibles. We showed the stimuli to respondents and asked them to provide the vernacular name of the species shown.

Common structured questionnaire: To assess conceptual knowledge on game and wild edibles, named here etho-ecological knowledge, we asked questions regarding the behaviour of three game species and the ecology of three wild edible species. One animal and one wild edible species were selected from each saliency group. We worked with only six species to limit potential biases generated by young children's short attention span.

A total of 244 individuals (175 adults and 69 children) answered both the *common identification test* and the *common structured questionnaire* (see Table IV-1).

Children's identification test: As our second goal was to analyse children's LEK, we collected additional data among children. Specifically, we presented them with visual stimuli for 11 additional animals in a specific identification test. Thus, children were asked to identify a total of 20 species of animals and eight species of wild edibles. The additional species included in the children's identification test are distributed across different saliency levels of children's free-listing: ten had a high saliency, five a medium saliency, nine a low saliency and four were not reported by children (see Annex 2 for detail on the questionnaire).

2.3. Variables' construction

We used data collected from the common identification test, the common structured questionnaire, and the children's identification test to construct individual knowledge scores. For the common identification test and the children's identification test, as the stimuli were from a known origin (i.e. pictures and recordings from the literature), we generated knowledge scores by contrasting informants' responses with bibliographic information. Specifically, we added a point to the identification score for each coincidence between the respondents' answers and the information extracted from the bibliography. As scientific etho-ecological data on most of the species included in the survey were missing, to evaluate the answers to the common structured questionnaire we generated a measure of agreement with the group based on the number of times the informant's answer matched the modal response to a question, after excluding missing answers (D'Andrade, 1987; Reyes-García, Díaz-Reviriego, et al., n.d.). Since both questionnaires, on game and wild edibles, had three questions, individual's scores rank from zero (when none of the respondent's answers matched the modal response) to three (when all the respondent's answers matched the modal responses). For both questionnaires, two different sets of modal answers were calculated: children's and adult's.

2.4 Data analysis

2.4.1. Similarities and differences between adults and children

To assess whether there is a specific “children's LEK”, we first examined the differences and similarities between children's and adults' responses to the three protocols. We analysed responses to free-listings using Anthropac 4 and Flame

(Borgatti, 1996; Pennec et al., 2012). Data were first analysed comparing the full samples (adults vs. children). Since our ethnographic understanding suggested that there were differences between boys' and girls' LEK, we also compared freelisting responses taking into account the sex of the respondent within each of those groups (women/men and girls/boys). For each group, we firstly compared the total number of items reported and then moved on to a more detailed analysis comparing the actual items in children's and adults' lists. Such analysis allowed us to assess particularities in children's responses as well as commonalities with adults' answers.

We compared adults' and children's scores of the *common identification test* and the *common structured questionnaire*, first with the full sample and then by sex. We tested whether differences between adults' and children's scores were statistically significant using a Wilcoxon ranking test. Finally we explored the differences and commonalities between children's and adult's scores by looking at the details of their answers.

2.4.2. Similarities and differences among children

The second goal of this work is to analyse variations in LEK during childhood, so we further analysed our data taking into account children's sex and age-categories. Drawing on bibliographic references (Brisson, 2010; Joiris, 1998) and our own interviews with Baka adults, we divided our sample of children into three main age categories: i) middle childhood (≥ 5 - < 9 years-old), ii) pre-adolescence (≥ 9 - < 13 years-old), and iii) adolescence (≥ 13 - ≤ 16 years-old).

We compared the number of items reported and the content of children's free-listing according to the sex and the age category of the respondent. We then tested whether the number of items reported by the boys and girls varied using series of

Wilcoxon ranking tests, and whether the number of items varied from one age category to another by running Kruskal-Wallis tests. We followed a similar procedure to analyse results from the *children identification test* and run Pearson's correlations to test whether the children's scores were related to their age.

3. Results

3.1. Similarities and differences between children's and adults' LEK

3.1.1. Naming abilities

Both the number of items reported by children and adults in free-listings and the items listed varied according to informant's age category and sex (Table IV-1). The total number of items reported by children and adults also varied depending on the domain of knowledge (Table IV-1a).

For the general domain of 'game', children reported an average of nine items (SD=2.8) whereas adults reported an average of 16 items (SD=4.3). In total, children reported 43 species and adults reported 83 species. A detailed analysis of the items listed suggests that there is a large overlap in the most salient items listed by children and adults. Thus, among the ten most salient game reported by adults, eight species were also highly salient in children's freelisting (see Annex 1). The list of overlapping animals exclusively corresponds to large mammals and includes 1) the most commonly caught mammals in the area (i.e. blue duiker and Gambian pouched rat), 2) highly appreciated bushmeat (i.e. African white-bellied pangolin *-kokòlo-* and brush-tailed porcupine *-mbòke-*), and 3) culturally emblematic species (i.e. elephant, gorilla and red river hog).

As for game, the average number of items listed by children when asked to name wild edibles was about half the number of items listed by adults (mean five for children (SD=3) vs. 13 for adults (SD=6.5)). Similarly, the total number of items reported by children (52 wild edibles) was almost half the total number of item reported by adults (103 wild edibles). Differently than for game, however, wild edibles listed by adults and children did not overlap. Thus, when comparing the ten most salient items in children's and adults' lists, only five items were common. Different types of honey (*pɔki*, *dàndù*, *keke*) predominate the items that are specific to children's lists, whereas marketable wild edibles (*pekè*, *ngìmbà*, *mabɛ*, *kɔkɔ*, *payo*) only appear as salient in adults' lists.

When looking at the lists of specific categories of animals, the differences between adults and children vary from one category to another. Thus, adults listed about twice the number of birds than children listed, with adults listing an average of nine birds for a total of 62 listed and children listing an average of five birds for a total of 32. Only two birds were different between the ten most salient species of the two lists. We found fewer differences in the number of mice and fish listed by adults and children. Thus, on average children listed four mice and four fishes, whereas adults listed an average of six mice and eight fishes. Overall, children reported 26 mice names and 22 fish names and adults reported 25 and 30 species respectively. As for the general category, the five most salient types of mice and fishes listed by children overlap with the five most salient items listed by adults (Annex 1). Interestingly, and despite similitude in the most salient items, 42% of the birds and more than 50% of mice and fishes reported by children were not reported by adults.

Children reported an average of four fruits, four caterpillars, and seven mushrooms, whereas adults reported seven fruits, five caterpillars and seven

mushrooms. In total, children and adults listed about the same number of fruits (32 listed by both), caterpillars (15 by children and 14 by adults), and mushrooms (28 by children and 32 by adults). For fruits, only two items were similar in adults' and children's five most salient items. For caterpillars and mushrooms, there was an almost complete overlap between the five most salient items listed by adults and children, with only one item differing. However, 29% of the mushrooms reported by children were not reported by adults, and more than 50% of the caterpillars and fruits reported by children were not reported by adults.

Table IV - 1 Items listed during free-listing.

	Children			Adults			Common items	Items reported only by children			
	N	Average	Standard Deviation	N	Average	Standard Deviation		Freq	%		
	Total			Total							
Game	25	43	8.7	2.8	26	83	15.5	4.3	35	8	19
Mice	18	26	4.3	2.1	24	25	5.6	2.9	13	13	50
Birds	23	36	4.75	2.6	24	62	8.6	5.4	21	15	42
Fishes	18	22	6.2	2.0	24	30	8.2	2.8	13	13	50
Wild edibles	27	52	5.4	3.0	27	103	13.2	6.5	30	22	42
Fruits	18	32	3.5	1.8	24	39	6.6	2.4	17	15	47
Caterpillars	17	15	3.5	1.3	26	14	4.6	2.0	7	8	53
Mushrooms	19	28	4.5	1.6	26	32	7.1	3.6	20	8	29

3.1.2. Identification abilities

We found differences between children's and adult's ability to identify game but not wild edibles (Table IV-2). Thus, in the *common identification test* for game, children recognized about 74% of the species identified by adults. Moreover, on average, children were able to recognize almost 1.5 less species than adults. Differently, we found low differences between children's and adults' scores in the *common identification test* on wild edibles, as children were able to identify a similar number of wild edibles species than adults (5.0 vs. 5.07 for adults).

The results of the Wilcoxon ranking tests showed that, among adults, the identification scores varied between men and women, both for game ($z=-5.28$, $p<.001$), and -to a lower extent- for wild edibles ($z=-1.66$, $p<.01$) identification (not shown). We also compared the scores taking into account the sex of the informant. As in the previous analysis, we found statistically significant differences in game identification scores when comparing scores from women and girls (respectively 5.26 vs 3.75) and from men and boys (respectively 6.33 vs 4.76), , but not for wild species identification scores (Table IV-2).

Table IV - 2 Identification scores, overall and by sex.

		All samples		Female		Male	
		Children	Adults	Girls	Women	Boys	Men
Game	N	69	162	32	84	37	78
(8 species)	Mean	4.29	5.78***	3.75	5.26***	4.76	6.33***
	SD	1.68	1.35	1.32	1.32	1.83	1.16
	Min	0	1	0	1	1	3
	Max	8	8	6	8	8	8
Wild edibles	N	69	175	32	96	37	79
(7 species)	Mean	5.0	5.07	4.81	4.76	5.3	5.28
	SD	1.62	1.35	1.38	1.78	1.31	1.37
	Min	0	2	2	0	2	1
	Max	7	7	7	7	7	7

*p<.1, **p<.05, ***p<.01 to the results of Wilcoxon ranking tests realized between adults and children

3.1.3. Etho-ecological knowledge

On the *common structured questionnaire*, children and adults tend to give similar answers to ecological questions on wild edibles but not on game. Specifically, children's modal answers on the behaviour of two animals were different to adults' modal answers. Moreover, scores for this questionnaire also differ between children and adults (see Table IV-3), with the average children's score on the game questionnaire being almost half the average of the adult's scores (0.65 for children vs. 1.22 for adults). The difference is even more evident for the score on the wild edibles questionnaire (0.54 for children vs. 1.81 for adults).

The examination of the specific answers given to the etho-ecological questions suggested that children were less accurate than adults. For example, when asked "Where does *bèmbà* (*Cephalophus sylvicultor*) rest during the day?" most children gave generic answers, such as "in the forest", whereas most adults provided a more specific answer, like the "in swampy forest clearings –*baye*".

Table IV - 3 Etho-ecological knowledge scores.

		Pooled		Female		Male	
		Children	Adults	Children	Adults	Children	Adults
Game	N	69	162	32	84	37	78
(from 0 to 3)	Mean	0.65	1.22***	0.69	1***	0.62	1.46**
	SD	0.85	0.84	0.82	0.79	0.89	0.83
	Min	0	0	0	0	0	0
	Max	3	3	3	3	3	3
Wild edibles	N	69	175	32	96	37	79
(from 0 to 3)	Mean	0.54	1.81***	0.66	1.95***	0.43	1.63***
	SD	0.65	1.81	0.70	0.86	0.60	0.92
	Min	0	0	0	0	0	0
	Max	3	3	3	3	3	3

*p<.1, **p<.05, ***p<.01 to the results of Wilcoxon ranking tests between adults and children.

3.2. Similarities and differences among children

3.2.1. Variation in children's naming abilities

We found variation in boys and girls naming abilities for some categories, but not for others. Specifically, we found differences in the number of items boys and girls listed as game, birds, fishes, and mushrooms, but not in the number of items girls and boys listed as wild edibles, mice, caterpillars and fruits (see Table IV-4a). Boys listed more game, birds and fishes than girls (40, 28, and 20 for boys vs. 22, 19, and 13 for girls, respectively), and girls listed more mushrooms (23 species) than boys (18 species). Furthermore, when listing fishes, several girls used the word *si*, a categorical word which includes all water-living beings, i.e. fishes, shellfishes, and amphibians. Differently, boys reported species which are not usually killed during collective women fishing expeditions. On the contrary, girls listed ten types of mushrooms more than boys, who reported three items which are not mushrooms.

Across the different domains of knowledge, the number of items reported does not change significantly according to children's age-category (Table IV-4b). However, a closer analysis suggests differences in the content of the lists. Thus, middle childhood respondents gave more generic names than pre-adolescents and adolescents. For example, when listing 'game', children in middle childhood listed categories of items such as *nguma* (fish), or *jo* (food), whereas such generic categories do not appear in adolescents' lists. Middle childhood respondents also listed more 'intruders', or items which are not part of the domain of knowledge, than older children. This was specifically the case for the category of wild edibles, for which middle childhood respondents listed names of animals.

Table IV - 4 Results of the free-listing among Baka children, by sex and age-category.

a) By sex.

	Girls				Boys				% of items in common (items common/total items listed)	Z (Wilcoxon ranking test)
	Respondents	Items	Average of no. of items	Standard Deviation	Respondents	Items	Average of no. of items	Standard Deviation		
Animals	12	22	7.1	2.2	14	40	10.1	2.6	47% (20/43)	-2.9***
Mice	10	16	3.8	2.1	14	17	4.6	2.1	23% (6/26)	-1.09
Birds	11	19	3.5	2.1	13	28	5.8	2.6	31% (11/36)	-2.08**
Fishes	12	13	5.3	1.6	14	20	7.0	2.0	50% (11/22)	-2.9***
Wild edibles	12	34	5.6	4.1	15	33	5.3	1.7	34 % (18/52)	-1.04
Fruits	10	19	3.2	1.9	14	22	3.6	1.6	28% (9/32)	-0.84
Caterpillars	11	9	3.5	1.6	15	12	3.4	1.1	47% (7/15)	-0.67
Mushrooms	11	23	5.4	1.5	15	18	3.9	1.5	46% (13/28)	1.77*

Note: *p<.1; **p<.05; *** p<.01 to the Wilcoxon Ranking test

b) By age category.

	≥5-<9 years-old		≥9-<13 years-old		≥13-≤16 years-old		Results of Kruskal- Wallis test (chi ² with ties)
	respondents	items cited	respondents	items cited	respondents	items cited	
Animals	7	8.9	13	8	6	10.2	0.36
Mice	6	5	12	3.9	6	4.2	0.94
Birds	5	3.6	13	4.7	6	5.8	2.23
Fishes	7	5.7	13	6.2	6	6.8	1.09
Wild edibles	6	4.8	14	4.1	6	4.7	1.61
Fruits	6	3.5	10	2.9	5	4.4	2.52
Caterpillars	6	3.2	13	3.1	5	4.6	3.80
Mushrooms	5	2.6	14	4.6	6	6.3	14.46***

Note: *p<.1; **p<.05; *** p<.01 to the Kruskal-Wallis tests

3.2.2. Variation in children's identification abilities

Children recognized a little more than half of the 28 species shown during the *children's identification test* (average=15.9 species, SD=4.13, min=7 species; max= 26 species) (Table IV-5). However, scores depend on the sex of the respondent: overall, girls' identification scores were lower than boys', differences being especially significant among pre-adolescents and adolescents (respectively $z=-2.31$, $p<.05$, and $z=-3.31$, $p=.001$ on the Wilcoxon ranking tests).

Scores on *children's identification tests* were positively correlated with age ($r=.4135$, $p<.001$), suggesting that as they grow up, children tend to improve their identification abilities (see Table IV-5 and Figure IV-1). Thus the average identification score increases from 14.4 species identified by children in middle childhood to 17.7 species identified by adolescents (not shown). When differentiating by sex, we observe that the correlation between age and identification scores is significant for boys ($r=.622$, $p<.001$) but not for girls ($r=.152$, $p=.4$).

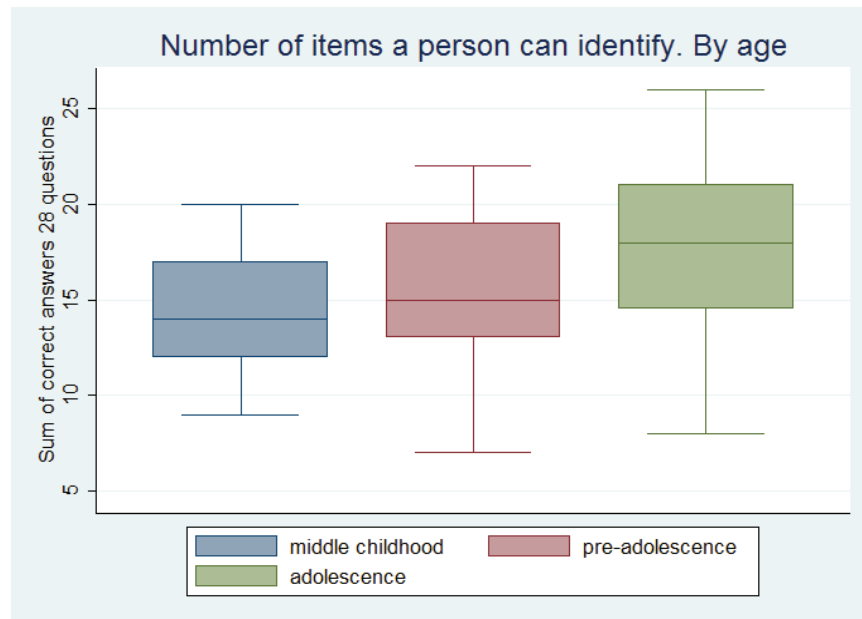
The previous results, however, seem to be driven by the ability to identify animals. Indeed, scores derived from the wild edibles identification test were not different between boys and girls (Table IV-5), nor between children from different age-categories (Wilcoxon ranking test $z= 0.1937$, $p=.11$). Thus, although adolescent boys tend to have higher wild edible identification scores than adolescent girls (6.7 vs. 4.9) the differences are not statistically significant (Table IV-5).

Table IV - 5 Children's identification scores, by sex and age-categories.

		Middle Childhood		Pre-adolescence		Adolescence	
		Girls	Boys	Girls	Boys	Girls	Boys
Game and wild edibles (28 species)	Mean	14.1	14.78	13.77	16.78	14.53	21.1
	SD	3.01	3.31	3.44	3.89	3.89	2.42
	Min	11	9	7	7	8	18
	Max	20	20	20	22	21	26
	Results of the Wilcoxon ranking tests		-0.71		-2.31**		-3.31***
Wild edibles (8 species)	Mean	5.44	5.33	5.08	5.44	4.9	6.7
	SD	1.13	1.87	1.38	1.54	2.02	1.06
	Min	4	3	3	2	2	5
	Max	7	8	7	8	8	8
	Results of the Wilcoxon ranking tests		0.22		0.69		1.99**

*p<.1; **p<.05; *** p<.01 to the Wilcoxon ranking test

Figure IV - 1 Results on the *children's identification test*, by age category.



4. Discussion

We organize our discussion around the three main findings of our work: 1) the existence of a ‘children’s culture’ in relation to LEK; 2) the overlap between children’s and adults’ LEK; and 3) changes in children’s LEK as they move into adulthood.

4.1. Is there a ‘children’s LEK’?

We started this paper defining children’s culture as a set of practices and knowledge produced by children for themselves, that is, separate from the adult’s world. The results presented here suggest that some of the knowledge and practices of the Baka children in relation to game and wild edibles are indeed specific to them and differ from the adults’ knowledge and practices. Thus, in the two domains of knowledge examined, children listed items which were not reported by adults. The categories in which children listed more items not listed by adults were mice and birds. To us, such differences reflect the different types of hunting in which children and adults engage. Baka adults’ hunting techniques have been described in length in previous work, and basically consist of capturing large animals using spears, shotguns, or snares made of iron wire (Hayashi, 2008; Duda et al., under review). In contrast, Baka children hunt small prey (birds, mice and fishes) using specific techniques that differ from those used by adults. For example, during middle childhood Baka children use bows and arrows and slingshots to hunt squirrel, mice, and small birds. Children also use weapons that mimic those used by adults, such as vegetable-made traps or self-made spears. Exploring the diversity of games and plays among Baka children, Kamei (2005) has documented that some specific hunting techniques were used only by children. Differences in hunting techniques used by adults and children likely result in the catch

of different preys, which in turn relates to different knowledge. In such context, children become specialist in preys that are not typically captured by adults (e.g. mice and birds).

As highlighted by (Morin, 2010), the maintenance of children's plays from one generation of children to another is mostly managed by children, i.e. acquired, adapted and transmitted among themselves. Results from our research suggest that children generate, adapt and transmit to other children knowledge related to mouse and bird hunting techniques, and that those techniques are generally deserted from adults' interest. Indeed, as children are much more involved in hunting and gathering activities than adults are (unpublished data), this high frequency of performance allows the transmission and the maintenance of a knowledge system within childhood, as suggested by Morin (2010), and which becomes specific to children.

Interviews with adults on the items listed by children provide further support for our interpretation of differences between children's and adults' naming abilities. Thus, when contrasting with adults the name of items listed by children, adults declared to be unaware of many of the names, especially for items in the categories of mice and birds. During our interviews, adults commonly argued that mice and small birds "are children's hunt." In the words of one of our adult respondents: "Children have their own knowledge about mice. They are always inventing new names!" Furthermore, in those interviews, it became evident that most adults do not consider the animals caught by children as real catches. Such overlook is surprising considering that, in similar contexts, children's catches seem to provide an important contribution to their diet (Bird-David, 2005; Tucker & Young, 2005). Similarly, adults did not consider children's hunting techniques as real hunting. For example, adults typically reject using children's hunting techniques, except for teaching purposes or if there is a real meat scarcity known as "*mò tè pène*", also described as "*faim de viande*" (Motte-florac et al.,

1996). In such events, rather than coming back home without any game, men might hunt small mammals or birds.

Results from free-listing also highlight another important aspect of children's culture: its potential for introducing cultural change. When considering together a) the large number of items reported only by children and b) adult's unawareness of such items, the question arise about the origin of those names. One plausible explanation is that children invent at least part of the names they provide. This explanation fits well with insights from research on childhood and learning strategies emphasising children's creativity and suggesting that children build their own knowledge by integrating what they are taught by others and what they experience by themselves (W. Corsaro, 2014; Johanson, 2010; Kamei, 2005; Niskac, 2013).

In any case, rather than discarding information provided by children which does not overlap with information provided by adults as “wrong knowledge” (as it differs from adults' knowledge), we argue that the study of such information is important to predict future cultural trends. For example, in our study, some of the terms used by children but unheard of by adults are linguistically close to the Nzime language, from the Bantu-linguistic family, or to French. Children in the studied villages are in daily contact with Nzime children, and the use of such names might, indeed, signal cultural changes or cultural adaptation (Sercombe, 1996). Acknowledged to be “*cultural sponges*” (Mesoudi, 2011), children rapidly acquire knowledge from different sources which they might then use to create new knowledge, and such knowledge reflects, both their past cultural heritage, and the new influences to which they are exposed.

4.2. The overlap between children's and adults' LEK

Acknowledging the specificity of some of children's knowledge does not preclude overlaps between children's and adults' knowledge, as –after all- they are all part of the same culture. So, the second important finding of this work is that -in parallel to the corpus of knowledge developed by and for children-some components of children's LEK relate to adult's LEK, both in content and structure.

Regarding content, there are important overlaps between children's and adults' knowledge, concerning both animals and wild edibles. This finding is not surprising and has been previously reported by research highlighting the precocious acquisition of ecological knowledge by children from small-scale societies (for examples see the works of Demps et al., 2012; Hewlett & Cavalli-Sforza, 1986; Hewlett et al., 2011; Hewlett, 2014a; Reyes-García et al., 2009; Soengas López, 2010; Zarger, 2010). For example, we found that children in middle childhood are familiar with species uncommon in their daily environment, but which are emblematic for the Baka culture. Thus, even young children are able to report animals or forest items which they rarely see and never hunt, such as gorillas, elephants or rare species of yams. Whereas those species are important for Baka adult's hunting and gathering practices, they are symbolically important for children, as they form Baka cultural cosmology (Fitzgerald, 2011). Such knowledge is likely acquired through tales, songs and reports of hunting expeditions performed by adults. Those oral stories, imaginaries or real, are important ways for children to assess adult culture (Sugiyama, 2011).

Children's LEK also relate to adult's LEK in the way it is organised, and specifically in the gendered intracultural division of knowledge. Thus, like Baka adult's LEK, children's LEK is clearly marked by the sex of the knowledge holder: boys and

girls tend to have similar levels of knowledge related to wild edibles, but boys tend to have a higher score on animal identification tests than girls (see Demps et al. (2012) for similar results). The result is not surprising as, echoing the sexual division of labour shown among adults, from an early age, since early age, children's daily life is clearly marked by their sex (Gallois et al., under review). For example, although children from both sexes spend time looking for food, there are differences in the way boys and girls practice these activities. Thus, even if girls do hunt small animals, especially in mixed-groups, hunting is a clearly boy-oriented activity. Thus, the gendered differentiation in children's knowledge is part of the construction of the gender across the lifespan (see Best (2004)), and the gendered structure of activities and LEK mimics the adult's structure of LEK. A similar early gendered differentiation of activities and knowledge has also been reported among children in other small-scale societies (Ruiz-Mallén et al., 2013; Setalaphruk & Price, 2007; Shukla & Sinclair, 2009).

4.3. The dynamic nature of children's culture

Our third finding relates to the dynamic nature of children's culture and specifically to the increasing convergence between children's and adults' knowledge as children grow up. Indeed, our data show how Baka children have expertise in specific categories, such as mice, fishes, caterpillars and mushroom, which seems to be lost in adulthood. The domains in which children have higher expertise than adults relate to items that are collected through techniques and in environments adapted to childhood, but such expertise –our results show- varies with age. Indeed, whereas children from middle childhood reported many generic terms, their knowledge became more precise with age, with adolescents reporting more accurate terms. In that sense, as also reported among other groups (Gurven, Kaplan, & Gutierrez, 2006; Hewlett & Hewlett, 2012),

the acquisition of such knowledge seems to be a requirement for the acquisition of more complex knowledge, as children seem to learn through a multi-stage process involving many actors (Reyes-García et al., 2016).

Once children enter adolescence, they begin to learn more complex skills, at the same time that they start undress their childhood behaviours, knowledge and practices (Montgomery, 2008a). Thus, our ethnographic observations suggest that the use of bow and arrows and even the use of slingshot are rare during Baka adolescence. Instead, adolescents perform collective hunting of small mammals using smoke, and they start to borrow adults' spears, mainly to kill game caught with dogs, a sign that they are entering adulthood. A similar case is observed among girls. While young girls usually play at cooking plants and gather sub-spontaneous tubers in the surroundings of the village, it is rare to see pre-teen girls indulging in such practices, and if so, it is mainly to accompany and take care of the younger ones. Among adolescents girls, these activities are being replaced by others that are more common in the adult world, such as the gathering of commercial forest products, or agricultural tasks.

In sum, through the focus of children's knowledge, the work presented here emphasises the specificity of Baka children's LEK and thus highlights the existence of a Baka 'children's culture'. While acknowledging overlaps between children's and adult's bodies of knowledge, both in content-related and structural aspects, especially concerning gender differentiation of LEK, this work brings new insights into the understanding of both childhood and LEK dynamic inside a hunter-gatherer society.

Chapter V

Children's daily activities and local ecological Knowledge acquisition

1. Introduction

Concomitant with the an increasing worldwide acknowledgement of the value of local knowledge systems (Reyes-García, 2015), a growing number of studies have been conducted to understand their depth and breadth (Zent, 2013). Recently, researchers have started to focus their attention on the Local Ecological Knowledge (LEK) held by children living in small-scale societies (Zarger, 2010). Such research has highlighted that LEK varies according to the sex and age of the child, and that this body of knowledge is mostly acquired before adolescence (Ruiz-Mallén et al., 2013; Zarger & Stepp, 2004), sometimes even before 10 years of age (Hunn, 2002), thus suggesting that childhood is a key period for the acquisition of LEK.

In their efforts to study children's LEK, researchers have used numerous methodologies, including interviews (Hunn, 2002; Zarger & Stepp, 2004), free listing, pile sorting (Setalaphruk & Price, 2007; Zarger, 2002), species identification (Cruz García, 2006; Setalaphruk & Price, 2007), and plant trails (Stross, 1969; Zarger, 2010). Few researchers, however, have focused on children's actual behavior and daily activities (for some exceptions see (Demps et al., 2012; Gurven et al., 2006). The approach is important because theoretical research suggests that what children actually do and the way they spend their time may provide important insights into the nature of

their learning (Lave, 1991; Rogoff et al., 2007), and thus on LEK acquisition. Indeed, the very definition of LEK, “*a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment*” (Berkes, Colding, & Folke, 2000: p.1252), includes the notion of *knowing things* (facts) as well as *knowing how* (Puri, 2013). In other words, LEK includes knowledge which is mostly perceptual, unconscious (Medin & Atran, 2004), intimately embodied (Marchand, 2010a), and not necessarily verbalized (Bloch, 1991). Such knowledge, we argue, might be captured through the study of daily activities.

Three bodies of theory support the preconception that children's involvement in daily activities impacts their LEK acquisition. Firstly, several anthropologists have noticed the importance of physical and social settings for cultural environmental learning (Rogoff et al., 2007; Zarger, 2010). From a very early age, children progressively acquire LEK related to the biophysical elements which are around them by observation and through their physical interactions and manipulations of environmental features (Zarger, 2010). Secondly, researchers focusing on the anthropology of learning have also acknowledged the importance of both physical and social settings for cultural learning. For example, the eco-cultural theory formulated by John and Beatrice Whiting (Whiting & Whiting, 1975) proposes that cultural aspects, and primarily maintenance systems, shapes where children go and with whom (their physical and social setting) and -therefore- what and how they learn. The way in which children spend their time is largely dependent upon or constrained by the needs of parents to do particular subsistence tasks; so children learn from these culturally established settings (Whiting, 1980). Similarly, the work of Boyette (2013) with the

Ngandu and the Aka in Central African Republic has shown how children's knowledge can differ in two different societies living in the same environment but with different subsistence patterns. Finally, a third body of research, namely practice (Bourdieu, 1979) and embodiment theories (Downey, 2010; Marchand, 2010b), emphasizes that to evaluate children's learning one should focus as much on what children do as on what they say (Marchand, 2007). Bourdieu (1979, 1986) uses the concept of *habitus* to indicate how and why daily life experiences are essential determinants in the acquisition of culture. Similarly, Ingold (2010) considers knowledge to be a process of embodiment, or *enskilment*, directly linked with the practical engagement of the individual in their surrounding environment. In a study among the Batek, Tuck-Po (2002) highlighted the importance of considering contextual knowledge, which she defined as knowledge that cannot be dissociated from the environment and that is directly embedded in the body and the mind, and showed how the local landscape is a key element for the emergence, learning and remembrance of local knowledge among the Batek.

In summary, given that the acquisition of knowledge seems to reflect the complexity of interactions between various factors which occur "*both within and without the individual, and of the spatial and temporal arrangements in which these interact*" (Marchand, 2010: p.S5) and in which both the mind and the body are involved (Downey, 2010), the analysis of context is of great importance for understanding the acquisition of knowledge. We, therefore, propose that the analysis of children's involvement in different daily activities can help us understand the process of LEK acquisition. Because there are trade-offs in the acquisition of different types of knowledge (Boyette, 2010; Morelli et al., 2003), the involvement into particular activities might be a useful tool for understanding how the process of LEK acquisition

operates. Moreover, the way in which children invest their time might be critical to understand preferences for the acquisition of different types of knowledge (Morelli et al., 2003; Sternberg et al., 2001) and can therefore potentially help predict changes in the transmission of different bodies of knowledge.

Surprisingly, and despite the importance given to context, previous studies of children's acquisition of LEK have seldom evaluated children's involvement in daily activities. This paper aims to fill this gap by analyzing Baka children's involvement in a specific set of daily activities. We first explore differences in the involvement in daily activities across the different sexes, age categories, villages and seasons, and then discuss the potential association between involvement in different daily activities and the acquisition of LEK during Baka childhood.

2. The Baka

The Baka are one of several hunter-gatherer groups living in the tropical forest of the Congo Basin. Their population, estimated at around 30.000 people, spreads across four countries: most Baka live in Cameroon, but some groups are found in the Democratic Republic of Congo, Gabon and Central African Republic. The Baka have been extensively studied (see for example Bahuchet (1991), Ichikawa (2001), Joiris (2003), Leclerc (2012)), so, rather than providing a complete ethnographic description, in this section we provide a brief general overview of the Baka and then focus on describing Baka childhood.

Until recently, the Baka were highly nomadic, moving between several forest camps and living on forest resources and the exchange of products with Bantu speaking neighboring farmers. However, over the last 50 years, the Baka have experienced

several important social changes. First, new outsiders, including missionaries, poachers, logging and mining companies, and members of international organizations representing conservationists' interests, have arrived to the territory occupied by the Baka. While interests vary from actor to actor, for the Baka, their arrival to the area has resulted in a gradual reduction in access to forest resources in general and to game and wild edibles in particular. Second, as a result of their reduced access to forest resources, Baka began to leave their forest camps, a shift reinforced by the influence of missionaries and government promoted sedentarization programs which, since the 1950's, led many Baka to establish themselves in settled villages (Althabe, 1965; Bahuchet, 1991; Bailey et al., 1992; Leclerc, 2012). Consequently, today most Baka settlements are along logging roads, some of them in proximity to Bantu speaking villages. Moreover, many Baka have started to engage in agricultural work, both by opening their own plots and by providing casual labor to neighboring Bantu villagers (Leclerc, 2012). A third important change relates to the increase of school attendance, facilitated by sedentarization. Schooling was first made available to Baka children by the missionaries and non-governmental organizations. As a result of all these changes, many Baka nowadays have adopted a mixed forager-horticulturalist subsistence strategy.

Differently from Western views of childhood, but similar to how childhood has been described in other small-scale societies (Barry S. Hewlett et al., 2011; Barry S. Hewlett, 2014a), Baka children are highly autonomous from an early age. In a way, Baka children receive the same treatment than adults, even if it is understood that they are in a learning process. For example, Baka children have the freedom to make their own decisions, but they are also considered responsible for the consequences of such decisions. Baka children are also expected to participate on daily household chores such

as fetching water, bringing meals to neighboring households, or collecting firewood. However, very few obligations are imposed upon Baka children, and physical punishment is very rare. Another important element during Baka childhood is allo-parental care: It is common that older siblings, grand-parents or adults other than the parents take care of a child (Weisner et al., 1977; Weisner, 1982). Moreover, among the Baka, it is assumed that older sisters are the secondary caregivers of infants (Hirasawa, 2005). Since Baka mothers restart their activities soon after giving birth, but since Baka infants are mostly held, it is common that children –specially girls- as young as 6 years of age are asked to accompany their mother to help taking care of infants. Due to the importance of allo-parental care, Baka children witness a high degree of physical and emotional intimacy with others, including adults outside their nuclear family and older siblings (Barry S. Hewlett, 2014a).

3. Methodology

Our study took place in several Baka communities of the department Haut-Nyong, in southeastern Cameroon, where we collected qualitative and quantitative data during 18 months, from February 2012 to May 2014. We obtained free prior and informed consent in all the villages from every individual participating in this study, as well as the consent of all the parents of the children we worked with. This study adheres to the Code of Ethics of the International Society of Ethnobiology and has received the approval of the ethics committee of the Universitat Autònoma de Barcelona (CEEAH-04102010).

3.1. The sample

Intensive field work was conducted in two communities, comprising 264 and 410 individuals, of which 145 and 208 were children (or people ≤ 16 years of age). Both communities differed in their proximity to the village of Bantu-speaking neighbors-the Nzime- and the type of school. The first community is settled on the prolongation of the Nzime farmer's village and Baka children have the opportunity to attend a public national school, together with Nzime children. In contrast, the other community is located at approximately 2 kilometers from closest Nzime neighbor village and has a private school managed by a local institution promoting schooling among the Baka.

The sample for this research included all the children between 5 and 16 years of age willing to participate. The upper limit was fixed at 16 years of age because at this age, the Baka generally start a separate household and are thus considered adults. Although evidence exists that the transmission of LEK starts earlier (Zarger, 2002), the lower limit was fixed at 5 years of age because younger children were generally too shy or too unreliable to answer interview questions.

3.2. Data collection

Over the whole period of data collection, the two first authors lived in the Baka communities, following Baka socio-cultural norms and participating on the daily life of neighboring households, e.g. while washing clothes, cooking, taking care of children, accompanying them on fishing, hunting and gathering expeditions and to their forest camps and agricultural plots. Participant observation was conducted among adults and children and with as many households as possible.

Qualitative data collection. During the first six months of fieldwork, we observed children's daily life. Additionally, we conducted spontaneous discussions and semi-structured interviews with adults and children about children's daily activities. Initially, most interviews were performed with the company of a translator. Eventually, we learned enough Baka to be able to communicate directly with our informants. To get a better understanding of children's daily life, we followed groups of boys and girls of different ages in their daily activities. During such observations, we noted the composition of the group of individuals, the location of the activity, and the amount of time invested in the activities performed. We beware of following groups of girls and boys of different ages. The qualitative information collected with such method provided us an overview of Baka livelihood and of the main patterns of Baka children' daily activities. Moreover, other than being at the basis of our questionnaire design, information collected with qualitative methods is largely used in the discussion section to interpret our findings.

Quantitative data collection. Quantitative data collection methods included a census of all the individuals living in both studied villages and a questionnaire on children's daily activities. The census included the name, age, clan, kinship data, and level of education of all children in the sample. As most Baka cannot recall their date of birth nor have birth records, we used kinship information (i.e., order of birth) to estimate the age of children in our sample.

To assess children's involvement in their daily activities, we used a systematic interview protocol consisting on asking children whether they had performed a set of selected activities during the 24 hours previous to the interview. First, we established a list of the activities most frequently conducted by children. The list was constructed using etic and emic inputs: we used information from semi-structured interviews and

participant observation during the first part of the fieldwork to identify the activities performed by boys and girls between 5 and 16 years of age. We then grouped these activities into 15 clusters of similar activities. For example, we clustered together different types of hunting, or fishing with different techniques.

During the systematic interview, we asked children to report all the activities they had performed since the previous day at the time of the interview, and we coded the activities listed in one of the 15 clusters of activities. After children had finished spontaneously listing activities, we asked whether they had also performed any of the other activities pre-defined in our list. We conducted a total of 232 interviews with 102 children, 53 boys and 49 girls, representing 34% and 64% of the children in the selected range age in the studied villages.

3.3. Data analysis

As the main goal of this work is to discuss children's involvement in daily activities in relation to the process of LEK acquisition, we grouped the 15 categories of activities in three different clusters: a) subsistence-related activities that may favor the acquisition of LEK; b) activities indirectly-related to subsistence but that might also favor the acquisition of LEK through norms, values and cosmology; and c) activities unlikely to favor the acquisition of LEK. We are aware that the notion of subsistence is disputed (Schumann & Macinko, 2007), but for the purpose of this work we included in the category of subsistence-related activities those activities that procure essential elements for living, including both nutrition and shelter. We also include activities related to the procurement and processing of resources. Consequently, our first cluster includes the following activities: household maintenance, hunting, gathering, agricultural work, fishing and handicraft and considering both work-playing and actual work. Our second

cluster includes playing, but only when the games were not related to subsistence activities from the previous cluster, traditional singing dances, tales and maintenance. Finally, our third cluster includes attending school, playing football, listening to music, alcohol drinking and socializing with Nzime people (see Table V-1).

Table V - 1 Description of children's daily activities.

Cluster	Category	Activities
Subsistence-related activities	Household maintenance	Fetching water; collecting firewood; washing clothes/dishes; sweeping house; cooking.
	Hunting	Hunting small animals with traps; hunting with sling, bow and arrows, or stones; collective hunting; hunting cable snares; hunting with spear; unearth game with smoke; wheel and <i>lékà</i> playing.
	Gathering	Gathering of sub-spontaneous and/or wild edibles products.
	Fishing	Collective fishing with dams; fishing with hook; fishing with net.
	Agricultural Work	Cleaning fields; planting or harvesting agricultural products in household's or Nzime's plots
Non-subsistence related activities	Handicraft	Making toys with plants (such as <i>Raphia sp.</i>); building replicates of <i>móngulur</i> , weaving mats and baskets.
	Play ^a	Play with Baka children; collective plays, such as hide-and-peek, and marbles; solitary plays such as wheel/car pushing.
	Maintenance	Sleeping; resting; eating with other Baka.
Activities unlikely involved in LEK acquisition	Traditional songs, tales and dances	Performing Baka's songs and dances; narrating tales; listening to tales.
	Listening to music	Listening to music
	School	Attending school; doing homework
	Other activities	Trade, hairdressing...
	Football	Football playing
	Alcohol drinking	
	Socializing with Nzime children	Spending time with Nzime children (playing, chatting...)

^a This category only includes leisure play not related to subsistence activities; plays related to subsistence or work-playing are part of the first cluster

We aggregated data collected through our structured interviews on children's main daily activities by computing the frequency with which each of the 15 categories of activities was reported by a child. To avoid the potential biases of overrepresentation of some children who were interviewed more than others, for children with more than one observation, we randomly selected one (n=102). Frequency was coded as 1 (if the activity was performed) or 0 (otherwise), independently of whether the activity was mentioned more than once in the 24-hour recall (i.e., if a child reported hunting with traps and hunting with bows and arrows we only coded hunting as 1).

Using census data, we analyzed Baka children's engagement in different activities by sex and age. Age categories were determined drawing on bibliographic references (Brisson, 2010, Joiris, 1998) and our own interviews with Baka adults and consisted in: i) middle childhood (≥ 5 -<9 years-old), ii) pre-adolescence (≥ 9 -<13 years-old), iii) adolescence (≥ 13 - ≤ 16 years-old). We also compared variation of children's involvement in the different activities analyzed according to the village of residency. Then, since our data were collected during two different seasons - the major dry season (from beginning of February to mid March) and the minor rainy season (from mid March to the end of June) - we also analyzed the variation according to the season.

To assess differences in children's involvement in daily activities by sex, village and season we calculated the difference of proportions (Agresti, 2002). For that aim, we first calculated the relative proportion of each cluster of activities (i.e. the number of observations reported by children in each cluster of activities from the total amount of observations reported) and for each of the groups of analysis (i.e., girls/boys, community closest/furthest to neighbor's village, and major dry/minor rainy season). We then ran two-sample test of proportions at the level of 95% of confidence, to evaluate differences as statistically significant (Agresti, 2002). We also test whether

there were significant differences in involvement across children from different age categories by running Fisher's exact tests for each cluster of activities. In a final analysis, we used multivariate logistic regression models to analyze the association between sex, age category, seasonality, and village of residency with each of the 15 types of activities.

4. Results

4.1. Children's main daily activities

The cluster of subsistence-related activities emerges as the one with most commonly performed activities, with several activities being performed every day by about half of the sample. Activities indirectly related to subsistence and activities unlikely related to the acquisition of LEK were less common (Table V-2).

Table V - 2 Frequency of activities' performance. For the full sample and by sex.

Cluster	Category	Full sample Frequency (n=102)		Girls Frequency (n=49)		Boys Frequency (n=53)		Results of two- proportion tests
		N	%	N	%	N	%	Z
Subsistence- related activities	Household maintenance	97	95.1	49	100	48	90.6	2.2**
	Gathering	50	49.0	28	57.1	22	41.5	1.57
	Hunting	46	45.1	9	18.4	37	69.8	-5.21***
	Agricultural work	32	31.4	18	36.7	14	26.4	1.12
	Fishing	26	25.5	17	34.7	9	17	2.05**
	Handicraft	12	11.8	3	6.1	9	17	-1.71*
Non- subsistence related activities	Plays	60	58.8	29	59.2	31	58.5	0.07
	Maintenance	25	24.5	9	18.4	16	30.2	-1.38
	Traditional songs, tales and dances	9	8.8	6	12.2	3	5.7	1.16
Activities not involving LEK acquisition	Listening to music	46	45.1	25	51	21	39.6	1.16
	School	22	21.6	11	22.4	11	20.8	0.2
	Other activities	13	12.7	4	8.2	9	17	-1.33
	Football	13	12.7	1	2	12	22.6	-3.12***
	Alcohol drinking	12	11.8	5	10.2	7	13.2	-0.47
	Socializing	6	5.9	1	2	5	9.4	-1.59

* p>.1; **p<.05; ***p<.01

Among the subsistence related activities, household maintenance was predominant. Children mentioned having conducted household maintenance in almost 95% of the interviews. Other common activities in this cluster included hunting and gathering, reported in 45% and 49% of the interviews. Agricultural work was reported in 31% of the interviews, fishing in 25.5% and handicraft in 12% of the interviews (Table V-2).

Among the non-subsistence related activities, wherein LEK might be indirectly acquired, playing appears as the most frequently mentioned activity, reported in almost 59% of the interviews. Overall, playing is the second most frequently cited activity, after household maintenance.

Finally, among the activities unlikely related to LEK acquisition, listening to music was reported in 45% of the interviews, whereas attending school was only reported in 22% of the interviews.

4.2. Gendered involvement in daily activities

Boys and girls show different levels of involvement in most, but not all, activities (Table V-2). We found an overall similar frequency of participation in activities related to household maintenance, but statistically significantly different between boys (almost 91% of the interviews) and girls (100 % of the interviews), although this similarity masks differences in the specific activities performed (Table V-3). Thus, a closer look at the data shows that water fetching was listed in 71% of the interviews conducted with girls, but only in 58% of the interviews conducted with boys; similarly cooking was mentioned in 92% of the interviews conducted with girls, but only in 13% of the interviews conducted with boys.

Table V - 3 Frequency and percentage of listing activities related to household maintenance, by sex.

Activities	Girls		Boys	
	N	%	N	%
Cooking	45	91.8	23	13.4
Caretaking Children/Babies	17	34.7	11	20.8
Fetching Water	35	71.4	31	58.5
Collecting Firewood	13	26.5	10	18.9
Washing Clothes/Dishes	16	32.7	11	20.8

Statistically significant differences exist in the frequency boys and girls perform hunting and fishing activities. Hunting appeared as a male orientated activity, with which boys (70%) and girls (18%) report hunting (Table V-3). In contrast, fishing is a girl-oriented activity, with girls reporting fishing twice as often as boys (35% vs. 15%). In the same line, but to a lower extent, gathering activities tend to be more girl- than boy-oriented (cited in 57% of the interviews with girls and in 41% of the interviews with boys). From all the activities in the cluster of subsistence related activities, the only one that seems to be reported with similar frequency between boys and girls is agricultural work.

Girls and boys seem to engage with the same frequency in activities indirectly related to subsistence, with one exception: Girls report performing traditional songs, tales, and dances more frequently than boys (12% vs. 6%) (Table V-2). Regarding activities unlikely related to LEK acquisition, the only statistically significant difference

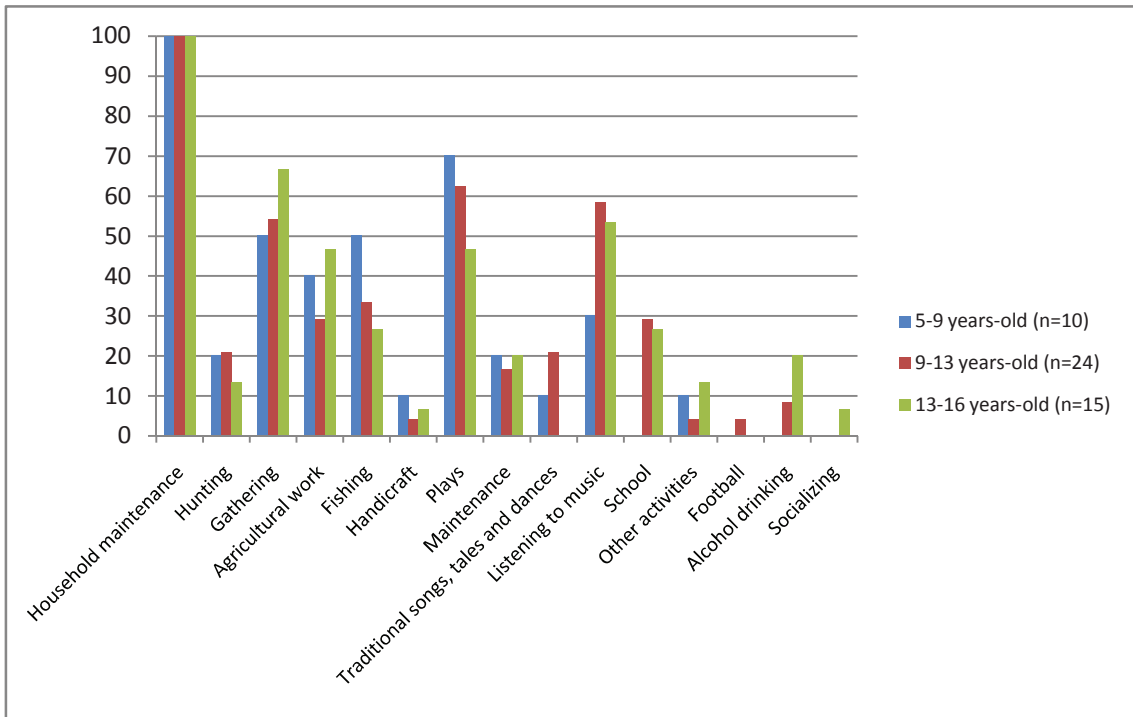
between girls and boys relates to playing football, a male-oriented activity in the study area (23% for boys vs. 2% for girls) (Table V-3).

4.3. Variation among age-sex categories

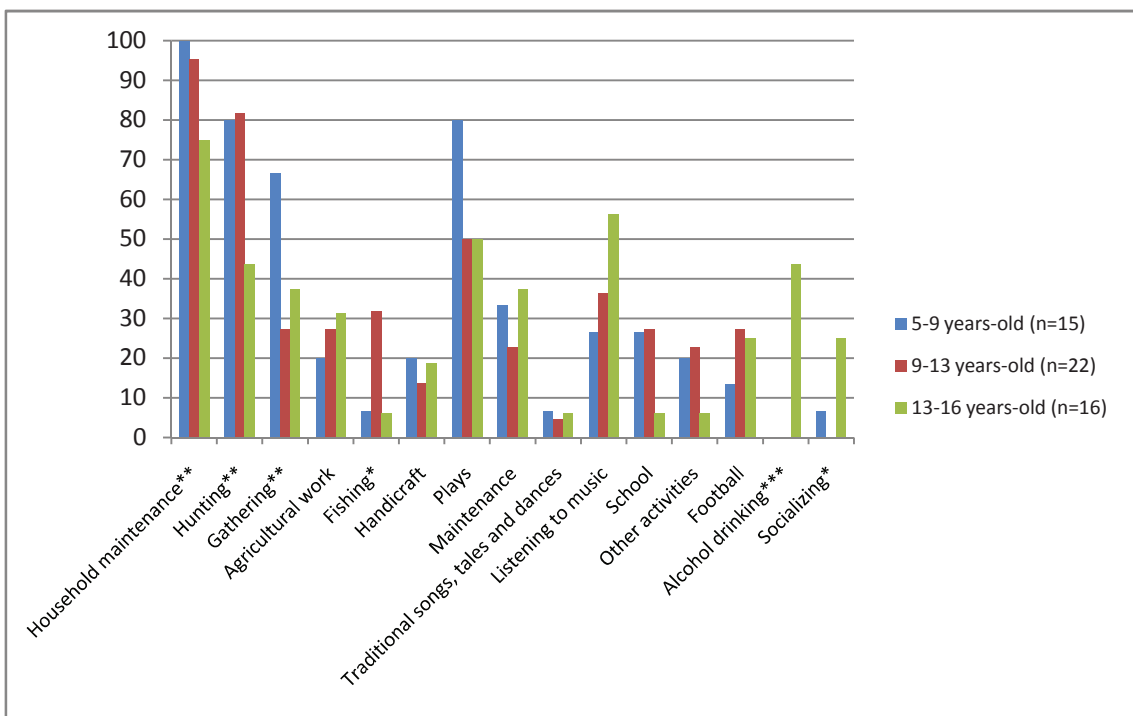
Given the magnitude of the gendered differences found, we kept the sample of boys and girls separated to analyze children's involvement in daily activities by age-categories (Figure V-1a). Overall, the analysis shows differences in time investment as girls and boys move from middle childhood to adolescence. Among the activities related to subsistence, as they grow up both girls and boys perform hunting activities and play less frequently. In contrast, they spend more time performing activities unlikely related to the acquisition of LEK, such as socializing, listening to music and drinking alcohol. As girls move into adolescence, they invest less time in fishing, reported only in 26.7% of the interviews of adolescent girls vs. in 50% of the interviews of middle childhood girls (Figure V-1). In the same line, adolescent girls invest even less time in hunting activities than middle childhood girls do (13.3% vs. 20%). Contrarily adolescent girls are more frequently involved in agriculture (47% vs.40%) and in gathering activities (67% vs. 50%) than middle childhood girls.

Figure V - 1 Percentage of children's activities by sex and age category.

a) Girls



b) Boys



* $p > .1$; ** $p < .05$; *** $p < .01$ at the Fisher's exact tests

Although the differences on the frequencies of activities between age categories appear higher among girls, we only found statistically significant differences between age categories in the frequencies of activities among boys (Figure V-1b), which were especially related to hunting, gathering, and household maintenance. As boys enter adolescence, they become less frequently involved in hunting (reported in 44% of the interviews with adolescent's boys vs. 80% of the interviews with middle childhood boys). Differently to girls, boys are less frequently involved in household maintenance activities as they grow up. Also in contrast to the pattern found among girls, adolescent boys allocated less time than younger boys to gathering activities (38% of the interviews of adolescents boys vs. 67% of middle childhood boys).

4.4. Differences among villages

Overall, we found few differences regarding frequency of involvement in the selected activities between children and adolescents of the two studied villages: the only statistically significant differences appear in agricultural activities, school and alcohol consumption (Table V-4). Children in the community further to Nzime's village, the most isolated village, reported engaging in agriculture two-times more often than children from the other community (43.1% vs. 15.9%). Children reported drinking alcohol more frequently in the community further to Nzime's village than in the other community (19% vs. 2%). Children tend to attend school (27.6% vs. 13.6%) more frequently in the community further to Nzime's village, where they have a school directed by missionaries, than in the other community where they share the school with the Nzime.

Table V - 4 Children time allocation, by village.

Cluster	Category	Community closer to Nzime's village		Community further to Nzime's village		Results of two-proportion tests	
		Frequency (n=44)		Frequency (n=58)			
		N	%	N	%	Z	
Subsistence-related activities	Household maintenance	43	97.7	54	93.1	-1.07	
	Hunting	16	36.4	30	51.7	1.54	
	Gathering	20	45.5	30	51.7	0.63	
	Agricultural Work	7	15.9	25	43.1	2.93***	
	Fishing	14	31.8	12	20.7	-1.28	
	Handicraft	4	9.1	8	13.8	0.73	
Non-subsistence related activities	Plays	23	52.3	37	63.8	1.17	
	Maintenance	7	15.9	18	31	1.76*	
	Traditional songs, tales and dances	3	6.8	6	10.3	0.62	
Activities not involving LEK acquisition	Listening to music	17	38.6	29	50	1.14	
	School	6	13.6	16	27.6	1.7*	
	Other activities	8	18.2	5	8.6	-1.43	
	Football	6	13.6	7	12.1	-0.24	
	Alcohol drinking	1	2.3	11	19	2.59**	
	Socializing	4	9.1	2	3.4	-1.2	

* p>.1; **p<.05; ***p<.01

4.5. Seasonal variation

Children's involvement in different activities does not seem to vary between the both seasons (Table V-5). Nevertheless, we found statistically significant differences for two subsistence activities that were more frequently performed during the dry than during the minor rainy season: hunting and agriculture. Hunting was mentioned in 63% of the interviews conducted during the dry but only in 33% of the interviews conducted during the minor rainy season. Agricultural work was listed in 44% of the interviews conducted during the dry season but only in 23% of the interviews conducted during the rainy season. To a smaller extent, gathering and fishing activities were also more frequently performed during the dry season (54% vs. 46% for gathering and 29% vs. 23% for fishing).

Activities indirectly related to subsistence show seasonal differences. Playing was reported more frequently during the minor rainy season than during the dry season (62% vs. 54%), a seasonal distribution that probably relates to the higher frequency of subsistence activities during the dry season. Interestingly, children also seem to perform more frequently maintenance activities during the dry than during the minor rainy season (32% vs. 20%). Finally, whereas children tend to perform activities unlikely related to LEK acquisition in the same frequency during both seasons, alcohol drinking is almost three-fold more frequent during the dry than during the rainy season (20% vs. 7%).

Table V - 5 Frequency of children's activities, by season (18 girls and 23 boys during dry season; and 31 girls and 30 boys during the rainy season).

Cluster	Category	Dry Season Frequency (n=41)		Rainy season Frequency (n=61)		Results of two- proportion tests
		N	%	N	%	Z
Subsistence-related activities	Household maintenance	38	92.7	59	96.7	-0.93
	Hunting	26	63.4	20	32.8	3.05***
	Gathering	22	53.7	28	45.9	0.77
	Agricultural Work	18	43.9	14	23	2.24**
	Fishing	12	29.3	14	23	0.72
	Handicraft	5	12.2	7	11.5	0.11
Non-subsistence related activities	Plays	22	53.7	38	62.3	-0.87
	Maintenance	13	31.7	12	19.7	1.39
	Traditional songs, tales and dances	3	7.3	6	9.8	-0.44
Activities not involving LEK acquisition	Listening to music	18	43.9	28	45.9	-0.2
	School	9	22	13	21.3	0.08
	Other activities	3	7.3	10	16.4	-1.37
	Football	5	12.2	8	13.1	-0.14
	Alcohol drinking	8	19.5	4	6.6	1.99**
	Socializing	2	4.9	4	6.6	-0.35

* p>.1; **p<.05; ***p<.01

4.6. Correlates of children's involvement in daily activities

Logistic regression analysis mostly confirms results from bivariate analysis (Table V-6). Namely, a set of multiple logistic regressions with the frequency of performance in the different categories as dependent variables show that differences between both sexes are statistically significant for most activities included in the cluster of subsistence related activities. Hunting is a boy-oriented activity (odd ratio=13.6. $p < 0.001$), whereas gathering and fishing are girl-oriented activities (respectively odd ratio=0.5. $p > 0.1$; and odd ratio=0.37. $p < 0.05$). Since all girls performed household maintenance, we cannot compute a coefficient for this activity. Boys are much more frequently involved in football than girls (odd ratio=14.75. $p < 0.05$). The variable sex is not statistically significant for the other activities.

Table V - 6 Results of multivariate logistic regression among the different categories of activities.

Cluster	Category	Pseudo R ²	Predictors			Community closer to Nzime's village
			Male	Age	Dry Season	
Subsistence-related activities	Household maintenance	0.17	omitted	0.72*	1.56	1.77
	Hunting	0.30	13.6***	0.86*	0.20***	0.87
	Gathering	0.03	0.50*	0.95	0.76	0.79
	Agricultural Work	0.11	0.53	1.11	0.56	0.32*
	Fishing	0.08	0.37**	0.94	0.44	2.37
	Handicraft	0.05	3.09	1.01	1.22	0.62
Non-subsistence related activities	Plays	0.08	0.94	0.83***	2.34*	0.35**
	Maintenance	0.05	1.83	0.99	0.72	0.50
	Trad. songs, tales and dances	0.04	0.41	0.95	1.8	0.45*
Activities not involving LEK acquisition	Listening to music	0.05	0.62	1.13*	1.36	0.57
	School	0.04	0.84	0.95	1.46	0.34*
	Other activities	0.07	2.60	0.98	2.04	1.95
	Football	0.15	14.75**	1.06	1.12	1.34
	Alcohol drinking	0.45	1.27	2.06***	0.75	0.15
	Socializing	0.26	6.07	1.63**	0.43	11.14

Note: Cells include the odd ration. * p<.10; **p<.05; ***p<.01

Multivariate models also confirm the importance of age in explaining children's involvement in daily activities. Thus, older children engage less frequently in household maintenance and hunting (respectively odd ratio=0.72. $p<0.1$; odd ratio=0.86. $p<0.1$). Age is also negatively associated to play (odd ratio=0.83. $p<0.01$), but positively associated to alcohol drinking (odd ratio=2.06. $p<0.01$), socializing (odd ratio=1.63. $p<0.5$) and, to a lower extent, to listening to music (odd ratio=1.13. $p<0.1$).

Finally, results from our Multiple Logistic Regressions also show that there are some differences between both villages but not from one season to another. Thus, children from the community closest to Nzime's village tend to be less engaged in agricultural work (odd ratio=0.32. $p<0.1$), play (odd ratio=0.35. $p<0.5$), traditional songs and dances (odd ratio=0.45. $p<0.1$), and school attendance (odd ratio=0.34. $p<0.1$) than children from the other community. In relation to the season, the only associations found relates to a lower frequency of hunting during the dry season (odd ratio=0.2. $p <0.01$) and a higher frequency of play during the dry season (odd ratio=2.34. $p<0.1$).

It is worth noting that most multiple logistic regressions explain, a relatively small fraction of the variation found (about 10% for most regressions), which suggest that other variables not accounted for in our model do affect children's involvement in daily activities. The two activities best explained by the variables included in our models are hunting, for which the model explained almost 30% of the variation, and alcohol drinking (45%).

5. Discussion

We organize the discussion around two main results derived from our analysis: a) differences in children's involvement in traditional and new daily activities according to sex and age-category; and b) the relative importance of different activities in relation to their potential for LEK acquisition.

5.1. Baka childhood: Similarities and differences between boys and girls and across age groups

A main finding of our work is that, irrespectively of their sex and age category, most Baka children engage in household maintenance, a finding also reported among other small-scale societies (Boyette, 2013; Ruiz-Mallén et al., 2013). Similar to what has been reported in other societies (Lancy, 2008), and also according to adults' information, from the earliest age, Baka children are expected to participate in household maintenance, especially helping their mothers with tasks such as collecting firewood, fetching water, and taking care of younger siblings or relatives.

Differently to what has been reported in farmer societies (Barry S. Hewlett & Lamb, 2005), Baka children are not expected to directly participate in household's economy, a situation that has led some researchers to coin the notion of 'children in paradise' (Lancy, 2008). Nevertheless, Baka children are frequently involved in subsistence related activities including hunting, gathering, fishing, and even agricultural labor. Interestingly, our ethnographic observation suggested that Baka children seem to perform these subsistence activities mostly out of enjoyment, as even productive activities are often embedded in games (see Kamei (Kamei, 2005) for the importance of

play among the Baka). However, as it is the case in other settings (Bird & Bliege Bird, 2005; Crittenden et al., 2013; Tucker & Young, 2005), many of those activities provide them with an important part of their nutritional intake during parental absences. Thus, from early age, Baka children hunt birds or rodents or gather sub-spontaneous tubers which are immediately cooked and eaten by the children themselves. These activities, in addition to contribute to their own subsistence, also contribute to strengthen children's autonomy and independence (Boyette, 2010; Gardner, 1991; Barry S. Hewlett et al., 2011).

An important finding of our work relates to gender differences in Baka children's daily activities. Among the Aka, another hunter-gatherer group from the Congo Basin, Boyette (2010) found that the only difference in children's time allocation relates to childcare, an activity which is more performed by Aka girls. However, other studies among farmer societies (Kramer, 2005; Lancy, 2008), and also among hunter-gatherer (Ruiz-Mallén et al., 2013), have found gender differences in children's activities from a appear at young age. Here, Baka children tend to reproduce adult's same-sex activities: girls are more involved in children caretaking, cooking, agricultural work and fishing, as Baka women are in their daily life, whereas as Baka men, Baka boys are more often involved in hunting. Furthermore, in addition to differences in frequency of engagement in certain activities by boys and girls, additional gendered differences exist regarding the way in which such activities are practiced. For example, although girls occasionally hunt, they only hunt little mammals using their hands or the machete, and later, during adolescence, they unearth game with smoke. Boys, however, use a broader diversity of techniques for hunting, such as bow and arrows, slingshot, spear and snares. Contrarily, fishing is more frequent among girls, although boys also fish. While girls typically engage in a collective fishing elevating dams and extracting

the water, boys are more likely to use poles or ichthyotoxics, techniques practiced generally alone or in reduced groups (for a similar finding see Díaz-Reviriego et al. (*under review*)).

It is worth noting, however, that while some activities are clearly gender-oriented, it does not seem to be an exclusionary gender distinction, and thus girls and boys, as women and men, occasionally perform activities most commonly performed by people from the different sex. This emphasizes the importance of a certain flexibility of gender roles, a common, but seldom noted distinction of hunter-gatherers versus farmers (Noss & Hewlett, 2001).

The study of children's involvement in daily activities also shows changes as children grow up. Similar to what Boyette reported among the Aka (Boyette, 2013), Baka children tend to spend less time playing and more time in productive and specifically in income generating activities (i.e. agricultural wage labor or commercial hunting and gathering) once they become adolescents. Ethnographic information suggests that both Baka children and adolescents considered that one of the most important things to know before adulthood is how to perform agricultural work. In parallel, girls consider household maintenance as a priority as to what an adult has to know. Such reports of what activities are important are consistent with the greater amount of time adolescents devote to those activities.

Thus, consistent with the Whiting's (Whiting, 1980) predictions about subsistence and cultural learning environment, our data suggest that Baka children's daily activities are shaped by their specific cultural settings and that the sex and the age of the child are important factors that pattern children's development. However, in contrast with their findings, Baka children's daily activities seem to be shaped rather by

children's own choices than by their parental subsistence activities, as already reported elsewhere (Gallois et al., *under review-b*). Baka children have extensive autonomy in their daily life, a pattern common among hunter-gatherer societies (Barry S. Hewlett, 2014a), but witness early gender differences, similar to what has already been reported among several farmers societies (Lancy, 2008).

The last part deserving this section relates to the performance of new activities, which were not previously reported for hunter-gatherer children, such as attending school and new forms of leisure (i.e., soccer, or listening to African popular music). Consistent with previous studies, both among the Baka (Kamei, 2001; Pyhälä, 2012), and among several other hunter-gatherer groups (Reyes-García et al., 2010; Ruiz-Mallén et al., 2013), we found that school attendance is very limited. Thus, for the school year 2012-2013, only 54% of the schooled-aged children were actually registered at school. Furthermore, even for the registered children, school attendance was low and short, and decreased as the year advanced. Reasons for this low attendance do not differ from those highlighted by Kamei (2001): such as lack of fit between the national educative system and Baka's livelihood or teachers' low level of commitment. Consequently, children quickly loss interest in schooling, and typically they do not complete their classes. However, it is worth mentioning that schooling varies according to the type of school. Indeed, in the community further to Nzime's village, where missionaries settled the specific school only for Baka, schooling was significantly higher than in the other community with a public school where Baka and Nzime children attend classes together. Differently from schooling, a new form of leisure, such as listening to music, was a very common activity for Baka children. Listening to music was reported in more than 40% of the interviews. From our ethnographic experiences, we know that children generally listen to African popular music during the evening

where they might also drink alcohol. These activities, generally highly appreciated by all the Baka, are much performed by adolescent and young adults, as those activities might also give to them the opportunity to socialize and to potentially find a future partner, what appears as one of the most important aspect for this stage of age, as also reported among other hunter-gatherer societies (B. L. Hewlett & Hewlett, 2012).

5.2. LEK acquisition through daily activities

We devote the second part of this discussion to analyze how the time involved into the different activities might shape LEK acquisition, and to describe how such acquisition varies according to the age and the sex of the children.

First, as mentioned, activities in which LEK is related to subsistence are predominant during Baka childhood. All along their childhood, most of the activities Baka children perform occurs in their natural environment and relate to subsistence. The central place of activities related to household maintenance underscores the importance of such activities for knowledge acquisition, both to obtain the cultural bases of adult's livelihood and to acquire LEK. Indeed, activities such as fetching water, collecting firewood, cooking, sharing meals, or even taking care of younger siblings are considered as key elements in Baka children's learning process. According to the parents, performing such activities is part of their learning. It is worth noticing that while conducting such household chores, especially those that take place in the forest, children also have the freedom to perform other activities such as hunting little birds, fishing, or gathering mushroom. Adults clearly know that those tasks let children learn and practice on their own, alone or in groups of peers, skills that they would later need.

Moreover, the acquisition of LEK follows a sexual division of labor. Boys and girls are more involved in sex-specific than in general activities, acquiring embodied knowledge and practices. During their youngest childhood, boys spend a considerable amount of time hunting, whereas girls invest more time fishing. Such use of time highlights the importance of childhood to acquire and embody such knowledge. Time involved in both activities decreases once they become adolescents; however these activities imply specific knowledge and more complex techniques than the most of other activities. Although hunting, as performed by adult men, implies the mastering of several techniques which might be only acquired over the long period (see Gurven et al. (2006) for an estimation of the time it takes to become a hunter), the high involvement of children in middle childhood in the practice of these technical activities might be considered as essential for the acquisition of hunting-related LEK, as these skills become embodied at this early age, illustrating the assumption of multi-stage learning process.

Another aspect of knowledge acquisition to consider is the daily use of time as it relates to the variation and complexity of techniques and practices across lifespan. The number and complexity of children's tools and practices related to subsistence increase with age. Hunting provides a particular example of such change. From the earliest age, children perform various hunting-related games, such as shooting wheels, throwing spears to easy-to-target objects and animals and then, children from middle childhood use very popular hunting tools: the *mèndàmbà*, small replicas of the common snare with cable used by adults (called *mòlingè*). Differently, adolescents prefer hunting with spears or collective hunting of small mammals using smoke. In that sense, children's activities also show that LEK acquisition is following "multi-stage learning model", concept proposed in a recent work (Reyes-García et al., 2016) stipulating that children

would first acquire basic knowledge and abilities which then in turn allows them to build progressively on more complex skills and knowledge. We find similar situation in the gathering of wild edibles. Even young children easily gather tubers of spontaneous agricultural plants, such as *mèbùtâ* (*Ipomoea batatas*), and *lángá* (*Xanthosoma mafaffa*) growing around the village. Differently, adolescents gather wild edibles, such as the leaves of *kɔkɔ* (*Gnetum africanum*), which constitutes an important component of the household consumption. Adolescents also gather forest products, such as *mbalaka* (*Pentaclethra macrophylla*), *màbè* (*Baillonella toxisperma*), or *payo* (*Irvingia excelsa*), that can be sold in local markets. Although gathering does not require many tools and techniques (except for some specific products such as honey and yam we will not present here), effective gathering requires the acquisition of knowledge related to observation, the capacity of wild edibles identification, and the ability to navigate the landscape, abilities that also evolve across the lifespan.

Finally, as neither schooling nor listening to music were traditional activities of Baka (Althabe, 1965b), their performance might have unknown effects on LEK acquisition. Studies focusing on the impact of schooling on LEK (see Reyes-García and colleagues (2010) for an example), have neglected children's involvement in new activities such as the one reported here. Results from our study show that Baka children seem to devote more time to modern leisure than to schooling, suggesting that the important question to ask is whether such types of activities are the ones that actually replace activities wherein LEK might be acquired. Considering that children might spend large amount of time in such activity, one could speculate on its actual impact on the acquisition of cultural representations and knowledge. As this activity is mostly conducted at night, at first sight one might think that it does not replace any other activities which could be more related to LEK acquisition. However, the fact is such

leisure activity does replace the performance of tales, songs and traditional dances, which play an essential role for the acquisition of cultural knowledge, as reported among other African hunter-gatherers (Lewis, 2013). Indeed, even if many of Baka songs and dances are principally performed during rituals, funerals or social events, which are always apparently well followed, tales and many of children's songs and dances, especially girls' songs, begin as night falls (Fürniss, 2005). Even if the impact of those activities on the process of LEK acquisition seems still low, such activities do affect Baka daily life and social cohesion, as reported in a recent work (Townsend, 2015). In this sense, we need longitudinal data to evaluate the long-term impact of those activities on children's daily life and knowledge acquisition. Although some studies exist, such as the study of White (White, 2012) on children's use of time in Java comparing children's time budgets in the 70s and the 90s, they are not very common. In that sense, our data represents a valuable baseline for future research.

Chapter VI

On the multiple strategies of learning: LEK acquisition during middle childhood and adolescence.

1. Introduction

A variety of disciplines including anthropology, psychology and education have addressed cultural transmission, or how different aspects of culture are passed from one individual to another (Guglielmino et al., 1995; Henrich & Broesch, 2011; Hewlett & Cavalli-Sforza, 1986; Hewlett et al., 2011). This body of research, which includes work among small-scale societies, has yielded four important findings. First, in small-scale societies cultural knowledge is mainly acquired through observation and imitation during daily activities (Gaskins & Paradise, 2010; Rogoff et al., 2007; Zarger, 2010). The active or passive engagement of the learner with the environment through daily activities performed in the company of others shapes the content of the knowledge the individual acquires (Bliege Bird & Bird, 2002; Demps et al., 2012; Gurven & Kaplan, 2006; Haselmair et al., 2014; Ingold, 2010; Rogoff et al., 2007).

Second, the acquisition of cultural knowledge starts early in life. Thus, research shows that, in small-scale societies, the acquisition of large amounts of subsistence-related knowledge generally occurs before individuals reach 12 years of age (Demps et al., 2012; Gurven et al., 2006; Barry S. Hewlett & Cavalli-Sforza, 1986; Hunn, 2002; Reyes-García, Broesch, et al., 2009; Schniter et al., 2015; Zarger, 2002).

Third, cultural transmission can follow several pathways and, while one pathway can be temporally predominant, oftentimes the transmission of cultural knowledge occurs simultaneously through two or more pathways. For example, Boyette (2013) reported that among the Aka, children between four and sixteen years of age acquire knowledge mainly through horizontal transmission whereas adolescents favor oblique transmission. Differently, Hewlett and colleagues (2011) found that cultural transmission between children from the same age (horizontal) and from non-parental adults or older children to younger children (oblique) simultaneously occur during middle childhood. In other words, in contrast to previous works highlighting the importance of vertical transmission during childhood, recent research suggests that children might, indeed, use different strategies and even combine multiple learning strategies to update their cultural knowledge in what has been named a multiple-stage learning pattern (Reyes-García et al., 2016; Schniter et al., 2015).

Finally, the last important finding on research on cultural transmission in small-scale societies is that, knowledge acquisition might also be influenced by individuals characteristics, i.e. sex, age or social status, and how such characteristics condition group composition. For example, cultural acquisition might be shaped by social preferences to form groups with same-sex or same age individuals (what is known as homophily) (Acerbi & Bentley, 2014; Wood et al., 2013), or by social proximity to high prestige individuals (Chudek et al., 2012; Henrich & Gil-White, 2001; Henrich & McElreath, 2003; Richerson & Boyd, 2005).

The idea that children make use of multiple strategies for learning points to the importance of understanding social structure to grasp the process of cultural transmission, as children would likely learn from different sources (people) over the course of their lifespan (Bliege Bird & Bird, 2002; Gurven & Kaplan, 2006; Haselmair

et al., 2014; Ingold, 2010; Rogoff et al., 2007). However, we know of no study focusing on children's social organization and how such organization might relate to their acquisition of cultural knowledge. The gap is surprising given that, in other settings, researchers have long assessed the processes through which different aspects of culture (i.e., information, practices, tools) are transmitted within a given social group (Phelps et al., 2012). Such work has generally used social network analysis to study the flow of knowledge in the context of companies (e.g., Brown & Duguid, 2001; Tsai, 2002) or through the online social networks (e.g., Subramani & Rajagopalan, 2003; Wasko & Faraj, 2005), with only a handful of scholars recently focusing on how social structures shape the flow of non-written knowledge (Calvet-Mir et al., 2012; Hamilton et al., 2007; Hopkins, 2011; Labeyrie, Rono, & Leclerc, 2013; Salpeteur et al., 2015).

Here, we contribute to this nascent body of research by exploring the social network composition of children from a hunter-gatherer society from the Congo Basin: the Baka from southeastern Cameroon. Specifically, we focus on the children's social network composition during subsistence activities (i.e., hunting, gathering, fishing and agriculture). Assuming that people performing activities together share related information and knowledge related to the activity, we aim to analyze the composition of children's networks while conducting such activities to potentially elucidate differences in knowledge flow across the different activities, and across groups of different ages, sex, and kin relation.

By exploring the composition of children's social network, we aim to assess three main aspects related to cultural knowledge acquisition. First, by exploring with whom children are while performing subsistence activities, we aim to evaluate the likelihood that vertical, horizontal and oblique transmission occur during children's performance of subsistence activities. This will be assessed by looking at the presence

of older, younger children or peer as main companions during such activities. Second, by exploring whether the predominant child's companions vary according to the sex and the age of the child, we aim to evaluate whether there is a gendered preference in the model-biased transmission. We do so, by looking at the kinship, age and sex of the individuals across a range of subsistence activities. Finally, by looking at the overall structure of children's networks during different subsistence activities, we aim to assess whether there is tendency in the structure of the flow of information according to the activities performed, and whether such structure vary according to the age and the sex of the child.

The work presented here is original in at least two ways. First, although a handful of studies have used social network analysis to examine the social organization of hunter-gatherer societies (see Apicella et al. (2012); Hamilton et al. (2007); Hill et al. (2011); Hooper et al. (2013)), these studies have mostly focused on social processes such as cooperation, reciprocity and competition, and not on the transmission of knowledge, although in some instances researchers have done inferences about how social networks affect the transmission of knowledge. For instance, in a study among the Ache and the Hadza, Hill and colleagues (2014) calculated the number of individuals with whom an adult might interact during her lifespan arguing that the number of people participating in social interactions is critical to understand cultural transmission and evolution. Second, most studies on childhood in small-scale societies have focused on early childhood (Barry S. Hewlett, 2014a). Differently, here I focus on middle childhood and adolescence (for some works on those periods see Hewlett et al., 2011; Hewlett & Lamb, 2005; Hewlett, 2014a), thus filling a gap in our understanding of knowledge acquisition at different moments of the lifespan.

2. The Baka

The Baka are a society of about 30,000 individuals living in the tropical forest of the Congo Basin. Their territory spreads among four different countries: the Republic of Congo, Gabon, Central African Republic and Cameroon (Joiris, 1998; Leclerc, 2012). The Baka have traditionally been a nomadic society, mostly living on hunting, gathering, fishing and exchanging products with their sedentary Bantu-speaking neighboring farmers. In southeastern Cameroon, the Baka have experienced several changes since the 1950s. Thus, due to the increasing arrival of outsiders into their territories, the reduction of forest resources (especially game), and the pressures by missionaries and governmental programs, the Baka have been settling in permanent villages mostly along the newly opened logging roads (Althabe, 1965b; Bailey et al., 1992; Leclerc, 2012). Nowadays, Baka mostly live in those permanent settlements, moving to their forest camps only during the season when they gather commercial Non Timber Forest Products (NTFP). While in the forest camps, they generally live in small bands (around 30 people), a situation that contrast with their live in the village, where the population can reach several hundreds of people. Even if Baka people are still highly dependent of forest resources, most of them also engage in agricultural work, both by cultivating their own plots and by providing casual labor to neighboring Bantu villagers (Leclerc, 2012).

Several scholars have studied Baka social organization highlighting that among the Baka 1) the family nuclei is the basis of social organization, with acephalous bands grouping several nuclear families (Joiris, 1998; Leclerc, 1999), 2) interethnic relations with farmer neighbors are deeply embedded in Baka culture (Joiris, 1998; Rupp, 2003),

3) there is a sexual division of labor (Joiris, 1998; Leclerc, 1999), and 4) egalitarianism and sharing are common (Joiris, 1998).

Moreover, researchers have also pointed at specific features of Baka childhood. First, as also reported among other hunter-gatherers societies (Barry S. Hewlett, 2014a), Baka children benefit since infancy of a high presence of allomaternal care, provided by family and non family members. Second, as highlighted elsewhere (Gallois, Duda, & Reyes-García, *under review -c*), Baka children present a high autonomy and independence during the performance of their daily activities. Finally, as shown among other African hunter-gatherers, knowledge transmission among the Baka is based on participation in daily activities, where learning is self-motivated and mainly occurs through observation and imitation (Barry S. Hewlett, 2014a)(Sonoda, 2014).

3. Methods

This study took place in two Baka communities from the Haut-Nyong Department, in the East Province of Cameroon. We firstly obtained Free Prior and Informed Consent in both villages and with every individual participating in this study. For children, we asked for parental consent. This study adheres to the Code of Ethics of the International Society of Ethnobiology and received the approval of the ethics committee of the Universitat Autònoma de Barcelona (CEEAH-04102010).

3.1. Ethnographic data collection

We conducted fieldwork in two communities where we lived during 18 months, from February 2012 to May 2014. These communities comprised 264 and 410 individuals, of which more than 50% were under 16 years-old and thus considered

children for the purpose of this study. Data collection was facilitated by immersion in Baka life, efforts to learn Baka language, adherence to social and cultural norms (on sharing, cooking, children caretaking, etc.), and participation in Baka daily life, from joining Baka during forest activities as gathering and fishing, to helping on domestic work as cooking, washing clothes, and the like.

3.2. Systematic data collection

Systematic data collection tools included a census of all the individuals living in both studied villages and a questionnaire on children's daily activities. Data collected with the census included the name, age, clan, and kinship relations of all people living in the village. As most Baka cannot recall their date of birth or have birth records, we used kinship information (i.e., order of birth) to estimate the age of children in our sample.

Systematic data collection on children's daily activities was conducted with a total of 102 children (49 girls and 53 boys), representing 34% and 64% of the children in the studied villages, where children are defined as individuals between 5 and 16 years of age. Although LEK acquisition starts earlier in life, we worked with children five years of age and older because younger children were too shy to answer to our questions. The upper limit was fixed at 16 years as, at about this age, young Baka typically form new households and are thus considered adults (Gallois et al., n.d.-b).

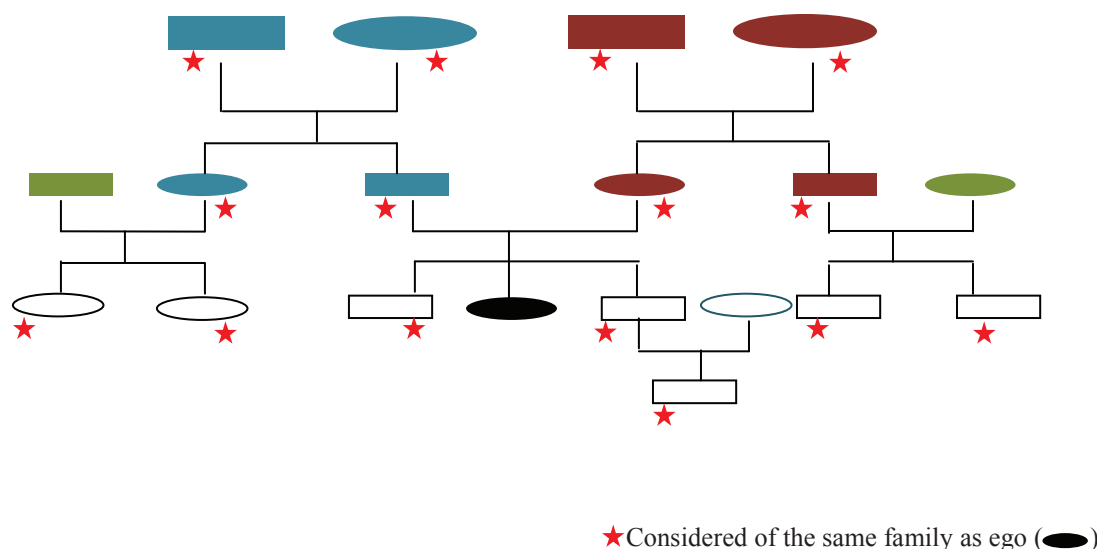
To assess children's social networks, we used self reported data collected through interviews. We first asked children whether they had engaged in hunting, gathering, fishing or agriculture during the 24 hours prior to the interview. Multiple reports of the same activity (i.e., hunting twice) were recorded independently, so each

time a child performed one of the selected activities was recorded it as a different observation. For each observation, we asked the children to report the name of all the individuals that were with her while performing the activity. A total of 232 interviews were conducted, from which 21 children were interviewed more than four times, 15 were interviewed three times, 24 were interviewed twice, and 42 were interviewed only once.

3.3. Data Analysis

We started the analysis by coding information on people accompanying the interviewed child during daily activities. Specifically, we used census data to derive the a) sex, b) age-category, and c) kinship relation with the respondent of all the people listed. Drawing on bibliographic references (Brisson, 2010; Joiris, 1998) and our own ethnographic data, we divided our sample in five age-categories: infants (<5), middle childhood (≥ 5 -<9 years-old), pre-adolescence (≥ 9 -<13 years-old), adolescence (≥ 13 - ≤ 16 years-old), and adults (>16). To classify kinship relations, we differentiate between people from the same nuclear family and others. Specifically, we considered that individuals were from the same nuclear family in the case of a) siblings, b) parents, c) grand-parents, d) biological uncle/aunt, e) direct cousin, or f) biological niece/nephew (Figure VI-1).

Figure VI - 1 Members of a same family



We analyzed children's social relations during four main subsistence activities (i.e., hunting, gathering, fishing and agriculture). We first explore the social network by specifically looking at a) the predominant dyadic relations during the performance of the four selected activities, b) the composition of the groups formed by children during their activities, and c) the overall structure of the social network for the four categories of activities. All calculations were done for each village separately.

Dyadic analysis: To assess which dyadic relations were predominant during the performance of each of the four selected activities, we first calculated the number of dyadic ties (i.e. pairs of people performing an activity together) for each of the four activities. Specifically, we considered whether each dyad was formed by a) two individuals from the same sex; b) two individuals from the same age; c) two children; d) two individuals from the same family. We considered that two children were from the same age, if they had less than 2 years of difference. We considered the listed individuals as members of the same family in the same cases than presented above (see Figure VI-1).

As Baka children's involvement in daily activities varies according to their sex and age-category (see (Gallois et al., *under review*), we assessed the predominance of dyadic relations differentiating between children from different sex and age-category. We tested whether differences in the predominance of dyadic relations were significantly different between boys and girls using Chi-squared tests.

Group composition: For each category of activities, we look at the percentage of observations in which the child was alone (vs. accompanied). Then, to have a more general view of the overall composition of children's groups during the performance of the selected activities, we also calculated metrics of the characteristics of the people participating in the different activities. Specifically, we took into consideration the age and the kinship relation of all the individuals listed for each observation. For age, we differentiate the individuals accompanying the interviewee between adults, older children (two years older than the interviewee), younger children (two years younger than the interviewee) and peers (or children with two years of difference (younger or older) than the subject). As in the previous analysis, we computed our calculations by sex, and age-category of the interviewee.

Social network analysis: We then explored the overall composition of children's social networks during their activities. To do so, we established and projected village visualizations of children's social network during hunting, gathering, fishing and agriculture. For each activity, we also calculated the density of the network structure, or the proportion of existing connections in the network relative to the maximum possible number of connections (from 0 to 1). The lower the density in a network, the fewer ties exist through which information might circulate (Hopkins, 2011; Wasserman & Faust, 1994). To complete our analysis, we also assessed whether individual level characteristics of the children (sex and age-category) relate to the children's position in

the social network of a given activity. Specifically, we evaluate a child's centrality in the network through *degree centrality*, or the number of ties a child has, where the higher degree the more sources of knowledge the individual has (Freeman, 1978). Then, to explore whether an individual centrality relates to other individual characteristics, we run factorial ANOVA crossing *degree centrality* with the respondent's sex and age-category. For this last analysis, we used only one observation (randomly selected) for child, thus reducing the sample to 102 interviews. Social network data were analyzed with IBM SPSS for Windows (22.0) and visualized with Visone (Brandes & Wagner, 2004).

4. Results

From the 232 interviews conducted, children reported 603 hunting, 126 gathering, 50 fishing and 161 agricultural activities.

4.1. Dyadic relations during children's subsistence activities

Most of the dyads formed during children's subsistence activities include people from the same sex (Table VI-1). The percentage of same-sex partners is higher for boys than for girls dyads in all the activities except gathering, in which girls engage in same-sex dyadic relations in 81% of the cases and boys in 64%. Differences in the predominance of same-sex versus different-sex patterns found across the four selected activities are statistically significant in a Chi2 test.

Regarding the preference to perform activities with people from the same age (i.e., less than two years of difference), whatever the activity, boys tend to engage with peers more frequently than girls. Almost half of the dyads formed by boys for hunting (in

54% of the dyads) and gathering activities (in 41% of the dyads) are with peers, whereas girls engage with a peer in 41% of the dyads formed while hunting and in 32% of the dyads formed while gathering. For fishing and agriculture activities, both boys and girls are more involved in dyads formed with a companion of different age. The pattern is especially marked for girls, who only reported having formed dyads with a peer in 19% of the dyads while fishing, and in 22% of the dyads while doing agriculture (Table VI-1). Interestingly, we also found that children do not necessarily engage in dyadic relations with adults, especially while hunting (less than 10% of the observations for both boys and girls) and gathering (almost 20% of the observations for both), or for boys' fishing (accompanied by an adult in 17 % of the observations). Children form more often dyads with adults for agricultural activities, where adults are present in almost half of the dyadic relations; a similar pattern is found for girls' fishing (42% of the girls dyads are with adults). Differences between boys' and girls' data regarding the predominance of child-child versus child-adult dyads are only statistically significant in the case of fishing.

Finally, when looking at the presence of a family member in the dyad, we found that almost half dyads are –indeed- form by family members. Fishing is the activity where the dyads formed by children are the least frequent formed by same family members (39% for girls' and 42% for boys'), with also a similar percentage for girls' agriculture (36% of the observations).

Table VI - 1 Frequency of dyadic relations during children's subsistence activities.

Activities	Interviewed child performed the activity with	Frequency of occurrence (in %)	
		Girls	Boys
Hunting	A person of same sex	69.4	89.2***
	A person of same age	40.8	53.8*
	An adult	10.2	4.9
Gathering	A person of same family	38.8	42.2
	A person of same sex	81.0***	64.7
	A person of same age	32.4	48.5
	An adult	19.7	21.2
Fishing	A person of same family	44.4	52.5
	A person of same sex	85.7	70.7***
	A person of same age	19.1	41.5***
Agriculture	An adult	41.7	17.1***
	A person of same family	44.1	53.7
	A person of same sex	85.7	67.0 ***
	A person of same age	22.1	38.1**
	An adult	48.6	43.2
	A person of same family	35.7	44.9

*, **, and *** significant at the 90%, 95% and 99% level for Chi2 tests testing whether the dyads were different according to the sex of the respondent.

We also examine the predominance of dyadic relations across the three different age-categories (Table VI - 2). During middle childhood and pre-adolescence, the patterns of dyadic relations are similar to the trends described above. However, during adolescence, we find differences regarding the age of the companion. Thus, while hunting, adolescents tend to prefer non-peer companions (only 27% of the dyad are with people of the same age) compared with pre-adolescents and middle childhood children, who are much more involved with peers. In the same line, girls tend to spend their time gathering and performing agriculture with non age-peers (for which only in 31% and 28% of the observations girls were with a companion from the same age), whereas boys tend to prefer spending time with their peers during such activities (62% and 55%) The differences are statistically significant.

Moreover, there is a higher presence of adults among the adolescent girls dyadic relations. Thus, while fishing adolescent girls engage in dyadic relation in 53% of the observations, and in 27% while hunting, whereas adolescent boys did not report any dyadic relation for any of those activities. Differences were statistically significant at the 90% level for fishing activities and at the 99% level for hunting activities.

Finally, it is worth noticing that except for girls' hunting, the dyads formed by members of the same family tend to decrease once children reach adolescence, especially while agricultural activities (reported in less than 30% of the observations) and for boys while fishing, for which there were no reports of dyad observations with family members.

Table VI - 2 Results of Chi2 test for dyadic relations (in %), by age-category.

Activities	Interviewed child performed the activity with	Middle childhood		Age-category Pre-adolescence		Adolescence	
		Girls	Boys	Girls	Boys	Girls	Boys
Hunting	A person of same sex	66.7	86.3***	75	92.7***	72.7	84.9***
	A person of same age	40.0	56.3	62.5	60	27.3	27.3
	An adult	3.3	7.5	12.5	4.6	27.3***	0
	A person of same family	36.7	57.5*	25	37.3	54.6**	21.2
Gathering	A person of same sex	74.4	57.8***	81.5***	56	84.7***	82.8
	A person of same age	32.6	51.1*	37.0	28	30.6	62.1***
	An adult	9.3	26.7	25.9	28	23.6*	6.9
	A person of same family	51.2	64.4	40.7	56	41.7	31.1
Fishing	A person of same sex	85.3	86.7***	77.8***	69.6	90.63	0
	A person of same age	20.6	53.3*	22.2	34.8	15.6	33.3
	An adult	35.3	6.7*	33.3	26.1	53.1*	0
	A person of same family	47.1	66.7	50	52.2	37.5	0
Agriculture	A person of same sex	82.4***	62.5	87.1***	44.4	86.7***	89.8
	A person of same age	8.8	33.3**	22.6	22.2	28	55.1***
	An adult	64.7	50	35.5	46.7	46.7	36.7
	A person of same family	50	75*	38.7	55.6	28	20.4

*, **, and *** significant at the 90%, 95% and 99% level for Chi2 tests testing whether the dyads were different according to the sex of the respondent

4.2. Children's groups composition

Hunting is the least collective of the studied activities, as boys reported hunting alone in 76% of the observations and girls in 85%. In contrast, agricultural activities were performed more collectively, with both boys and girls performing agricultural activities alone only in about half the observations (51% for boys and 54% for girls). Comparatively, children were less often alone when gathering (20% of the observations for boys and 15% for girls). The most collective activity was fishing, an activity that was almost exclusively collective for girls, who reported to go alone only in 3.2% of the observations (16% for boys).

When not performed alone, the average number of people accompanying the respondent during subsistence activities was 2.7, with girls groups being larger (3 people) than boys' groups (2.2) (Table VI-3). Group size also varies according to the activity. Larger groups were found during agricultural activities (average of 3.4 people) and smaller groups during hunting activities (2.0 people). For all the activities, except gathering, girls' groups were larger than boys' groups (Table VI-3).

Table VI - 3 Children's group composition.

	Activities									
	Hunting		Gathering		Fishing		Agriculture		Overall	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Nb of observations	476	127	60	66	19	31	85	76	640	300
Percentage of observations alone	75.6	85.0	20	15.2	15.8	3.2	50.6	53.9	34.7	46.7
Average number of people (when not alone)	2	2.6	2.5	2.1	2.6	2.8	2.8	4	2.2	3.0

Table VI-4 provides a more detailed analysis of the composition of children's group while they engage in the selected subsistence activities. It is first worth highlighting the near absence of adults during most children activities. This is especially the case for hunting (when adults were present only in 6% of boys' and 21% of girls' reports), gathering (with adult presence in 27% of the observations for boys and 30% for girls), and boys fishing. In contrast, girls' and boys' agriculture and girls' fishing were more often performed with adult's company. Adults were present in almost 57% of the observations of girls' fishing and in more than 60% of the observations of children's agriculture (Table VI-4).

It is worth noticing that the adult accompanying the child is not necessarily one of the parents, although parental involvement in children's subsistence activities varies according to the sex of the child and the activity. The lowest involvement of parents appears in hunting, where parents were mentioned in 2.6% of the events by boys and 5.3% by girls. The highest involvement was found in agricultural activities, during which parents were mentioned in 35.7% of the boys' and 28.6% of the girls' events (Table VI - 4).

Table VI - 4 Descriptive analysis of children's groups - age categories and kinship relations.

Nb observations	Hunting		Gathering		Fishing		Agriculture	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
With company	116	19	48	56	16	30	42	35
With ADULTS	7 (6)	4 (22.1)	13 (27.1)	17 (30.3)	6 (37.5)	17 (56.7)	26 (61.9)	25 (71.4)
With non-parents (%)	4(3.4)	3 (15.8)	6 (12.5)	13 (23.2)	4 (25)	10 (33.3)	13 (31)	18 (51.4)
With parents (%)	3(2.5)	1(5.3)	7 (14.6)	4 (7.1)	2 (12.5)	7 (35)	13 (31)	7 (20)
With CHILDREN only	109 (94)	15 (78.9)	35 (72.9)	39 (69.7)	10 (62.5)	13 (43.3)	16 (38.1)	10 (28.6)
With older children *	8 (6.9)	3 (15.8)	1 (2.1)	3 (5.4)	1 (6.3)	2 (6.7)	1 (2.4)	2 (5.7)
With peers and older children*	25 (21.6)	5 (26.3)	3 (6.3)	8 (14.3)	2 (12.5)	1 (3.3)	3 (7.1)	1 (2.9)
With peers *	63 (54.3)	5 (26.3)	22 (45.8)	18 (32.1)	6 (37.5)	4 (13.3)	10 (23.8)	5 (14.3)
With younger children only	13 (11.1)	2 (10.5)	9 (18.8)	10 (17.9)	1 (6.3)	6 (20)	2 (4.8)	2 (5.7)
With at least one family member	76(65.5)	13(68.4)	29(60.42)	32(57.1)	10(62.5)	24(80)	29(69)	24(68.6)

*(with or without younger)

Subsequently, it is worth highlighting the near absence of adults in some of these activities. This is especially the case for hunting activities (adults were present only 21% of the observations among girls, and in 6% of the observations for boys), gathering (at least one adult was present in only 27% of the observations for boys and 30% of the observations for girls), and fishing among boys, who performed fishing activities with adults mostly between 9 and 13 years-old. In contrast, fishing activities among girls and agriculture for both girls and boys were much more performed with the company of adults. Adults were present in children activities in more than 50% of the observations of fishing activities among girls; and in more than 60% of the observations of agriculture (Table VI - 4).

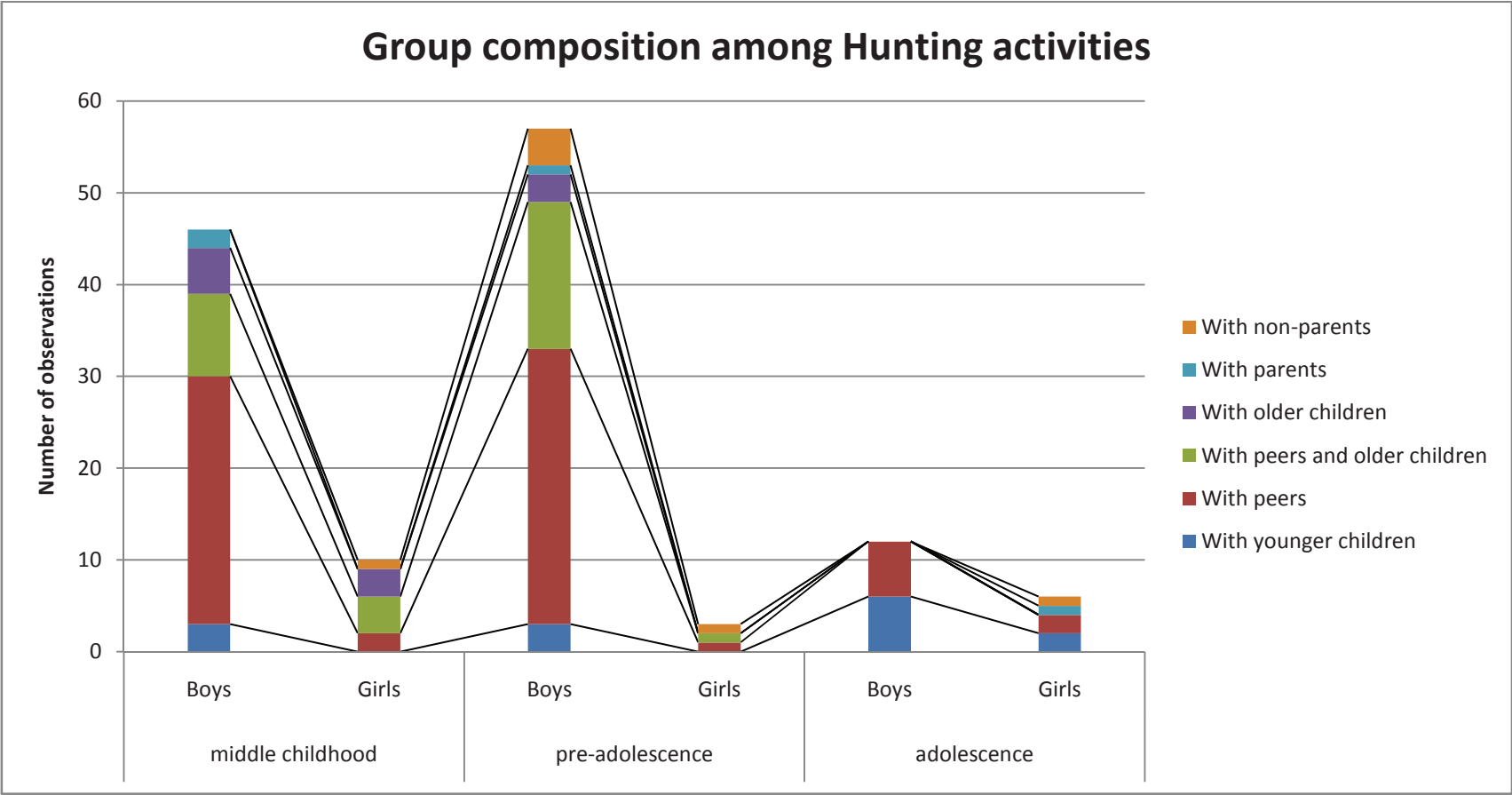
In general, whatever the activity, groups of children are mostly composed by age-peers, and sometimes with younger children (see Table VI - 4). The presence of older children is more frequent during hunting activities (in which older children were present in 29% of boys' and 42% of girls' hunting observations), girls' gathering activities (reported in almost 20% of the observations), and boys' fishing (reported in 19% of the observations). For agriculture, children were with older children in only 9.5% of the boys' and 8.6% of girls' observations.

Finally, at least one family member (either a child or an adult) was present in about 60% of the observations (Table VI - 4). The presence of family members is higher for agricultural activities (almost 69% of the observations) and for girls' fishing (80% of the observations). Additional data (not shown here) show that the most common family member in a child's group is a sibling. Thus, during agriculture siblings were present in 59% of the observations for girls, in 51% for boys, during gathering in 46% of the observation for boys, in 49% for girls, and during girls' fishing in 47% of the

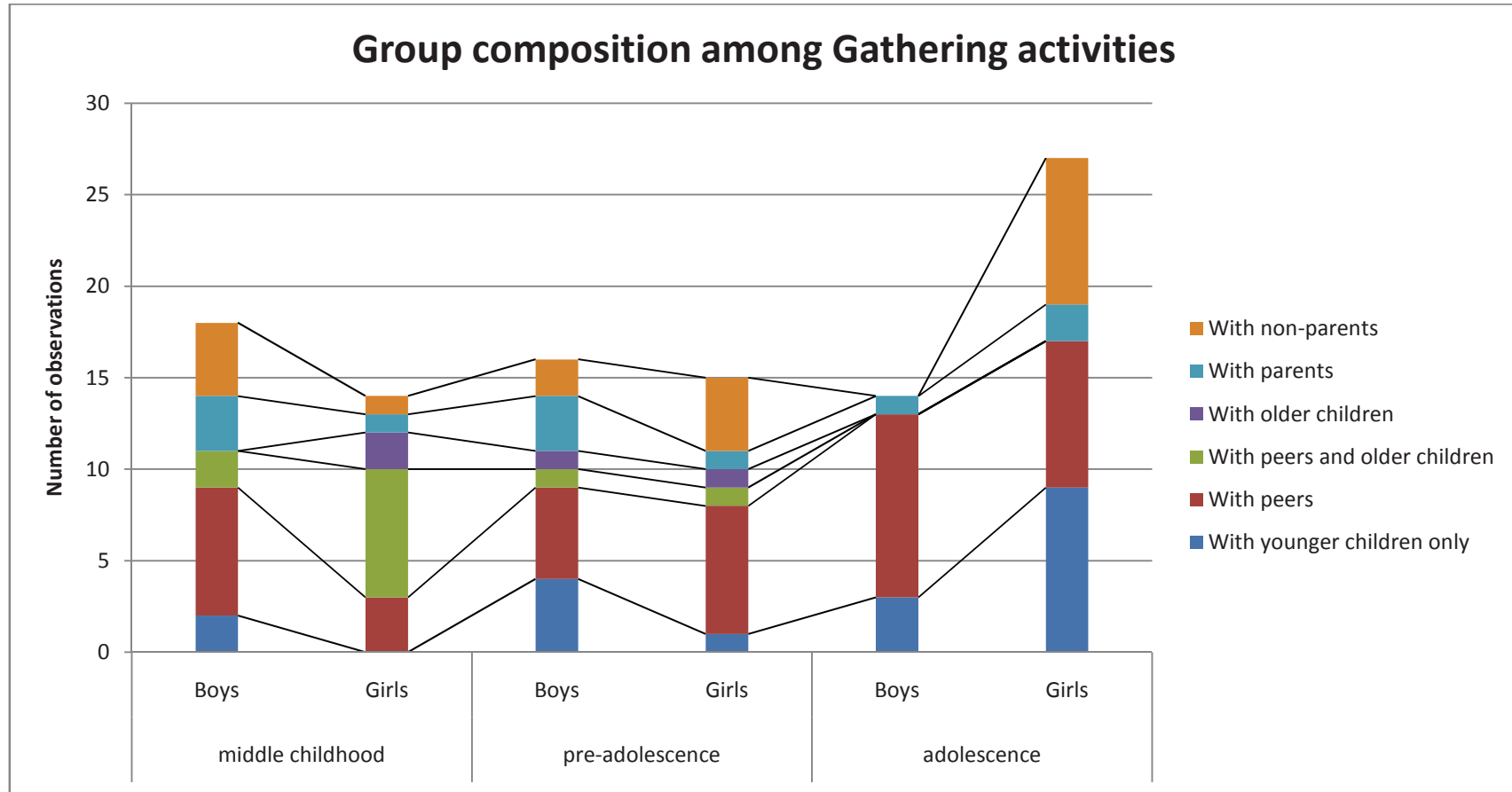
observations. The second most common type of family members in a child's group were cousins.

Figure VI - 2 Description of children's group composition, by activity and respondent's age-category.

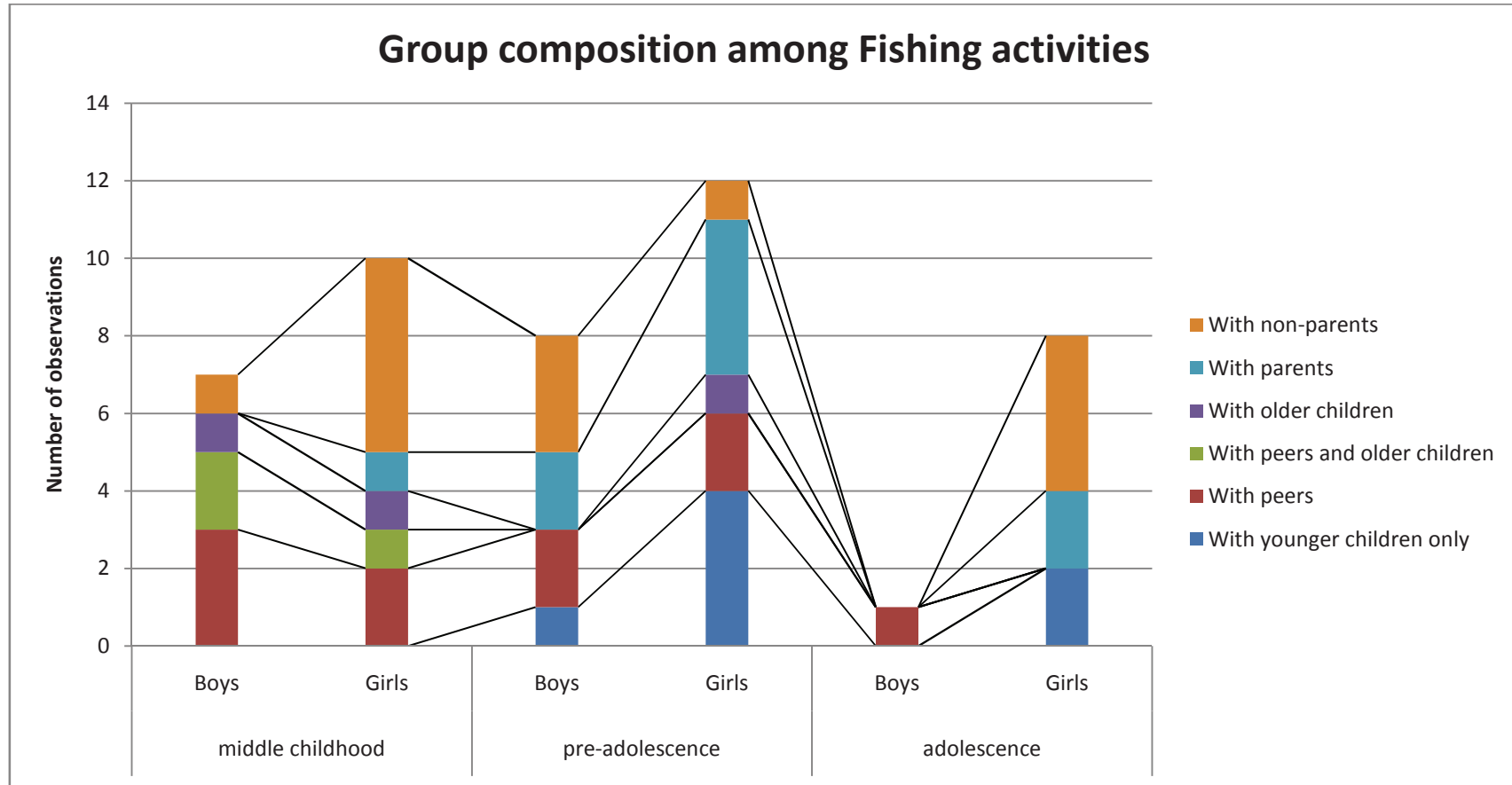
a) Hunting.



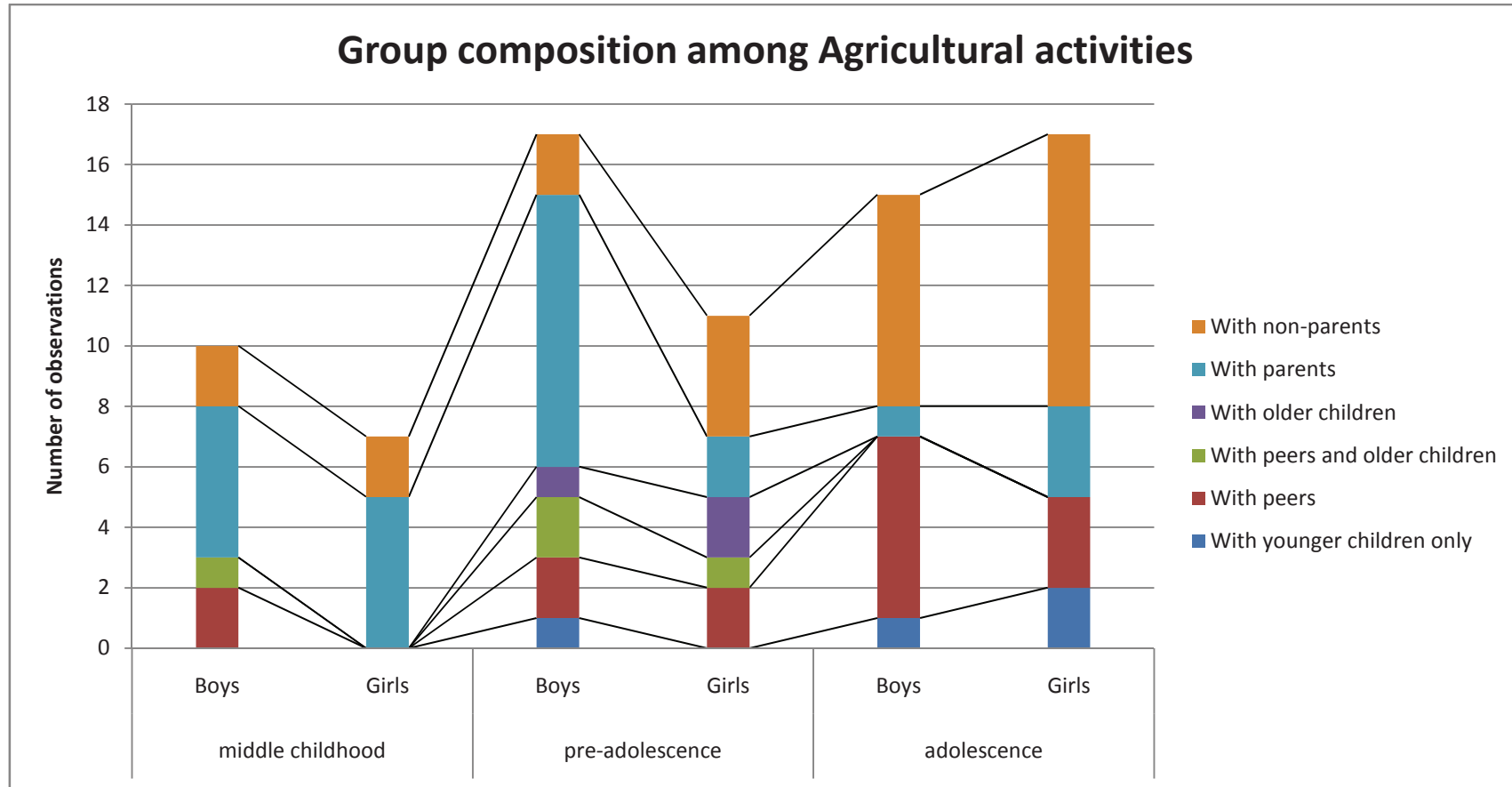
b) Gathering.



c) Fishing.



d) Agriculture.



The previously described patterns of children's group composition during subsistence activities present some variation when we look at the age-category of the respondent. Specifically, except for girls' gathering, adult's presence tends to decrease with age, especially for agriculture and fishing (see Figures VI - 2). During middle childhood, there are more groups formed with older children or adults (non-parents) than when taking the full sample. During pre-adolescence, the composition of children's groups is very variable and diverse, from groups only formed by peers, to groups with older children and peers, and groups only with older children. Pre-adolescents also tend to perform activities more frequently with younger children than during middle childhood: boys reported that 25% of the observations of gathering activities were performed with younger children, whereas girls reported 33% of the fishing observations with younger children (Figures VI - 2). Finally, during adolescence, most activities are performed with peers and without adults, and the number of observations in which the individual conducted the activity only with younger children is higher during hunting, gathering, agricultural and activities, than for the two other categories of age, especially for girls.

4.3. The different structures of social networks during children's activities

As described before, the structure of children's social networks varies according to the age, sex and activity, but also according to the village. The graphs visualized the social networks (Figures VI - 3) provide a visual aid to interpret results from the dyadic and the group composition analysis.

For example, in Figures VI - 3, we see that adults (orange tones) tend to be at the periphery of children's groups (green tones). This is particularly clear for hunting and gathering activities, where we see that most groups are composed only by children (Figures VI -3). This is in contrast with fishing and agriculture, where adults, mostly women, are closer to children's groups. Indeed, whereas adults are present in half of the fishing and agricultural groups in Elonda, adults are present in four of the five agriculture groups and seven of the ten fishing groups in Mombokola.

The figures also illustrate the findings, presented earlier, regarding 1) the predominance of same-sex groups in all the activities, and 2) the presence of subgroups formed by both same-age peers and children of different ages.

The structure of the social network and the position of the children in such network vary according to the activities. In both villages, the sex of the children is associated to a child's degree centrality in the network while performing hunting activities, with boys being connected to other individuals more than girls (in average 3.55 for boys vs 1.14 for girls). Such differences are statistically significant ($F=9.95$, $p<0.002$) (Table VI - 5). While gathering, children's position in the social network is significantly related to the age of the respondent ($F=6.83$, $p<0.000$), with adolescents holding the higher degree centrality, with an average of 4.3 compared to middle childhood children (mean=4.1) and preadolescents (mean=1.5). Then, while fishing, girls are significantly more connected to other individuals than boys are ($F=3.84$, $p<0.05$ on the results of the ANOVA tests), with girls having an average degree centrality of 1.2 and boys' of 0.62. Finally, results of the ANOVA tests showed that none of the variables selected (i.e, sex, age-category and village) is related to a child's position in the agriculture network.

Children's social networks largely vary according to the village. In general, for the four studied activities, social networks are much denser in Elonda than in Mombokola (Figure VI-2), and subgroups formed by children in Elonda are more frequently connected to each other than in Mombokola (see Figure VI-2b). In general, except for fishing where there are groups of more than six people, the subgroups formed by children in Mombokola are composed by only two to three people. The contrast between both villages is especially relevant for hunting and gathering activities, for which the density of the social network is respectively 0.019 and 0.014 in Elonda, whereas it only reaches 0.002 and 0.003 in Mombokola. Indeed, for hunting, individuals are significantly more connected to each other in Elonda than in Mombokola, with a degree centrality of children almost eight times higher in Elonda than in Mombokola (on average 3.8 in Elonda vs 0.55 in Mombokola) ($F=7.79$, $p<0.000$ on the results of ANOVA tests - Table VI-5). We found similar patterns for gathering activities, for which the degree centrality of children is significantly higher in Elonda (mean=4.8) than in Mombokola (mean=0.55) ($F=43.29$, $p<0.000$). In contrast, the patterns are quite similar between both villages for agricultural activities and fishing, with a high frequency of subgroups formed by two or three people. The density of the social network while conducting agricultural activities in Elonda (0.005) is higher than in Mombokola (0.004) but not for fishing activities for which the density reaches 0.006 in Elonda and 0.009 in Mombokola.

In Elonda, both for hunting and gathering we observed that the different groups knit together into larger components, indicating that children tend to go out hunting or gathering with different groups on different times. Consequently, indirectly, most of the children are connected to most of the other children of the village, and there is little segregation. When we combine all the activities into one graph (not shown here), this

result becomes even clearer, as all the children of Elonda are then connected in one large component. The younger children, together with the adults, are at the periphery of this network and the children from middle childhood to adolescence are divided in a very active core group and a peripheral group that seems to mix less with the other children.

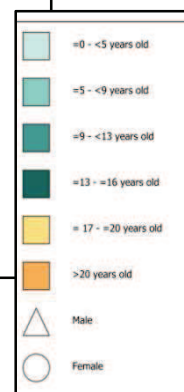
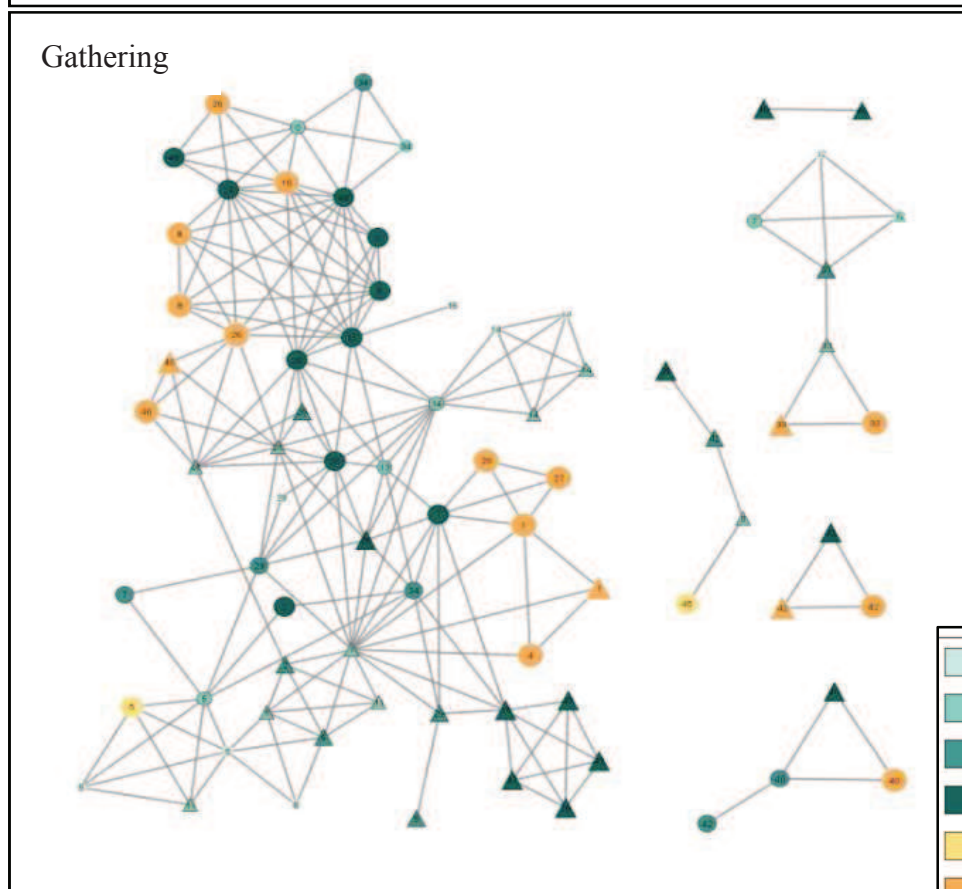
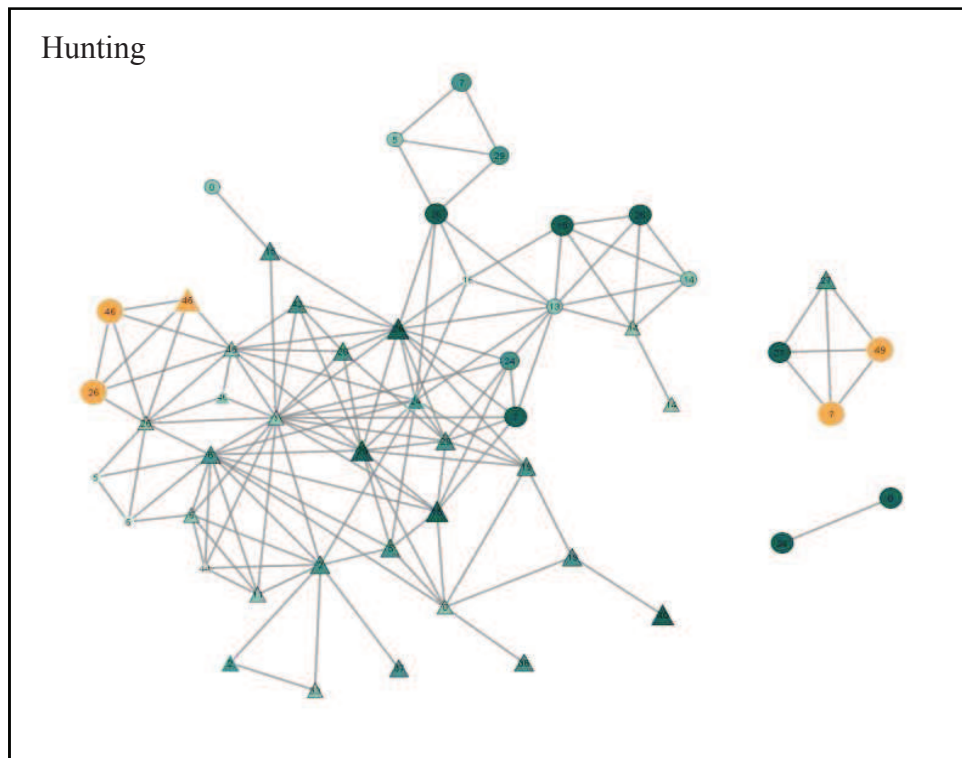
In Mombokola, as indicated before, the network is much sparser, and when all activities are combined (not shown here), we still identified ten different components (two larger and eight smaller) indicating that children in this village are more segregated. This implies that there are subgroups of children who do activities together, but not with anyone of the other subgroups.

Finally, in both villages, when comparing the graphs of the different activities while keeping the positions of the individuals constant across the graphs (not shown here), we found that that children tended to perform the different activities with different groups of people.

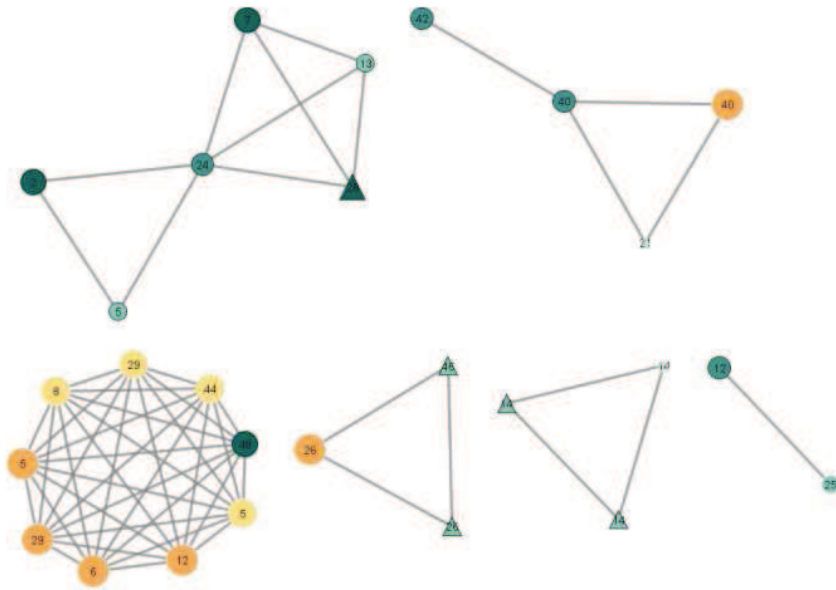
Figure VI - 3 Social network of children's subsistence activities, when not performing the activities alone.

Note: Nodes represent individuals and edges between two nodes represent activities performed together. Nodes with black border represent interview respondents, whereas the other nodes represent individuals who were mentioned by the respondents but were not interviewed. The network graphs further illustrate individuals' age-categories (by node color and size) and sex (node shape). Orange: >20 years-old; yellow: $\leq 17-20 \geq$ y.-o.; dark green: $\leq 13-16 \geq$ y.-o.; green: $\leq 9-13 >$ y.-o.; clear green: $\leq 5-9 >$ y.o.; blue: <5 y.-o.. Circle: female; triangle: male. Label present in the nodes refer to the household code.

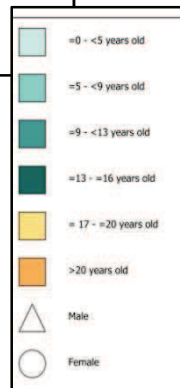
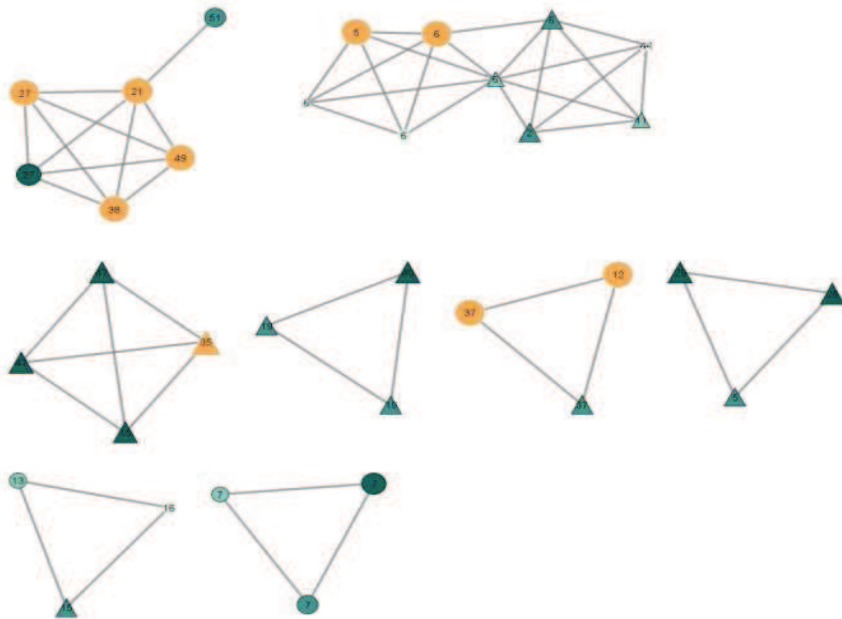
a) Elonda



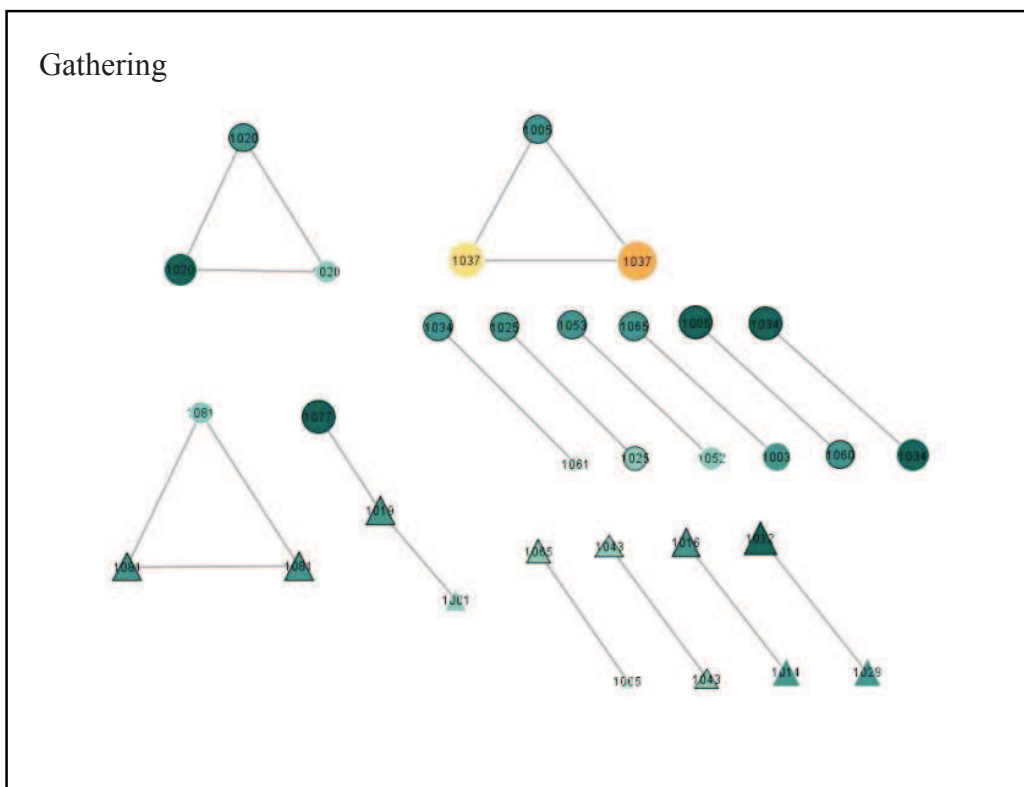
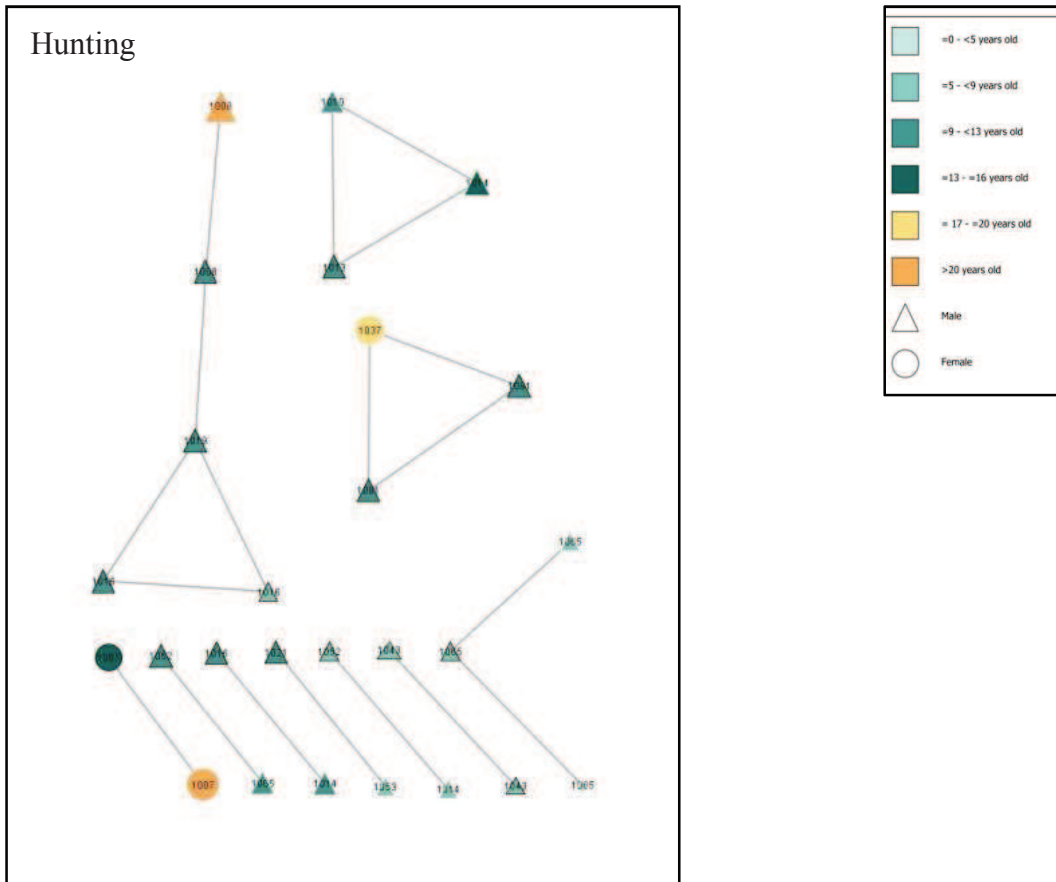
Fishing



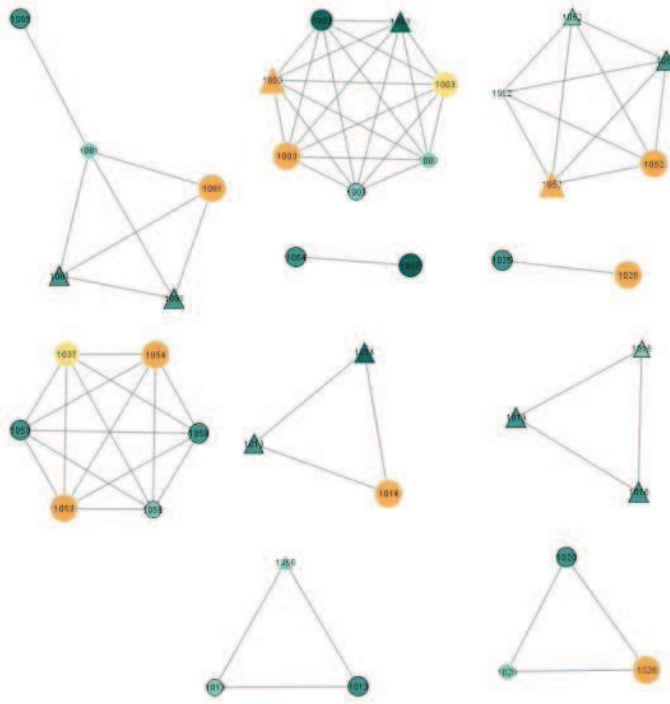
Agriculture



- b) Mombokola



Fishing



Agriculture

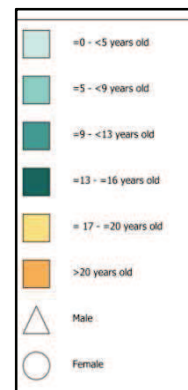
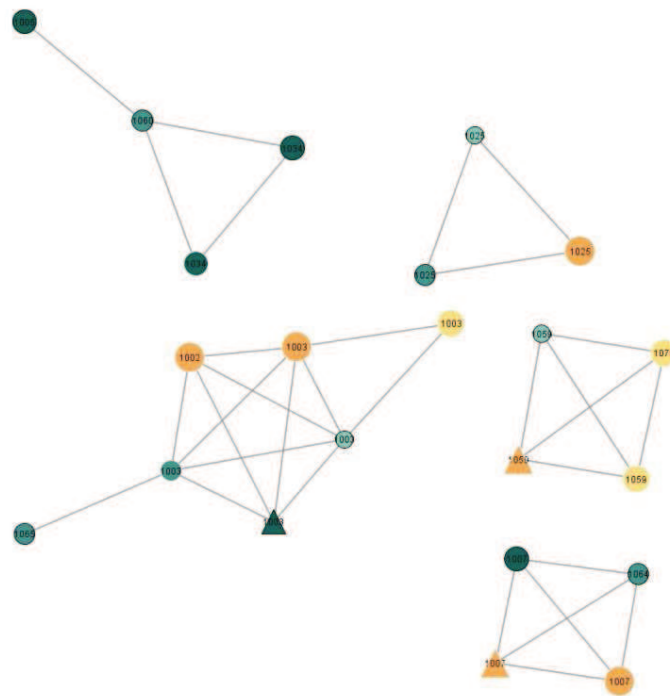


Table VI - 5 Results of the factorial Anova comparing children's degree centrality by sex, age-category, and village (n=102).

Children's centrality degree				
	Hunting	Gathering	Agriculture	Fishing
<i>Explanatory variables</i>	<i>F (p)</i>	<i>F (p)</i>	<i>F (p)</i>	<i>F (p)</i>
Model	7.79 (0.000)	13.35 (0.000)	0.77 (0.60)	1.58 (0.16)
Sex	9.95 (0.002)	4.68 (0.03)	0.01(0.93)	3.84 (0.05)
Age-category	1.74 (0.18)	6.83 (0.00)	0.56 (0.57)	1.58 (0.21)
Age*Sex	1.16 (0.32)	3.09 (0.05)	1.04(0.36)	0.26 (0.77)
Village	23.43 (0.000)	43.29 (0.00)	1.16 (0.28)	2.2 (0.14)

5. Discussion

The goal of this work was to analyze children's network during subsistence activities, with the assumption that the composition of children's groups during their daily activities would contribute to our understanding of the potential modes of knowledge acquisition. Our discussion is organized around three main aspects. We first discuss the social organization of Baka children's subsistence activities. We then we discuss our results in the light of cultural transmission theory by exploring whether there is a predominance of one of the three pathways of cultural transmission (vertical, oblique, horizontal), and whether there is other general tendency of cultural transmission biases-model. Finally, we discuss how social network analysis might inform us on how Baka children acquire subsistence-related cultural knowledge.

5.1. Children's Social organization during daily activities

The first important finding of this work is the almost absence of adults, and especially parents, during Baka children's daily activities. Indeed, except during agricultural activities and girls' fishing, adults are mostly absent while children perform their subsistence activities. The finding is not surprising as it meshes with previous reports highlighting the autonomy and independence of hunter-gatherer children (Barry S. Hewlett, 2014a), but it should be somehow clarified. Thus, from ethnographic observations, we know that adults were likely present in the surrounding environments, that is, many activities occurred within the visual or auditory range of adults. This also seems to be the case among the Aka, where Boyette (2013) reported that children were in the visual range of adults in 64% of the cases. Whereas adult's presence in the surrounding environment might help ensure child's safety, we argue that, as adults did

not engage in activities with children, our findings stress the marginal role of adults in children's subsistence activities.

There is a considerable variation in children's group composition while performing subsistence activities. Such variation, however, does not seem completely random, but rather it seems patterned by the age and the sex of the child and by the type of activity performed. For instance, boys seem to prefer hunting and fishing alone or in small groups, which contrast with girls who performed such activities more collectively. Interestingly, such differences resemble differences in adult's group composition for the same activities, as hunting and fishing are typically solitary activities for men and collective activities for women. In that sense, although children mostly perform their activities without adults, their social organization seems to mirror sexual differentiation of division of labor among adult's daily activities.

Our results also showed the importance of mixed-age groups during children's activities. This pattern has already been reported among other hunter-gatherer groups, and it is considered specific to hunter-gatherer childhoods (Barry S. Hewlett, 2014a). Mixed-age groups are common for agriculture, gathering and girls' fishing activities. An interesting input of our study, not reported in other studies on hunter-gatherer societies (Barry S. Hewlett, 2014a), is the presence of peer groups. Thus, we found that during gathering and hunting, Baka children -especially boys- were generally accompanied by peers. We think that the unusual presence of peer-groups in our data, when compared with previous studies, might be explained by the settlement size. Indeed, most previous studies reporting the predominance of mixed-age groups among hunter-gatherer societies took place in relatively small settlements, i.e., about 50 people (Barry S. Hewlett, 2014b). In contrast, our study was conducted in a village of about 200 people, where children have more opportunities to find in their close environment other

individual from the same age. Finally, our results also highlighted that children tend to spend more time in dyadic relations with a same-sex companion, in accordance with what has been reported among the Aka (Boyette, 2013).

5.2. LEK acquisition through social organization

In this section, we try to relate our findings on children's social organization during subsistence activities to the process of LEK acquisition. Importantly, the near absence of parents in children's daily activities brings new insights for the understanding of how knowledge might be acquired during middle childhood and adolescence. Table VI 7 shows our assumptions on the links between group composition and modes of knowledge transmission (vertical, oblique and horizontal) according to the participants' age.

Table VI - 6 Children's group composition and relation with modes of knowledge transmission, considering the respondent as the person acquiring knowledge

Group composition (in addition to informant)	Potential modes of knowledge transmission		
	vertical	oblique	horizontal
Children and adults	x	x	x
Only adults	x		
With children only		x	x
With older (with/without younger children)		x	
With peers and older children (with/without younger children)		x	x
With peers (with/without younger children)			x
Only with younger children			

If local ecological knowledge is largely acquired while performing subsistence activities, and if parents are not present during such activities, then one could argue that children largely rely in models other than the parents for the acquisition of local knowledge during the performance of subsistence activities. In other words, data from group composition during subsistence activities suggest that vertical transmission is not the predominant pathway for the transmission of knowledge for children between 5-16 years of age, as also suggested by previous scholars in other settings (Boyette, 2013; Henrich et al., 2008; Barry S. Hewlett et al., 2011).

In general, the variation of group composition from one activity to another suggests that there is a broad number of learning strategies, which vary according to the sex, the age-category, and the activity performed, and thus according to the domain of LEK. Despite such diversity of learning strategies, some patterns might be highlighted. For example, in the case of hunting and fishing activities for boys, performed mostly alone, the acquisition of such related knowledge seem to largely rely on individual experiences, and knowledge circulating in horizontal and oblique pathways, with peers and older children rather than adults as sources of knowledge. In contrast, more collective activities would be more likely to favor the simultaneous presence of horizontal and oblique pathways, as they are conducted in groups of mixed-age individuals. This is, for example, the pattern for gathering activities during which children mostly engage with mixed-age groups of children. It is also the case during agricultural and girls' fishing activities, with the difference than for those activities oblique and vertical transmission might also occur as adults are more engaged with children in these activities.

Thus, overall, our results suggest that since middle childhood, group diversity might allow children to acquire their knowledge from several individuals and thus

mostly through different pathways of knowledge transmission. This is in concordance with what Boyette reported on the learning of sharing patterns among the Aka, highlighting "*the prominent and multifaceted contributions of other members to children's acquisition of sharing behaviour*" (Boyette, 2013: p. 116). The presence of mixed-age groups during children's subsistence activities, even intergenerational groups, would allow children to simultaneously learn new knowledge from several sources (Gray, 2011). We suggest that this might be a much more efficient strategy than performing activities only with same-age children or only with adults. Indeed, some scholars have suggested that, although being among peers facilitates communication, without the barrier created by age, and thus with individuals showing similar knowledge, capacities and also similar language, the approach limits the learner to a unique type of model, so if the learner wants to refer to another model, she/he would have to invest extra time with additional models, an alternative that seems costly (Reyes-García, Broesch, et al., 2009). In the case of mixed-age and mixed-generation groups, the child might more likely go from one model to another while performing the activity, thus maximizing opportunities to acquire knowledge from different models.

Whereas the diversity of social organization continues to be high during adolescence, we also find some particularities at this period. our results show that as children grow up and enter adolescence, adult's presence decreases in favor of a higher frequency of mixed-age children groups, with a high proportion of younger children. During adolescence, there is also a decrease in the number of family members in children' group, suggesting that at this age children start expanding their set of resources for knowledge acquisition to a broader network settled out of the family (see (Aunger, 2000; Henrich et al., 2008). Finally, the large presence of younger children during pre-

adolescent and adolescent activities suggests the important role model of adolescents for younger children.

Despite the diversity of learning strategies reported in this work, one commonality stands out: irrespectively of the age of the children, we found a high sexual homophily. Homophily was found in all activities, although it was especially marked for hunting and gathering activities. This trend might shed light on a sex-biased model of knowledge acquisition, as already reported in other settings (Reyes-García, Broesch, et al., 2009).

5.3. Children's social network

The comparison of children's social networks between the two villages shows that there is variation between Elonda and Mombokola. In both villages, the lack of connection between subgroups formed during children's activities might be explained by the spatial organization of the villages. Indeed, most subgroups present in both villages are formed by children living in the same hamlet. In that sense, the higher presence of unconnected subgroups in Mombokola than in Elonda might be explained by the difference of spatial organization between both villages. Indeed, whereas Mombokola is much more extended, hamlets in Elonda are much closer. In that sense, Elonda is a village more bond, and physically-, but also biologically- closer. This proximity allows children to interact directly with a bigger number of individuals, which also reflects in denser networks while performing subsistence activities. In contrast, Mombokola is more extended and is composed by different hamlets much more dispersed. In that sense, it looks more like an aggregation of different bands, which joined together along the logging road but which still do not feel part of the same village.

Finally, the different structure of the social networks during different children's activities suggests that the flow of knowledge occurring during the performance of such activities does not circulate in a similar way. Because children are much more connected to each other during the performance of some activities, as it is the case with gathering, we might suggest that the amount of information available for children would be higher and more diverse than in other activities, such as agricultural activities, where the social networks are much more reduced to individuals frequently belonging to the same extended family. Such pattern meshes with what has also been recently reported in other settings, where it has been found that the transmission of ethnobotanical knowledge is largely shaped by kinship relations (Salpeteur et al., 2015). Moreover, as children's groups composition varies according to the activity, children do not seem to learn LEK related to different domains from the same individuals, but rather they acquire different pieces of knowledge from different individuals and networks. In that sense, our results underline the presence of multiple set of resources for LEK acquisition, which vary according to the sex, the age, and the domain of LEK.

6. Conclusion

This study highlights the importance of considering children's social organization during subsistence activities and argues that the analysis of children's group composition is a powerful tool to understand the potential pathways for cultural knowledge acquisition.

The main input from this work relates to the almost absence of adults into children's daily activities, especially the ones related to subsistence. We also showed a high variability of social organization, and group composition among both boys and

girls during the performance of the activities where they would be acquiring knowledge. Thus, we showed that the number of potential models, i.e. the number of people and the characteristic of such people accompanying children, varies according to the activities, suggesting the presence of a multiple learning strategies of LEK.

Chapter VII

How do social changes affect children's daily activities and LEK acquisition? Exploring parental livelihoods strategies

1. Introduction

Contemporary hunter-gatherer societies living in tropical forests face important social-ecological challenges. New economic activities, such as logging, large-scale farming, mineral, oil and gas extraction are some of the current drivers of social-ecological change in the tropics (Laurance, 2015). These drivers are especially acute in developing nations, where the standards of living are rapidly changing. For decades, the Cameroonian tropical forest has witnessed the opening of mining and logging concessions, first from European, American, and more recently from Asian companies (Ichikawa, 2006; Wasseige et al., 2012). The improvement in the transport system propitiated by those companies brought poachers, bushmeat and ivory traders to the area, who all together are impacting wild species and local populations (Ichikawa, 2006, 2014; Wilkie, Bennett, Peres, & Cunningham, 2011). In response to threats to the local ecological system, international institutions and policy-makers have promoted biodiversity conservation programs, including the creation of natural parks. Less political emphasis, however, has gone to mitigate the impact of current social-ecological changes on local populations, who face pressures both from new actors arriving to the forest they inhabit and from conservation polices which restrict their access to natural

resources (Ichikawa, 2014). In this context, Baka populations have to adapt their livelihoods strategies to their new circumstances (Ichikawa, 2001).

Here, we examine an understudied impact of current social-ecological changes among the Baka: the impact of socio-ecological change on children's acquisition of Local Ecological Knowledge (LEK). LEK is defined as the knowledge, practices and beliefs related to the environment. Because of the importance of LEK for subsistence and for the preservation of bio-cultural diversity (Luisa Maffi, 2005), numerous studies have focused on how local knowledge systems react in face of social-ecological changes similar to the ones described above (see for example Gómez-Baggethun & Reyes-García (2013); Reyes-García (2015)). However, few studies have considered the dynamic nature of LEK, mainly shaped by the way knowledge is culturally transmitted and acquired within each specific society. In many small-scale societies the acquisition of knowledge, devoid of written forms, is largely embedded in daily activities through observation and mimicry (Barry S. Hewlett, 2014a; Zarger, 2010). In such context, the analysis of children's participation in daily activities would inform us of the likelihood of LEK acquisition (Bliege Bird & Bird, 2002; Gurven & Kaplan, 2006). Indeed, because there are trade-offs in the acquisition of different types of knowledge (Boyette, 2010; Morelli et al., 2003), either directly related to the environment or not, children's involvement in different activities would inform us on the type of knowledge children would likely acquire (Morelli et al., 2003; Sternberg et al., 2001).

Specifically, in this chapter we assess whether changes in parental livelihood relate to changes in children's involvement in daily activities, a proxy for children's LEK acquisition. We first describe children's daily activities. We then examine three indicators of change in parental livelihood: use of time, income, and level of schooling.

Finally, we analyze whether these three indicators relate to children's use of time, discussing potential effects on children's LEK acquisition.

2. The Baka

The Baka are hunter-gatherers from the Congo Basin, mostly living in southeastern Cameroon, counting around 30,000 individuals (Leclerc, 2012). Holding deep knowledge about their environment, the Baka are known for their forest expertise [e.g., they are valuable guides for foreigners seeking access to forest's natural resources (ivory, game, ebony)]. Their knowledge of the local environment, essential for their subsistence, is embedded in specialized practical skills, adapted to their daily subsistence needs. For example, previous researchers have documented how Baka wild yams gathering was indeed a complex system of paracultivation including specific techniques and knowledge for the maintenance of such resources (Dounias, 2001; Sato, Kawamura, Hayashi, Inai, & Yamauchi, 2012). Wild yam gathering was also intimately related with rituals, involving both a rich set of material items and many cultural beliefs. (Joiris, 1998)

During the last five decades, the Baka have witnessed changes in the forest they inhabit, somehow responding to those changes. As a result, Baka are now relatively sedentary, have partially adopted agriculture, are involved in wage labor for their neighbors, and are exposed to national education and health programs (Althabe, 1965b; Bahuchet, 1991; Leclerc, 2012).

As other hunter-gatherer societies (Hewlett, 2014), Baka rely on oral communication and daily experiences to transmit their cultural knowledge and cosmology. Since infancy, Baka children experience a high physical and emotional

intimacy with both their parents and with other members of their family and community (Barry S. Hewlett, 2014a), which are probably important in the transmission of knowledge. Thus, children acquire their ecological knowledge mostly through close interaction with the social and ecological environment, and through the observation and imitation of those around them.

3. Methods

Data were collected from February 2012 to August 2013 in several Baka communities in southeastern Cameroon, in the districts of Lomié and Messok from the Haut-Nyong department. We conducted extended fieldwork in two communities, one comprised of 264 individuals (119 adults, > 16 years of age) and the other comprised of 410 individuals (187 adults). The sample includes children and their respective parents. We obtained Free Prior and Informed Consent of each village and individual participating. For children, we obtained the informed consent of one of the parents. The research adheres to the Code of Ethics of the International Society of Ethnobiology and has received the approval of the ethics committee of the Universitat Autònoma de Barcelona (CEEAH-04102010).

3.1. Data collection and variable construction

Our extensive fieldwork enabled qualitative data collection through participant observation. We followed local socio-cultural norms, e.g. on sharing, cooking and children caretaking; we participated on the daily life of neighboring households. Initially, we worked with two translators, a Baka and a Nzime, although after some months in the field we could speak enough Baka to directly interact with adults and

children. Drawing on information collected during the initial months in the field, we designed the tools presented below for the collection of systematic data.

3.1.1. Children's daily activities

To assess children's involvement in daily activities, we asked 98 children (boys and girls 5-16 years of age) to report the activities they performed during the day time of the previous 24 hours. During the interviews, we coded self-reported activities into one of 15 activity clusters, developed over the course of ethnographic data collection. Each cluster of activities may thus contain similar activities using different techniques (e.g., a child who responded that he hunted rats with machete, or that he hunted birds with bow and arrows would be coded in the hunting cluster). Once the children stopped listing activities, we continued the interview by systematically asking whether they had also performed any of the remaining activities in our list. Involvement in the 15 clusters of activities was coded as 1 if the child performed the activity and 0 otherwise.

The 15 clusters were grouped into three higher-level categories, according to the activity's potential for LEK acquisition. The first category includes subsistence-related activities that may favor the acquisition of LEK. The second category includes activities indirectly-related to subsistence but that also favor the acquisition of LEK because they are integral to Baka's culture (through the acquisition and transmission of norms, values and cosmology). The last category includes activities unlikely related to the acquisition of LEK, such as school attendance or modern leisure (playing football, or going to bars).

3.1.2. Parental indicators of cultural change

We proxied cultural change among Baka parents through three indicators: main daily activities, total income, and level of schooling.

To evaluate parental main daily activities, we used self-reported interviews on the main activity performed during the day time of the two days before the interview. Between August 2012 and August 2013, we visited every household in the sample every week and conducted interviews with all the adults present. Parental activities were grouped into 17 different categories. We estimated the individual's involvement in an activity as the ratio between the number of times the activity was mentioned by the respondent and the total number of days reported in interviews. Therefore, the variable that captures an individual's involvement in an activity took a value between 0 and 1, where the sum of the involvement in the 17 activities equals to 1.

To measure total income, we collected thrice over the course of a year data on all the sources of income received during the 15 days before the interview. We asked about income perceived from sales and wage labor. As Baka are often paid in kind for their work, we converted the products obtained into their monetary equivalent. Income data were averaged to obtain a single measure for each individual. Economic values were recorded in local currency (Francs CFA) and then transformed into US\$ PPP values (Purchasing Power Parity; 251 XFA=1 \$ ppp - according to World Bank website, 2015).

Additionally, we conducted a census with all individuals living in the two study villages. As most Baka cannot recall their birth date, we estimated age using both physical estimations and kinship information. We also asked every individual about the highest level of education reached. We coded 0 when they have never attended school;

0.99 when they only completed the first year of schooling, and assigned a number from 1 to 8 corresponding to 1st to 8th school grade. None of the Baka in our sample had attended high school.

3.2. Data analysis

We analyzed children's involvement in daily activities by computing the frequencies with which the different activities were performed by children. We also run the analysis differentiating between boys and girls. As children's activities can largely vary with age, we also took into account the child's age category (middle childhood ≥ 5 - < 9 years-old; pre-adolescence ≥ 9 - < 13 years-old; adolescence ≥ 13 - ≤ 16 years-old). We conducted similar descriptive statistics (for the full sample and by sex) for Baka adult's use of time, and for our two other proxy measures of parental cultural change (total income and schooling).

We first examine the correspondence between children's and parent's involvement in different types of activities. Specifically, we focus our attention on three potential associations: 1) parent's and children's involvement in subsistence activities (i.e., hunting, gathering, fishing and agriculture); 2) parent's involvement in wage labor (i.e., for logging companies and commercial agriculture) vs. children's involvement in subsistence activities; and 3) parent's involvement in wage labor vs. children's involvement in activities where LEK acquisition is unlikely (i.e., soccer playing, listening to modern music). For the three cases, we ran a series of Wilcoxon ranking tests between children's and parent's involvement in the selected activities. We ran the analysis first with the aggregated sample, then by sex, and finally by children's age category. We followed a similar approach and ran a series of Wilcoxon ranking tests to assess whether parent's income or level of schooling were related to children's

involvement in daily activities. As in previous analysis, we conducted such analysis for the full sample, by sex, and by children's age category.

4. Results

4.1. Baka children's use of time

Irrespective of sex and age, Baka children's predominant daily activities relate to subsistence, mostly household maintenance and play. Boys and girls show different levels of involvement in most, but not all, daily activities (Table VIII-1). Regarding activities directly related to LEK acquisition, irrespectively of age, girls are more frequently involved in household activities (97% of the girls interviewed) and fishing (32%). Boys are more frequently involved in hunting activities, with 69% of them reporting having hunted the day before the interview. Finally, gathering also tends to be more frequent among girls, especially during preadolescence (53%) and adolescence (64%).

In contrast with activities directly related to subsistence, girls and boys engage with the same frequency in activities indirectly related to subsistence, with one exception: once they reach pre-adolescence, girls report performing traditional songs, tales, and dances more frequently than boys (13% vs. 4%).

Adolescents play less frequently than younger children but socialize and listen to music more frequently than them. Interestingly, as girls move into adolescence, they go fishing less frequently than during middle childhood (20% vs. 36%); and are also less involved in handicraft activities than during middle childhood (4% vs. 13%). Contrarily, adolescent girls are more frequently involved in gathering activities than during middle

childhood (reported by 64% vs. 37%). For boys, as they enter into adolescence, they are less frequently involved in household maintenance activities. Adolescent boys are also less frequently involved in hunting (43% vs. 81.8% for middle childhood boys), gathering (43% vs. 62%), and fishing (4% vs. 20%) activities.

Table VII - 1 Children's involvement in daily activities (in frequency - percentage).

Categories of Activities	Activities	Middle childhood		Pre-adolescence		Adolescence	
		Girls (n=10)	Boys (n=15)	Girls (n=22)	Boys (n=22)	Girls (n=14)	Boys (n=15)
Subsistence activities, directly related to LEK acquisition	Household maintenance	100.0	93.1	95.4	97.0	96.4	73.3
	Hunting	17.5	81.8	19.3	79.3	26.2	42.5
	Gathering	36.5	61.8	53.4	39.0	64.3	43.8
	Agricultural work	46.0	15.6	30.0	22.6	41.1	34.3
	Fishing	35.5	20.0	38.6	25.1	19.9	3.9
Indirectly related to LEK acquisition	Handicraft	12.5	8.9	2.3	13.4	4.2	18.0
	Plays	64.0	75.6	55.7	52.0	37.9	52.3
	Maintenance	12.5	31.3	12.5	24.4	23.5	35.8
	Traditional songs, tales and dances	13.5	13.3	20.4	5.5	12.5	4.4
Unlikely related to LEK acquisition	Listening to music	25.0	25.3	46.2	32.7	45.2	62.8
	School	11.5	23.3	22.7	29.5	20.2	4.9
	Other activities	9.0	16.9	6.8	25.0	17.5	20.4
	Football	4.5	19.6	3.4	23.0	0	24.9
	Alcohol drinking	2.5	0.0	6.8	2.0	18	38.6
	Socializing	2.0	11.1	2.3	0.9	16.9	25.4

4.2. Parental indicators of cultural change

Agriculture is the predominant daily activity of parents, including agricultural work in Nzime's fields (18% of the reports) and subsistence agriculture in their own plots (19% of the reports) (Figure VII-1). Leisure was reported as the main activity in 14% of the interviews, followed by gathering (12%), hunting (7%), and craft making (6%).

Baka's main daily activity largely varies according to sex. Women are more involved in agricultural work (24% of the reports working in Nzime's fields and 21% in their own plots) than men (10% and 17%). Women also spend more time than men in gathering (14% vs. 9%) and fishing (5% vs. 1%). Conversely, men are more involved in hunting (14% vs. 2%) and unskilled labor (4% vs. 0%) than women. Moreover, it is worth noticing that Baka adult's main daily activities are diversified and vary largely between individuals (Table VII-2). For instance, whereas women's involvement in agricultural activities is high, with only 5% of them reporting never having performed subsistence agriculture (and 7% of them for agricultural job), their involvement varied (SD=14 for subsistence agriculture; SD=16 for agricultural job). Father's involvement in agriculture was also variable (SD=11 for subsistence agriculture; SD=9 for agricultural job), as 10% of them reported having never performed subsistence agriculture, and 18% of them reported having never performed agriculture jobs. The same occurs with other subsistence activities, such as the involvement of women in hunting activities (not reported by 59% of the mothers). Father's involvement in gathering activities also varied (SD=7) and 12% of them did not report gathering. Finally, father's involvement in unskilled labor also varies (SD=8; and 53% did not report unskilled labor).

Figure VII - 1 Parental main daily activities (2359 direct reports: 1312 of women, 1047 of men).

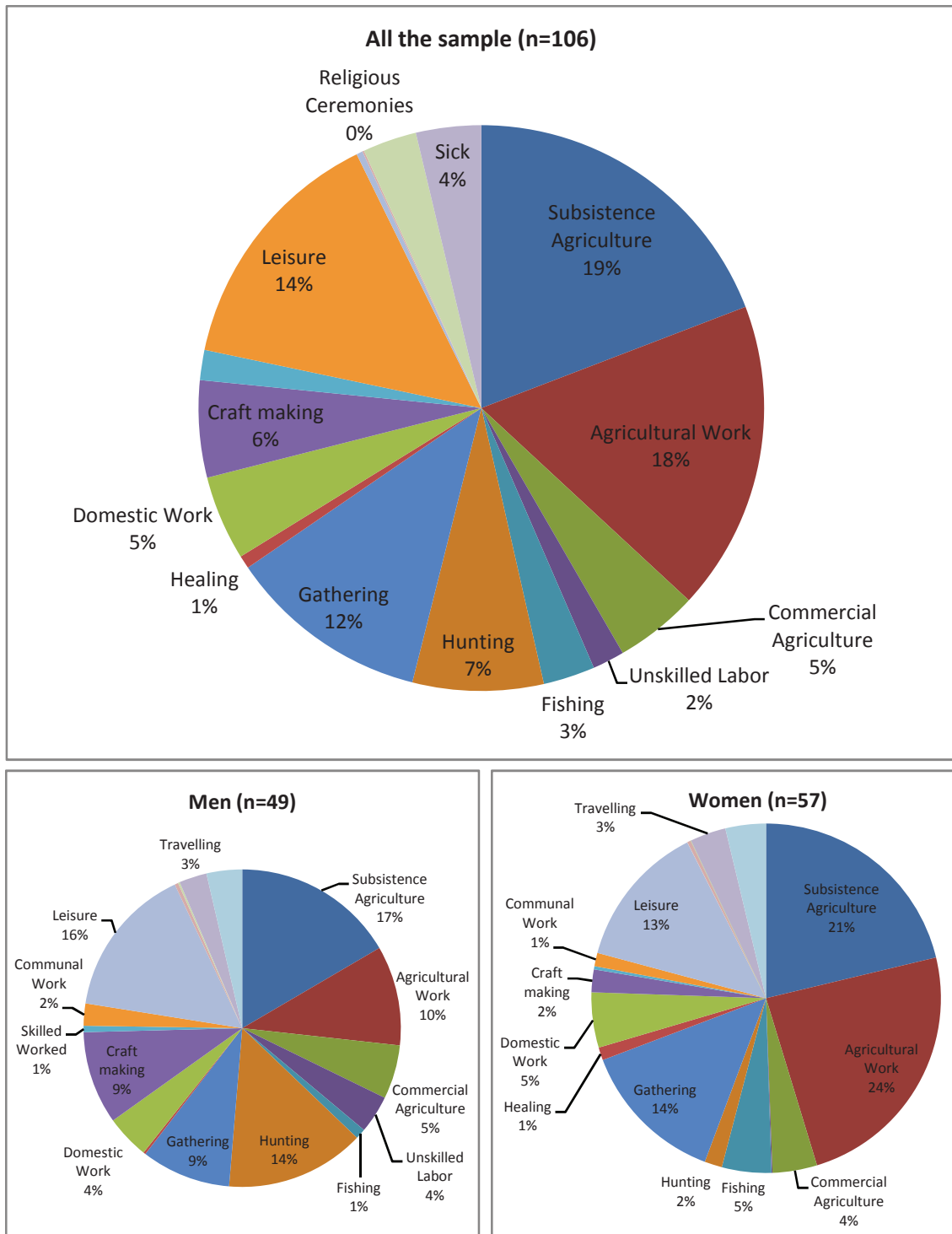


Table VII - 2 Parental main daily activities, by sex; in percentage.

Activities	Women		Men	
	Mean	Std. Dev.	Mean	Std. Dev.
Subsistence Agriculture	21.18	13.83	16.56	11.32
Agricultural Work	23.96	15.86	10.15	8.89
Commercial Agriculture	4.11	6.19	5.49	6.19
Unskilled Labor	0.09	0.38	3.83	8.42
Fishing	4.56	4.36	1.05	2.21
Hunting	1.63	2.50	14.17	9.91
Gathering	13.46	7.86	9.11	7.08
Healing	1.19	2.78	0.23	0.85
Domestic Work	5.09	5.39	4.45	6.09
Craft making	2.10	3.65	9.46	14.41
Skilled Work	0.29	1.11	0.62	1.81
Communal Work	1.24	2.82	2.25	3.56
Leisure	13.31	7.62	15.50	10.59
Religious Ceremonies	0.37	1.05	0.34	1.09
Trading	0.00	0.00	0.20	1.43
Travelling	3.32	6.26	2.80	3.17
Sick	3.75	5.09	3.63	5.62

We also found diversity among parental income (Table VII-3). The average income earned in a fortnight period was 9.31\$ppp, varying between 0 and 24\$ppp for women and 0 to 51\$ppp for men. Four percent of the sample did not receive any income. Most income earned by Baka adults in our sample comes from wage labor performed for the Nzime. However, total income largely varies among men and women. Additionally, while men are typically paid in cash, most women are paid in kind (typically with agricultural products). Income from sale is mostly owned by men through the sale of wild meat and forest products.

Table VII - 3 Descriptive statistics of parental total income, and level of schooling.

		Income (in \$ppp/15days)	Level of schooling*
All the sample (n=106)	Mean	9.31	1.19
	Std. Dev.	8.88	1.12
	Min	0	0
	Max	50.67	5
Women (n=57)	Mean	7.28	0.73
	Std. Dev.	5.00	0.64
	Min	0	0
	Max	24.33	3
Men (n=49)	Mean	11.59	1.71
	Std. Dev.	11.45	1.32
	Min	0	0
	Max	50.67	5

* 0=no school, 0.99: kindergarten, 1-8: 1st to 8th grade

We found lower diversity in parental levels of schooling. On average, Baka adults had only completed the first school grade, although averages were higher among men (1.71) than among women (0.73). Six percent of men and 33% of women had never attended school; 4% of the men in the sample had completed fifth grade, but the higher school level completed by a woman was third grade (reached by 3.5% of them).

4.3. Association between parents' and children's use of time

Results of a series of Wilcoxon Ranking tests showed no statistically significant association between parents' and children's involvement in similar subsistence activities (aggregated, by sex, and by children's age category), with only two exceptions (Table VII-4). Children's involvement in gathering activities bears a positive association with mother's involvement in gathering ($z=-2.11$, $p=.03$), especially for boys ($z=-2.46$, $p=0.01$); and children's involvement in agriculture is associated with father's involvement in agriculture ($z=-2.12$, $p=.05$), especially for girls ($z=-1.99$, $p=.05$).

We found, however, association between parents' and children's involvement in *different* subsistence activities. For example, children are more frequently involved in agriculture, when their father are more involved in fishing ($z=-2.29$, $p=.02$), and preadolescent boys are more frequently involved in agriculture when their father are more involved in hunting ($z=-2.08$, $p=.04$). Boys are also more frequently involved in agriculture when their mother perform more fishing ($z=-2.13$, $p=.03$). We also found some associations between parent's involvement in agriculture (own plot) and the performance of other subsistence activities by children (Table VII-4). For example, boys are more frequently involved in fishing when their father devotes more time to subsistence agriculture ($z=-2.70$, $p=.007$). When their mother involved more time in agriculture for subsistence, pre-adolescent children are more frequently involved in hunting ($z=-4.1$, $p<.001$), and preadolescent boys are more frequently involved in fishing ($z=-2.6$, $p=.001$). When looking at parent's involvement in agricultural job for the Nzime, we found a positive association with children's involvement in hunting for both girls ($z=-2.02$, $p=.04$) and boys ($z=-2.64$, $p=.008$) (Table VII-4).

Table VII - 4 Association between indicators of adult’s cultural change and children's involvement in daily activities - Results of Wilcoxon ranking test.

Indicators adult cultural change			Girls involvement in				Boys involvement in			
			Hunting	Gathering	Fishing	Agriculture	Hunting	Gathering	Fishing	Agriculture
Father	Involvement in Subsistence Activities	Hunting	0.26	-1.38	-0.31	0.32	0.72	0.16	1.20	-1.67*
		Gathering	-0.17	0.02	-0.58	-0.58	-0.61	0.58	0.67	0.63
		Fishing	-0.08	-0.25	0.62	-1.65*	-0.72	-0.32	1.33	-0.82
		Agriculture	0.21	-1.64	1.30	-1.99**	-0.56	0.47	-2.70***	-0.85
	Modern wage labor	Agri job	-2.02**	-1.62	-0.22	-0.11	-2.64***	0.37	-1.15	-1.15
		Com Agri Unskilled labor	-2.30**	-0.23	-2.04**	-0.65	-0.43	0.17	-1.56	1.56
			-1.08	0.64	1.14	0.61	-0.60	-1.76*	0.63	-2.18**
		Total Income	-1.08	0.46	0.34	0.59	-0.42	-0.54	1.10	-0.78
Level of Schooling	-0.43	0.62	1.11	-0.29	1.77*	-1.59	1.28	0.37		
Mother	Involvement in Subsistence Activities	Hunting	-1.13	-0.11	-0.06	-0.92	1.15	-1.44	0.51	-0.26
		Gathering	-0.72	-0.05	0.23	-0.34	0.38	-2.46**	1.10	0.90
		Fishing	-1.04	0.60	0	0.05	-1.24	1.68*	-1.0	-2.13**
		Agriculture	-1.29	-0.89	0.15	-1.44	-1.13	-0.75	-0.30	-0.19
	Modern wage labor	Agri job	-0.35	-0.35	-0.40	0.95	-1.11	1.62	-0.88	-1.42
		Com Agri Unskilled labor	-0.97	-0.38	-0.40	-0.97	-0.24	-0.83	-0.40	1.39
			0.87	-0.24	-1.14	1.36	-	-	-	-
		Total Income	-2.5**	-1.31	-0.21	0.05	-0.12	0.46	0.82	-2.36**
Level of Schooling	-0.99	0.58	-0.56	-0.43	-0.42	-2.12**	0.46	1.04		

there is no observation of boys whose mother was involved in unskilled labor; *p<.1, **p<.05, ***p<.01 to the Wilcoxon ranking tests.

When exploring whether parental involvement in modern wage labor relates to children's involvement in subsistence daily activities, we generally found low associations (Table VII-4). The most remarkable associations in this group include that, when fathers are more involved in commercial agriculture, children are more involved in hunting and fishing activities (respectively $z=-2.08$, $p=.04$, and $z=-2.15$, $p=.03$), and especially girls ($z=-2.30$, $p=.02$ for hunting and $z=-2.04$, $p=.04$ for fishing). Similarly, when their father is more involved in logging work, boys are more frequently engaged in agriculture ($z=-2.18$, $p=.03$), especially during preadolescence (-3.42 , $p=.000$).

We found few associations between parental involvement in unskilled labor or commercial agriculture and children's involvement in activities unlikely related to LEK acquisition, except the association between father's involvement in wage labor and children attendance to school: positive association for girls ($z=-2.24$, $p=.02$), but negative for boys ($z=1.82$, $p=.07$).

4.4. Association between parent's income and education and children's use of time

We ran similar analyses with our two other proxies of adult cultural change: total income and schooling (Table VII-4). The only statistically significant results found are the positive association between mother's income and girls' involvement in hunting ($z=-2.5$, $p=.01$) and boys' involvement in agriculture ($z=-2.36$, $p=.02$). Parental income is not associated with children's involvement in activities not linked to LEK, except for the positive association between father's income and girls frequency of reports in listening to music ($z=-2.06$, $p=.04$), and the negative association between mother's income and boys school attendance ($z=1.71$, $z=.09$) (results not shown).

Some statistically significant associations appear when testing the relations between parents' schooling and children's involvement in subsistence activities (Table VII-4): higher father's education is associated to lower children's reports of hunting ($z=2.31$, $p=.02$) especially for boys ($z=1.77$, $p=.08$). In contrast, boys ($z=-2.12$, $p=.03$) engage in gathering more frequently when their mother's schooling is higher. Finally, higher schooling among mother's is associated to lower children school attendance ($z=1.71$, $p=.09$), especially during middle childhood ($z=1.73$, $p=.08$). For preadolescents, higher schooling among father's is associated with lower boys' school attendance ($z=1.92$, $p=.06$) but higher girls' school attendance ($z=-2.26$, $p=.02$).

5. Discussion

5.1. Children's daily activities and local ecological knowledge learning

As in other hunter-gatherer societies (Boyette, 2010; Demps et al., 2012; Ruiz-Mallén et al., 2013), subsistence activities predominate in Baka childhood, which implies that Baka children are frequently involved in activities where they are likely to acquire LEK.

The predominance of activities related to household maintenance also suggests that the mechanisms that facilitate the acquisition of culturally relevant knowledge continue to be largely in place. During our ethnographic observations, parents told us that children would take advantage of activities such as fetching water, or collecting firewood to engage in the opportunistic hunt of little animals or in the gathering of wild edibles. Engaging in such activities from an early age allows children to obtain basic

knowledge needed for more complex skill acquisition as they age (Reyes-García et al., 2016; Schniter et al., 2015). Our data also show that, as early as middle childhood, activities are sex-differentiated, with hunting appearing to be a predominant boys' activity whereas fishing and household chores (specifically children caretaking) are predominantly girls' activities. Such data then suggest that the progressive acquisition of LEK is sex-differentiated.

Newly introduced activities have infiltrated children's lives to varying degrees. School is not very frequently attended among children in our sample, and our observations suggest that, even among children who attend school, they do so for very few hours. Yet children spent considerable time at bars, listening to music and dancing. As these activities mostly occur during the evening, they seem to be replacing other traditional leisure activities (tales, songs and traditional dances). In that sense, the increase in evenings spent at local bars may be impacting acquisition of cultural knowledge (Weig, 2015), including local ecological knowledge (Fitzgerald, 2011).

5.2. Cultural change among the Baka

The analysis of contemporary Baka adult's use of time allows for a discussion of the impact of cultural change in Baka livelihoods. Scholars have highlighted the progressive changes faced by the Baka and the potential consequences on their livelihoods. Such changes relate, for instance, to the sedentarization (Althabe, 1965b; Leclerc, 2001, 2006), the adoption of agriculture (Leclerc, 2012; Yasuoka, 2012), and the impact of the monetarization (Kitanishi, 2006; Oishi, 2012). Our results corroborate the importance of such changes. For example, we found that agriculture—not hunting and gathering—is now Baka adults' main occupation. Agriculture provides the Baka with food and cash and has become the main subsistence activity for some households

in our study area (Leclerc, 2012). From ethnographic observations, we know that there is certain gender specialization in agricultural chores. When working in their own plots, men seem to specialize in tasks bounded to a specific time, whereas women's involvement is prolonged through the agricultural cycle. When performing wage agricultural labor, women are generally more involved in Nzime's plots for subsistence; whereas men seem to work more often in Nzime's cacao fields. There is also a sexual division of agricultural wage labor that relates to income differences between men and women, with men's labor receiving up to twice the salary received by women. Men's and women's income differences in are exacerbated by men's participation in the logging industry.

The changes described affect to some extent all Baka households, although variation exists in the use of time and the income received among different households. Indeed, whereas some households tend to develop strategies based mostly on hunting and gathering, others concentrate in agriculture, and still others in wage labor. However, many households also display a diversified strategy, combining hunting, gathering (for subsistence or commercial purposes), wage labor and agriculture (see also Gallois et al. *(under review -c)*).

Finally, among the three different indicators of cultural changes, parental education appears as the least variable, probably because schooling is relatively recent in the area. Although many adults, especially young adults, reported having attended school, they mostly attended for few years. In that sense, parental education seems not to be a relevant indicator of cultural changes for the studied villages.

5.3. Local ecological knowledge learning and parental livelihoods

The third important finding of this work is that, despite the high diversity in parental livelihood activities and income, children's daily activities do not seem to be associated to any of those two indicators of cultural change. Why children's choice of activities does not resemble parental choices? We can think of two related explanations.

Our first explanation relates to specific traits of Baka childhood. As in other hunter-gatherer societies, Baka children are highly autonomous and independent since an early age (see Hewlett (2014)). For instance, Baka parents are rarely present during children's daily activities. Moreover, allo-parental care is very common among the Baka: several adults and adolescents out the family are involved in child caretaking, what allow children to get several models out of their parents. Contrarily to what is known among farmers (Hewlett, 2014), Baka children are not necessarily pushed to help their parents in subsistence activities. Baka children are much more free than the children of Bantu-speaking neighbors to decide how to use their time. So, our first explanation for the lack of association between children's choice of activities and parental indicators of cultural change is that parents are not sufficiently present in children's days as to exert a strong influence in children's activity choice.

Second, our results also suggest that children tend to perform different activities than their parents, especially when their parents are involved in agricultural work or wage labor. By engaging in different activities than their parents, children might be contributing to the diversification of sources of food (fishes, tubers, small animals) within the household. During middle childhood, while their parents are away, children mostly engage in subsistence activities, including catching little animals and gathering sub-spontaneous tubers for which they often get their own food. In accordance with

what has been reported in other settings (Bird & Bliege Bird, 2005; Crittenden et al., 2009; Tucker & Young, 2005), the outcomes of Baka children's subsistence activities seem to provide them an important part of their daily food during parental absences. As they grow, the products gathered are increasingly important for household consumption, complementing the products brought by their parents. Therefore, our second explanation for the lack of association relates to the adoption of a diversified strategy within the same household in which the activities that children's and their parents perform are complementary.

6. Conclusion

Although Baka children frequently engage in subsistence activities, they also engage in activities unknown decades ago. There is also an important shift in the way parents use their time, with a predominance of agricultural work and wage labor. Nevertheless, there is no association between children's and parent's engagement in activities. The puzzle we are left with is: if parental changes do not affect children's daily activities, then, what does?

Data presented here mainly focus on behavioral characteristics, but cultural change also refers to changes in perceptions, ideas, and values (Godoy et al., 2005). In that sense, the impacts of cultural change on children's involvement in daily activities, and thus, on ecological knowledge learning, might also relate to more general trends that affect children and adults equally. For example, as new opportunities of wage labor appear, they convey a new way of valuing nature: through commercialization, a shift that can affect how Baka adults and children alike perceive their environment and their own livelihood. Therefore, in the study of local ecological knowledge learning more

emphasis should be made in the way both children and adults perceive and value the different activities, and how those perceptions and values shape children's choices towards their daily activities. From children's voices, we frequently heard that agriculture, wage labor and household maintenance were valuable activities to master to be a complete adult. In conclusion, we propose that cultural changes on children's LEK acquisition might relate more to the general tendency driving several cultural changes among Baka society, rather than to parent's indicators of cultural change. Further research could explore such assertion through the study of changes in children's representations and worldviews.

Chapter VIII

How social changes might affect LEK acquisition? Exploring local perceptions on Baka own culture

1. Introduction

Scholars from multiple disciplines have tried to assess both the universal and the specific traits of child behavior and development. Among those, in the anthropological discipline, the work of Beatrice and John Whiting proposed the concept of ‘cultural learning environment’ to argue that patterns found on children's development and behaviors are shaped by specific cultural physical and social settings, and most importantly by the cultural maintenance systems (Whiting & Whiting, 1975; Whiting, 1980). The idea that cultural maintenance systems condition children’s behavior led to numerous posterior theories (Edwards & Bloch, 2010; Weisner, 2015). For example, some researchers added the emotional dimension, highlighting that child development might be assessed not only through both the physical and social but also the emotional settings in which children live (Harkness & Super, 1992, 1996; LeVine et al., 1988; Whiting & Whiting, 1975; Whiting, 1980). Harkness & Super (1986) proposed the concept of "*developmental niche*" to highlight the relation between the child and the surrounding environment and proposed three main factors driving children’s behavior and development: a) the social and physical context wherein the child lives; b) the cultural practices and rules that guide child’s education; and c) the parental psychology

towards education and child development, also referred as parental ethno-theories (Super & Harkness, 1986). In other words, in addition to what people around children do, children's behavior also seems to be shaped by parent's perceptions and representations (Harkness & Super 1996; Harkness & Super 1992; Hollos 2002; LeVine et al. 1988; Sigel et al. 1992). Such theory departs from the concept of cultural learning environment in the sense that it proposes that, more than by the cultural settings, children's behavior and development is also influenced by the household to which they belong. For example, Hollos reported that among the Pare from Tanzania, children's use of time varies according to the type of household they live in, showing that "*children in small, so-called 'partnership' families work little, play a lot, rest a bit and study. (...) Children in larger, so-called 'lineage-based' families work a lot, play little and rest and study even less*" (Hollos, 2002: p. 187). In sum, according to these theories, children's behavior and development has to be assessed considering at the same time the cultural specificities related to their physical, social and emotional settings, but also parental and household specificities.

It is important to notice, however, that cultural and familiar settings are not fixed, as they rather "*evolve continuously over time to promote adaptation to constraints imposed by external factors, changes in subsistence base, climatic changes and the political economics of the region*" (Edwards & Bloch 2010: p.489). Furthermore, this is especially the case for most small-scale societies worldwide, most of them facing important social-ecological changes. For instance, new economic activities, such as logging, large-scale farming, oil-palm plantations and oil and gas extraction are some of the current drivers of change in the tropics, significantly affecting standards of living of previously autarkic populations (Laurance, 2015). However, such changes are not only affecting adult's livelihoods, but rather they also permeate to affect childhood. Indeed,

as Thompson notices, “*Children are influenced directly and indirectly by changes in cultural values, institutions, and social interactions that occur within these social ecologies, which are increasingly being altered by processes associated with globalization*” (Thompson, 2012: p. 188). In sum, such work suggests that acknowledging cultural change might be important to understand child behavior and development. Despite such intuition, to date, few studies have empirically analyzed how social ecological and environmental changes might actually relate to child behavior and development.

The aim of this chapter is to advance our understanding of how, in a context of social change, children's choice of daily activities is shaped by parental behavior and expectations towards the skills children should master to be competent adults. Moreover, based on research highlighting the importance to “*listen long, and listen wide*” (Cross 2009: p.351), we gave a special emphasis to what children perceive about their own life and their expectations towards adulthood. Our study was conducted among a contemporary small-scale society settled in a tropical forest and facing important social-ecological changes: the Baka, a hunter-gatherer society mostly living in southeastern Cameroon, who have been exposed to those changes in a drastic way (Ichikawa, 2014). Given the importance of the social-ecological changes in Baka's livelihoods, it is worth wondering how such changes affect Baka children.

The first aim of this study is to assess how current social-ecological changes are affecting adult's livelihoods. We do so by analyzing whether there are different adult's household strategies. We then explore whether what children do during their daily life might be related to the profile of the household to which they belong. We then analyze if what children and adults expect about their daily life is related to the household

profile, and finally we explore what are children's and adults' perceptions and expectations for being a competent adult.

2. The Baka

The Baka are one of several hunter-gatherer groups living in the tropical forests of the Congo Basin. Their population, estimated at around 30,000 people, spreads across four countries; most Baka live in Cameroon, while some groups are also found in the Democratic Republic of Congo, Central African Republic and Gabon (Leclerc, 2012). As in other tropical regions (Laurance, 2015), new economic activities, such as logging, large-scale farming, oil-palm plantations and oil and gas extraction are important drivers of change in southeastern Cameroon, significantly affecting standards of living of previously autarkic populations (Ernst et al., 2013; Lewis & Nkuintchua, 2012). Thus, for decades, the Cameroonian tropical forest has witnessed the opening of mining and logging concessions, first from European, then from American, and more recently from Asian companies (Ichikawa, 2006). The improvement in the transport system propitiated by those companies, has also brought poachers, bushmeat and ivory traders to the area, all together having a large impact on the local ecological system (Bennett, 2014; Taylor et al., 2015; Wilkie et al., 2011). In response to those changes, international institutions and policy-makers have promoted biodiversity conservation programs as well as the creation of natural parks, faunal reserves, and wildlife sanctuaries. Thus, local populations with a long history of interaction with the environment and dependent on natural resources for their subsistence now face considerable changes in terms of access and the use of the natural resources, and – consequently– have to adapt their livelihoods strategies (Ichikawa, 2001).

Highly nomadic until the turn of the 1960s, the Baka traditionally followed a seasonal migration between different forest camps. Their livelihood was based on the use of forest resources and the exchange of products with farmer neighbors. With the development of new economic activities in the area, the Baka have witnessed the gradual reduction of access to forest resources, especially to game and wild edibles. Consequently, they have gradually abandoned their forest camps to establish themselves in villages along logging roads. This shift has been reinforced both by the missionaries and by national policies -such as the extensive sedentarization program instituted in Cameroon since the 1950s- which led many Baka to reduce their mobility (Althabe, 1965; Bahuchet, 1991; Bailey et al., 1992; Leclerc, 2012). Consequently, today, most Baka live in villages close to Bantu-speaking neighbor's villages. They have also progressively started to engage in agricultural work by opening their own plots (Leclerc, 2012) and many Baka children have now the opportunity to attend school (Kamei 2001). Thus, nowadays, albeit with many variations, most Baka live in permanent settlements, engage in agricultural work, both providing wage labor for their neighbors and in their own plots. The different combinations of one or another activity has resulted in the Baka developing a range of different living strategies (Yasuoka, 2012).

As the Baka have been extensively studied, (see for example the works of Bahuchet (1991), Ichikawa (2001), Joiris (2003), and Leclerc (2012)) here we only focus on describing some aspects of Baka childhood that help contextualize our results, namely Baka emic description of child development and cultural patterns of child caring.

First, Baka differentiate between six different stages of child development, mostly related to physical characteristics and abilities to perform daily activities. Childhood is considered to end with the onset of the reproductive stage (Figure VIII-1).

Even before birth, Baka children-to-be receive attention and have a specific position in the household and the village. For example, to ensure the physical and spiritual health of the infant-to-be, both the pregnant woman and her partner have to follow several restrictions, including dietary restrictions on the consumption of wild animals and plants. The first months of a child's, *dindo*, are perceived as a critical period in Baka life. During this period, the Baka recognize a triangular relation between father-mother-infant which seems to shape many daily activities. For example, during infancy parents restrict some practices during the performance of hunting, gathering, and fishing expeditions, as prescribed by cultural prohibitions regulating diet and activities performance. Men are also warned against having sexual relations with other women. Failure to follow such restrictions is believed to cause abortion or new-born's illnesses. While most restrictions are limited to the pregnancy and the first months of an infant's life, some are prolonged until weaning. Interestingly, weaning represents not only the onset of children's autonomy, a condition that starts as soon as the child begins walking, but also the end of the mentioned children-related social norms that regulate parents' behaviors. Once weaned, and concomitant with walk acquisition, children are called *yande*.

Figure VIII - 1 Terminology of the individual development among the lifespan.

		Terms	Baka's descriptions
		mε	Fœtus
bimi a bo (Half a human)	}	1-1.5 y.- dindo	From birth to walking (infant)
		2-3 y.-o. libenda	From walking to weaning (toddler)
yandε	}	ngama	Weaned, however, they still need help to accomplish their daily activities (washing, eating...), they don't express clearly their needs and cry often (child)
		5 y.-o. ngùmà nà bo	They are able to perform their activities for their own, they are more independent, and can express their needs (child)
		9 y.-o. lingi/ sia	They are able to perform work (agricultural work for instance) ; girls <i>sia</i> begin to get breast and arrival to menstruation (pre-adolescence)
		13 y.-o. ewanjɔ/ sia *	Their bodies are already more like adult's ones; period just before marriage (adolescence)
ko.bo	}	16 y.-o. mbotaki	After first birth / new household (adult)
		ko.bo na bo	They don't have the energy to work, they become like children, since they need other people to feed (elder)
		gbekoa-bo	
		mε	Dead spirit

* there were some differences between what Brisson and Joiris said about *lingi*, *sia* and *ewanjo* and what Baka people reported to me. For Brisson and Joiris (Brisson, 2010; Joiris, 1998), the adolescence stage is called *ewanjo* for both gender, however, Baka told me that we talk about *ewanjo* only for boys. Also, the term *sia* is the same between pre ado and adolescence, however, Baka I interviewed told me that there is a first stage of *sia*, the youngest *sia* and then the oldest *sia*, without giving me a clear distinction between what Brisson and Joiris consider as preadolescence and adolescence.

Baka also differentiate between several stages during childhood: middle childhood or *ngùmà nà bo*, preadolescence—called *lingi* and *sia*- and adolescence, called *ewanjo* for boys and *sia* for girls. Childhood is considered to end once a person establishes his or her own household, and especially after the arrival of the first child, when young adults are considered as *ko.bo nà bo*, or adults (Figure VIII-1).

Similar to other hunter-gatherer societies from the Congo Basin, Baka children witness a high level of physical and emotional intimacy with other members of the community (Barry S. Hewlett, 2014a). Since Baka infants are much more held, at least compared with their neighbors farmers (Hirasawa, 2005), mothers often recruit help from other people to hold infants. Thus, children as young as 6 years-old are asked to follow their mother in some activities, so they can help take care of the infant while she is working. Only when Baka adults leave the village without having an old-enough child to care for the infant do they delegate the care to specific adults, which frequently include grandparents, or parental siblings.

3. Research setting and methodology

This research took place among several Baka communities from southeastern Cameroon, in the districts of Lomié and Messok, in the Haut-Nyong Department. The first two authors conducted 18 months of fieldwork, from February 2012 to August

2013, in two communities with about 300 residents each (of which about half were children). Before starting data collection, we obtained free prior and informed consent in the two villages and from every individual participating in the study. As the study involved interviewing children, we obtained the consent of the parents of the children we worked with. This study adheres to the Code of Ethics of the International Society of Ethnobiology and received the approval of the ethics committee of the Universitat Autònoma de Barcelona (CEEAH-04102010).

We used a mixed-methods approach collecting both qualitative and quantitative data. We collected qualitative data on adults and children using participant observation and semi-structured interviews by observing and interacting with as many households as possible. For example, while living in the villages, we followed local socio-cultural norms, e.g. on sharing, cooking and children caretaking; we also participated on the daily life of neighboring households sharing with them daily live activities, such as washing clothes or cooking, or accompanying them on fishing expeditions, to their forest camps, or to their agricultural plots. Qualitative data provided an accurate overview of the diversity of Baka livelihoods. We alternately worked with a Baka and a Nzime (one of the Bantu-speaking ethnic groups from the area) translator fluent both in French and Baka language. As fieldwork advanced and we improved our competency in Baka language, we could develop closer interactions, a situation that provided more intimate and accurate data on Baka adult's and children's daily life. Close interactions with people favored our acceptance and gained us the trust of Baka adults and children. Our work with children was facilitated by children's own curiosity and desire to spend time with foreigners, a situation also reported in similar contexts (i.e., see the work of Bird-David (2005) among the Nayaka).

We performed semi-structured and structured interviews with both children and adults about 1) their perceptions and their valuation/appreciation towards children's activities, 2) their representation of adulthood and childhood and 3) their expectations for the future.

Quantitative data collection tools included 1) a census, 2) interviews with children's about their involvement in daily activities, 3) self-reported interviews about adult's use of time, income and wealth, and 4) interviews with children and adult on their perceptions and expectations towards the needed competences to become an adult.

First, we conducted a census to collect socio-demographic data (i.e., age, sex, clan, number of children, and level of education) of all the individuals in the village. As most Baka cannot recall their date of birth nor have birth records, we used kinship information (i.e., order of birth) to estimate the age of children in our sample. We asked every individual about the highest level of education reached, and coded 0 if they had never attended school; 0.99 if they had completed the first year of schooling, and a number from 1 to 8 corresponding to 1st to 8th school grades. None of the Baka in our sample had attended high school.

Second, to assess adult's livelihood profiles, we collected quantitative data on adult's main daily activities. During a period of 12 months, we visited all the households weekly and asked adults about the main activity performed during the daylight hours of the two days before the interviews. A total of 106 adults were interviewed, 57 women and 49 men, grouped in 57 households, for a total of 2359 observations. We also collected data on adult's income and wealth. To measure income, thrice over the course of a year we collected data on all the sources of income received during the 15 days before the interview. We asked about income perceived from sales and wage labor. As

Baka are often paid in kind for their work, we converted the products obtained into their monetary equivalent. Repeated measures of income were averaged to obtain a single measure for each individual. To assess wealth, we collected the total economic value of a set of items owned by adults. Economic values were recorded in local currency (Francs CFA) and then transformed into US\$ PPP values (Purchasing Power Parity; 251 XFA=1 \$ ppp - according to World Bank website, 2015).

Third, to assess children's involvement in daily activities, we first established a list of the 15 main activities performed by children, differentiating between activities conducted by boys and girls and by children at different development stages (see Table VIII - 1). Then we conducted interviews with 98 children, asking them to self-report the activities they had performed during the day time of the 24 hours previous to the interview. Each activity spontaneously listed by the child was coded in one of the 15 clusters of activities selected for analysis. Once the child stopped listing activities, we continued the interview by systematically asking whether she or he had also performed any of the remaining activities in our list.

Finally, we collected data on Baka's general perception of childhood and adulthood and on their daily activities. We first asked children to list the activities they prefer to do during the day. We then asked them to list the skills needed to become a competent adult. Data on preferred activities were collected through structured interviews with 47 children from 5 to 16 years-old, including 24 girls and 23 boys. Then, we asked adults to list the skills they consider a child has to learn to become an adult. Given the important differences in girls' and boys' daily life we asked these two questions separately in relation to boys and girls. We then completed the interview with open-ended questions about changes in knowledge and practices since their childhood.

We interviewed a total of 25 adults, 11 women and 14 men, ranging from 20 to 70 years-old.

Data analysis: Household profiles were established considering the time allocation of the male and the female household heads. To do so, we first selected the activities that were mentioned in at least 5% of the interviews, which included: a) subsistence agriculture, b) agricultural work in the fields of Nzime people, c) hunting, d) gathering, and e) unskilled work (mainly logging). We then classified each adult in the sample considering his or her involvement into those main subsistence activities through the year. We created four different profiles: a) Farmers, b) Daily-wage workers, c) Hunter-Gatherers, and d) Diversified. A person was classified in one of those profiles if he or she had reported the activity in 75% or more of the observations. Then, we used information from the two household heads to create the household profile with the following criteria: a) when both household heads shared the same profile, we attributed this profile to the household; b) when one of the household heads had a 'diversified' profile, we attributed the profile of the other household head to the household, and c) when both household head had different profiles, we classified the household as 'diversified'. We finally explore whether the individual different characteristics (age, level of education, income, and wealth) might depend on household profiles by running ANOVA.

Children's involvement in daily activities was coded separately for each of the 15 activities pre-selected. For each category of activities, we coded 1 if the child performed the activity and 0 otherwise. We calculated the frequency of activities' performance for all the children in the sample, and then by sex and household profile. We then assessed whether there is variation on the way children from different

household profiles allocate their time across the different activities using Fisher's exact tests.

Finally, we analyzed answers to children's preferred activities and expectations towards adulthood's competences using the free-listing procedure in Flame (Pennec et al., 2012). To do so, we first subdivided the sample and compared the differences in the most salient answers given by boys and girls. We then compared the percentage of answers reported according to their household profile. We then ran similar analysis for adult's answers on their expectations towards what girls and boys should learn to be competent adults. We compared the most salient answers given by adults according to their household profiles. Finally, we compared children's and adult's answers related to their expectations towards which skills girls and boys should learn and master to be a competent adult.

4. Results

4.1. Baka household profiles

The analysis of Baka adults' involvement in daily activities shows that there is a large diversity on Baka livelihood strategies. Among the 57 households interviewed, 15 fell into the 'diversified' category, 17 into the 'worker' category, and 15 under the 'farmer' category. According to our definitions, only 10 households fell under the 'hunter-gatherer' category. Adult characteristics, and specially age, income and wealth, varied from one household profile to another (Table VIII - 1). Adults in the 'diversified' and 'worker' profiles showed the highest average income and wealth (12 and 11 \$ppp average income and 50\$ppp and 63\$ppp average wealth, respectively), or about the

double than adults in the 'hunter gatherer' and 'farmer' profiles (6 and 5\$ppp of income and 30\$ppp and 37\$ppp of wealth, respectively). Adults in the 'diversified' profile were the youngest (33 years-old in average), whereas adults in the 'farmer' profile were the oldest (49 years-old in average) (Table VIII - 1).

Table VIII - 1 Description of the sample and analysis of covariance of household heads' characteristics, by household profile.

Sample	Household Profile				Results of ANOVA tests	
	Diversified- (n=15)	Hunter- Gatherer (n=10)	Worker(n=17)	Farmer (n=15)	F	p
Total Girls	13	7	18	8		
Total Boys	9	7	17	19		
Total	22	14	35	27		
Socio-economic characteristics						
Income*	12.37	6.40	11.4	5.13	5.1	0.004
Wealth*	50.36	30.47	62.73	37.16	2.91	0.04
Education	1.40	1.1	1.17	0.85	1.11	0.35
Age	33.03	36.7	39.6	49.4	5.24	0.003
Avg nb of children	1.87	1.45	2.38	2.07	2.11	0.11

* in \$ppp

Twenty-two of the children interviewed lived in ‘diversified’ households, 35 in ‘worker’ households, 27 in ‘farmer’ households, and 14 in ‘hunter-gatherer’ households (see Table VIII 1).

4.2. Children’s daily activities

When considering the full sample of children, the predominant daily activities are those related to subsistence and especially to household maintenance (reported in 90% of the observations among boys and 100% among girls). The next most common activity is playing, reported in 60% of the interviews, and listening to music (reported in 40% of the observations among boys and 50% among girls). There are, however, important gender differences in activities’ involvement: girls are more involved in household maintenance (mentioned in all the interviews with girls) and fishing (37% of the interviews), whereas boys are more involved in hunting (71% of the interviews) (Table VIII - 2).

Table VIII - 2 Percentage of children mentioning involvement in selected daily activities. By sex and household profile.

Children's Activities	All the sample			Household Profile		
	Girls (n=46)	Boys (n=52)	Diversified (n=22)	Hunter-Gatherer (n=14)	Worker (n=35)	Farmer (n=27)
Household maintenance	100	90	100	86	97	93
Hunting	19	71	45	21	51	56
Gathering	59	42	59	43	54	41
Agricultural Work	37	27	36	14	31	37
Fishing	37	17	23	21	29	30
Handicraft	7	15	5	7	17	11
Plays	57	60	64	64	54	56
Maintenance	17	31	23	14	29	26
Traditional songs, tales and dances	11	6	9	0	8.6	11.1
Listening to music	50	40	55	21	46	48
School	20	21	31	14	17	18
Football	2	23	23	14	11	7
Alcohol drinking	11	13	9	7	11	18
Socializing	100	90	9	0	0	15
Other modern	19	71	9	21	14	7

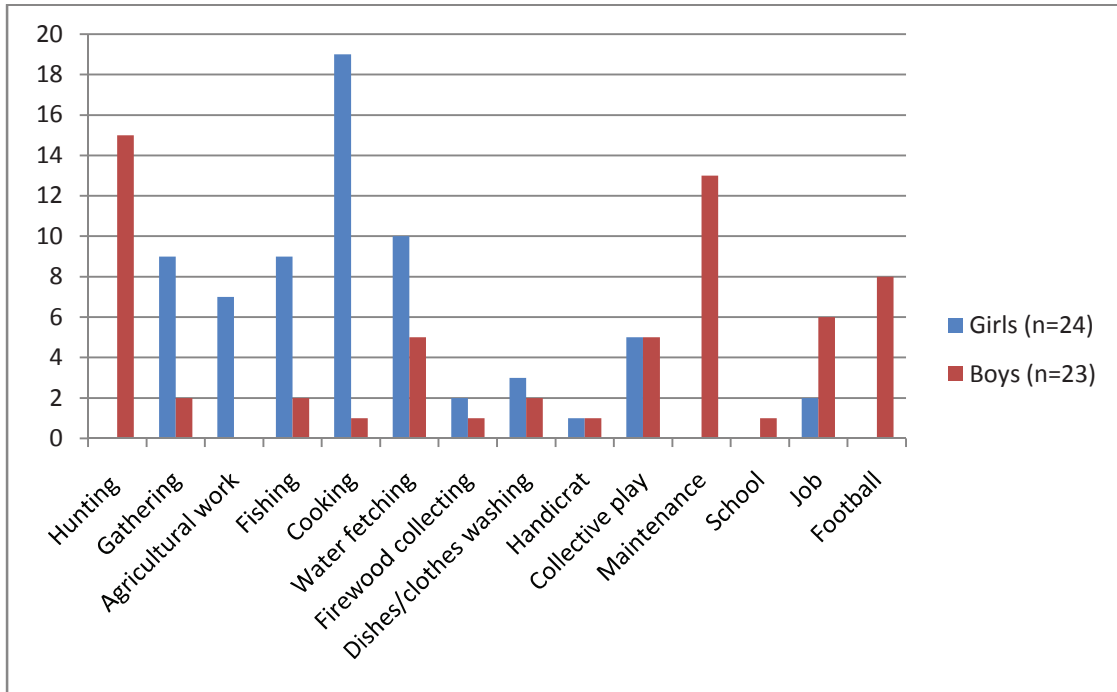
Children belonging to different household profiles seem to spend their time in similar ways, with slight differences (Table VIII-2). For example, children living in 'diversified' households reported gathering in 59% of the interviews, whereas the same activity was only reported in 41% of the interviews with children living in 'farmer' households. Children from 'hunter-gatherer' households are the least engaged in agriculture (14% of the interviews) and hunting (21%), at least compared to children from 'farmer' households (who reported agriculture and hunting in 21% and 56% of the interviews). Children from 'diversified' households also tend to listen to music (21% of the interviews), attend to school (31%), and play football (23%) more than children from other household profiles. Despite those differences, children from different household types share most of the activities they perform. Indeed, none of the Fisher's exact tests comparing involvement in different subsistence activities among children living in households with different profiles give statistically significant results, either aggregated or by sex of the children.

4.3. Children's preferred activities and expectations towards adult's competences

When asked to list their preferred activities, girls listed very different activities than boys (Figure VIII-2). The activity most frequently reported as 'preferred' by girls is cooking (mentioned by 19 girls), followed by gathering and fetching water (reported respectively by 9 and 10 girls). Differently, the activity most often reported as preferred by boys is hunting with snares (15 boys) and maintenance related activities, such as resting and hanging around (reported by 13 boys). Whereas all the activities listed by girls, except agricultural work, were also reported by boys, several activities, such as hunting, schooling, and playing soccer, were only listed by boys. Only one activity,

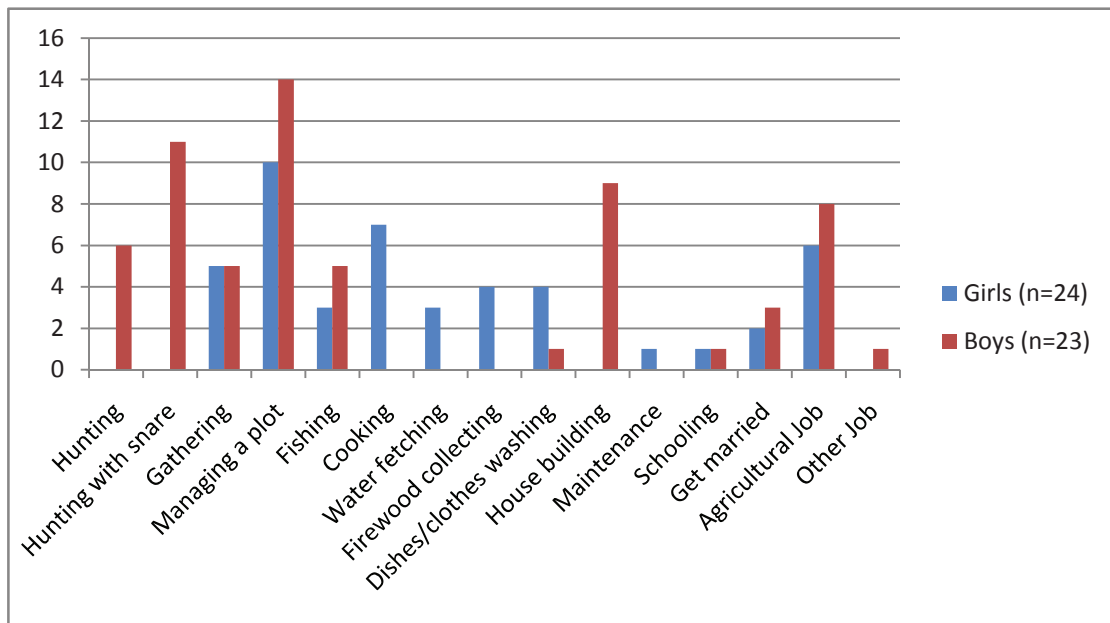
collective play, was reported by the same number of boys and girls -five- (Figure VIII - 2).

Figure VIII - 2 Percentage of children listing an activity as preferred. By sex.



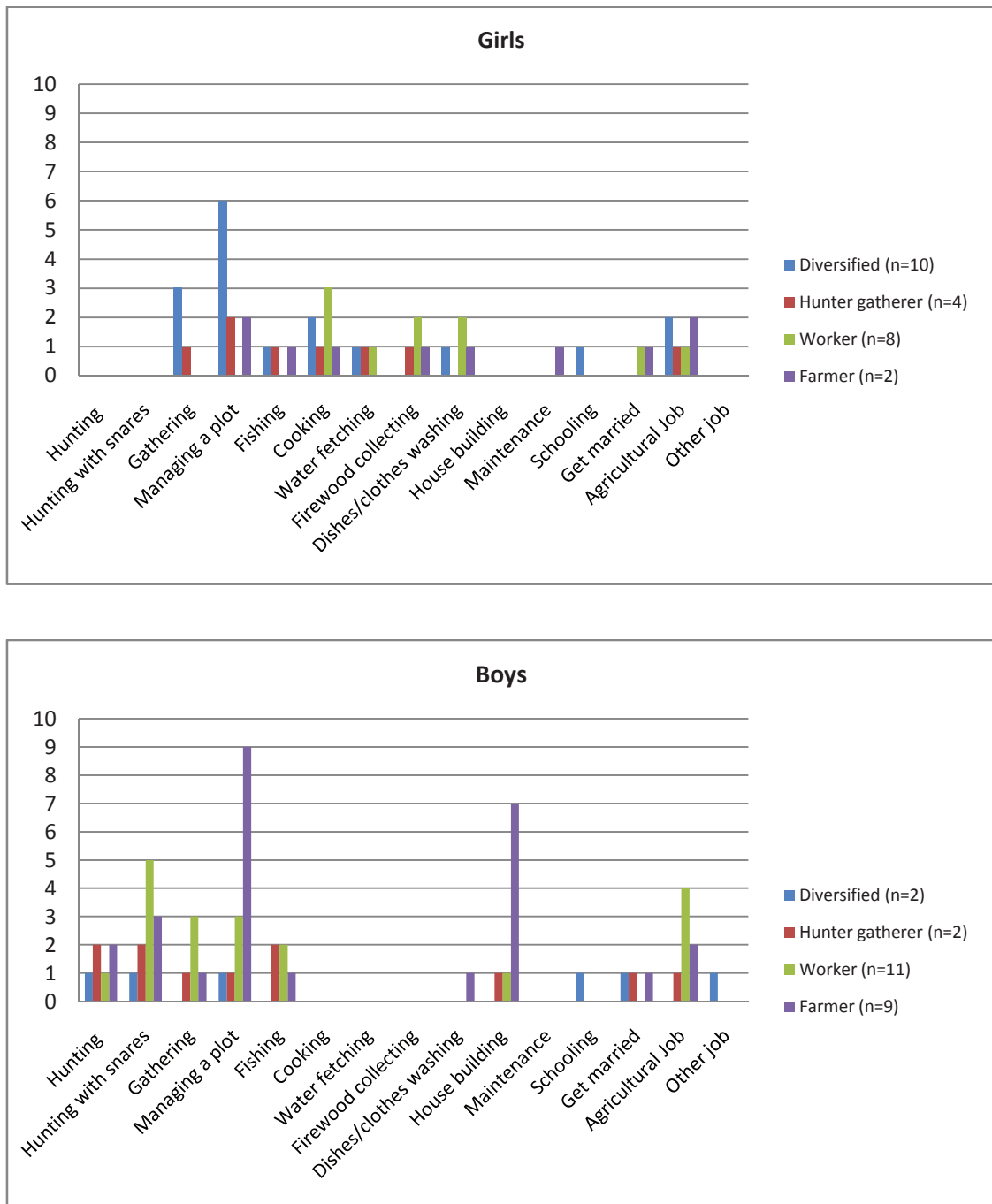
When asking children about the most important skills needed to be a competent adult, both girls and boys mentioned getting and managing an agricultural plot (14 boys and 10 girls), gathering (five boys and five girls), and working in Nzime’s agricultural plots (eight boys and six girls) (Figure VIII-3). For the rest of the activities, the number of children mentioning them varied according to the sex of the respondent. Only boys reported hunting as an important activity to learn to become a competent Baka adult: six boys considered important to know how to hunt in general and 11 to hunt with snare. Similarly, only boys (9 of them) reported building a house as an important activity to learn. In contrast, only girls listed activities related to household maintenance as important to become a competent Baka adult: seven girls listed cooking, four collecting firewood, and 13 fetching water.

Figure VIII - 3 Percentage of children listing competences needed in adulthood. By sex.



While the list of preferred activities did not vary among children from households with different profiles (data not shown), we found some differences among children from households with different profiles in relation to the skills reported as important to master to become an adult (Figure VIII-4).

Figure VIII - 4 Number of children listing competences needed in adulthood. By sex and household profile.



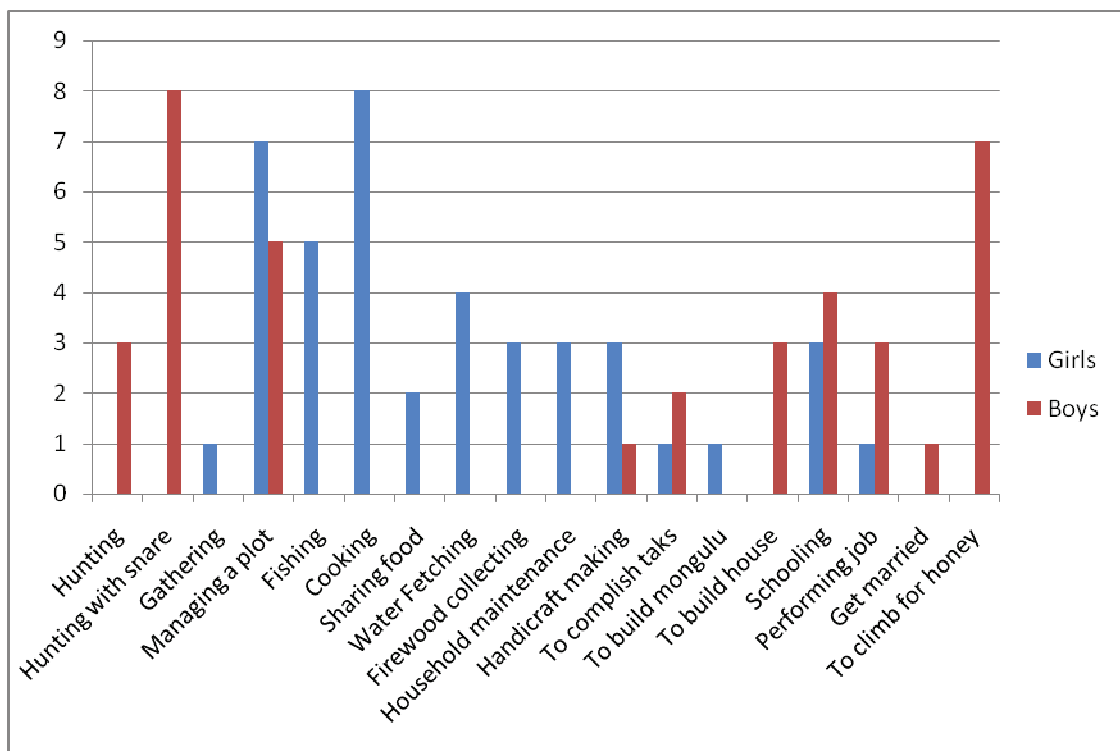
For instance, only children from ‘diversified’ households mentioned attending school and performing other jobs as essential to become competent adults. When looking at the differences considering the sex of the child, we found that girls in all household profiles, except from ‘workers’, mentioned getting and managing a plot as important for adult life. girls from ‘diversified’ and ‘hunter-gatherer’ household profiles

also mentioned gathering as an important skill. Boys from all the household profiles except the ‘diversified’ profile valued gathering and fishing activities. In sum, our data suggest that there are few differences between the expectations of children from the different household profiles on what are the important skills to learn to become a competent adult.

4.4. Adult expectations

Adults interviewed considered that the essential competences boys need to learn before entering adulthood are putting snares, climbing trees, and managing a plot. They also mentioned attending school as an important childhood activity. Adults listed many more activities as essential for girls to learn, including attending household chores in general and cooking in particular, but also maintaining a plot and fishing (Figure VIII-5).

Figure VIII - 5 Number of adults listing a skill boys and girls need to learn to become competent adults (n=25). By sex of child.



We found some differences in the answers given by adults belonging to different household profiles. In general, all adults consider getting and managing a plot as an important skill for girls to learn, but adults from 'hunter-gatherer' household profiles valued more attending school as an essential skill for girls, whereas adults from 'diversified' households valued more fishing. Adults from all the household profiles, except the 'hunter-gatherer' households, considered essential for boys to get a plot. Conversely, only adults from 'hunter-gatherer' and 'diversified' households considered important for boys to know how to climb a tree and to gather forest products, especially honey. Finally, only adults from 'farmer' households considered that attending school was an important activity for boys.

4.5. Children's vs adults' expectations

Both adults and children highly ranked getting and managing a plot as a skill that has to be acquired before adulthood. Cooking for girls and hunting for boys were also skills highly ranked by both adults and children. However, we also found some differences between adults' and children's expectations. Children considered that conducting agricultural work for Nzime neighbors and gathering (specifically commercial non-timber forest products) were important skills to master during adulthood, whereas few adults mentioned them. Conversely, adults reported skills which were not reported by children. Adults considered important that girls learn how to do handicrafts, especially basketry, but the skill was not mentioned by girls themselves. Similarly, adults considered essential that boys learn how to climb a tree in order to gather honey, but the skill was not mentioned by boys neither by girls. Moreover, adults also reported that children have to know how to accomplish tasks that adults ask them and that girls have to know how to share cooked food, by for example,

knowing the quantity to put according to the number of people in each household. Again, none of these skills were mentioned by children. Furthermore, attending school was mentioned by adults as an important activity to become a competent adult, but such activity was almost never listed by children.

Finally, when considering responses provided by adults and children belonging to the same household profile, we have not found any clear correspondence between what children and adults considered as essential skills to master to become competent adults.

5. Discussion

We highlight two main findings from our work a) the low differentiation in children's daily activities across different parental livelihood strategies and b) the difference between adults' and children's expectations towards adulthood. We first discuss these results focusing on how hunter-gatherer characteristics might explain the low relation between 1) children's involvement in daily activities and children's expectations and 2) parental household profile and parental expectations towards childhood. We finally discuss how the general tendencies affecting Baka's daily life might explain reported Baka expectations towards adult's competences.

We found different livelihood strategies within the studied sample. This finding supports the within group diversity on contemporary hunter-gatherers already reported by other researchers (Bird-David, 1992; Reyes-García & Pyhälä, n.d.). Despite such differentiation in household profiles, we found that subsistence activities and play predominate during children's daily activities. While the pattern found meshes with previous reports of similar patterns among the Baka (Kamei, 2005) and in other hunter-

gatherer societies (Boyette, 2013; Gray, 2009; Konner, 2010), it contrasts with the lives of children in agricultural societies (Boyette, 2013; Barry S. Hewlett, 2014a; Kramer, 2005). For instance, in contrast with Baka children, Nzime's children, as also reported among other agriculturalist societies (Barry S. Hewlett, 2014a; Kramer, 2005), are spending most of the time in school, performing household tasks and helping their parents in the plots. Thus, even if it could be argue that the socio-ecological changes that contemporary hunter-gatherer societies face today result in hunter-gatherer adults adopting new livelihood strategies increasingly resembling those of their neighbor farmers (Reyes-García & Pyhälä, n.d.), the way hunter-gatherer children spend their time is still in sharp contrast with farmer childhoods (Gaskins, 2000; Barry S. Hewlett, 2014a).

The lack of differentiation in children's activities in relation to household profiles suggests that children's daily life is not largely affected by parental behaviors. Following the approach of parental ethno-theories developed by Harkness & Super, Baka children's behaviors might be explained by several cultural characteristics that the Baka have in common with other African hunter-gatherer groups (Hewlett et al., 2011; Hewlett, 2014). First, from an early age Baka children are highly autonomous, in the sense that "*one does not coerce others, including children*" (Hewlett 2014: p. 247). Thus, adults, including parents, have a low involvement in the performance of children's daily activities (see Chapter VI). Moreover, as also reported among the Aka, the Baka are highly egalitarian, which "*leads to the perceptions of other people as equal regardless of age or status*" (Berl & Hewlett, 2015). Consequently very few obligations are imposed upon Baka children and physical punishment is very rare. Even if Baka children are requested by their parents to participate on daily household chores such as fetching water, bringing meals to neighboring households, or collecting firewood, Baka

children are free to take their own decisions. Baka children, however, are also considered responsible for the consequences of such decisions. In that sense, Baka children receive the same independent consideration that an adult would receive, even if it is understood that they are in a learning process. Another important characteristic that impacts Baka children's daily life comes from the importance of allomaternal care. Among the Baka, it is assumed that older sisters are infants' secondary caregivers (Hirasawa, 2005). As in other societies, including Western societies until the last century (Lancy, 2008), it is common that older siblings, grand-parents or adults other than the parents take care of infants (Weisner et al., 1977; Weisner, 1982). For example, it is really frequent to see children living for several weeks –or even months- with their relatives', i.e., grand-parents, uncles or cousins, whereas their parents are elsewhere (in forest camps, visiting family or doing seasonal wage labor in a different village). In sum, high children's autonomy, reduced parental involvement in children's daily activities, and allomaternal care might well explain why children's involvement in different daily activities is weakly shaped by parental livelihood profile.

Furthermore, our results suggest that not only the profile of the household in which a child life has a little relation to children's choice of daily activities, but we also found that there is little relation between skills valued by adults and those valued by children in the same type of household profile. This additional finding further suggest that parental expectations also have a relatively low impact on children's choice of daily activities, in contrast with what has been reported among the Pare (Hollos, 2002).

We did find some overlap between skills valued by children and adults as needed to become competent adults. Such skills include agriculture, hunting for boys and household maintenance for girls. The fact that both children and adults from a hunter-gatherer group consider managing a plot as a skill that needs to be acquired

before becoming a competent adult shows the magnitude of the change operating among this group. We argue that the fact that this activity is so highly valued can be explained by how the development discourse conveyed by governmental and NGO's programs has permeated Baka live (Althabe, 1965b; Leclerc, 2012). Such discourse promotes a lifestyle based on agriculture, sedentarization and schooling, activities that were far from the spectrum of Baka activities until recently, but that –according to our results– seem to be highly valued now. Differently, the importance of hunting for boys and household maintenance for girls seems to be more rooted in traditional Baka culture. As also reported in other hunter-gatherer societies (Noss, 2011; Vonrueden et al., 2008), success in hunting continues to confer prestige to the Baka (Duda et al., *under review*-a). In the same line, women who are known to be excellent household keepers and good mothers are also highly appreciated among the Baka, for which is not surprising that these two activities continue to be highly valued.

However, our results also showed a contrast between children's and adults' expectations, especially related to skills which can be related to a more 'traditional' and 'modern' way of living. For example, although adults value schooling, handicraft making, and climbing trees, children do not report any of these activities as important to become competent adults, furthermore, our data suggest that they do not appear to perform them frequently. While we have not analyzed whether there is a correspondence between the activities that children listed as important to become competent adults and the activities they actually perform, such analysis would provide important insights on the relation between perceptions and behavior.

We conclude reflecting on the overall lack of correspondence between Baka children's and adult's expectations towards the needed skills to be competent adults. We argue that such lack of correspondence can be largely explained by the large social-

ecological changes affecting Baka society nowadays. Indeed, the contrast between the skills that each of the two generations value might reflect influences of general trends conveyed by several external actors into the Baka communities, and the recent relevance that money has taken in Baka life. Indeed, the arrival of traders, poachers and logging companies in Baka's territories has led to a growing monetarization of Baka life (Kitanishi, 2006). In that sense, agriculture and hunting activities are highly valued as their derived products might be sold. At the same time, the ideas conveyed by the media, for example through video-clips and lyrics of new African hits, highly appreciated by Baka people (Oishi & Hayashi, 2014; Townsend, 2015; Weig, 2015), enhance this global trend of valuation of money and material possessions. For instance, recent studies also reported that the performance of dances and the possession of audio material to play modern music does bring to the Baka a high feeling of pride and well-being (Townsend, 2015; Weig, 2015). This attraction to money and material products, and therefore the preference for activities that might result in cash, is more present among adolescent and youth adults.

To some extent, it is then not surprising that adolescents and young people tend to prefer activities from which they would obtain cash, as, similar to what has been reported in other settings, *"moving 'beyond childhood' and finally becoming a young adult is displayed, for example, by the possession of certain brands and type of clothes"* (Buhler-Niederberger & van Krieken 2008: 152). Thus, we argue that children's choices of daily activities might be more influenced by general trends occurring into the communities rather than by their familiar nuclei. As children's behaviors and expectations might not be assessed by parental behaviors and expectations, it seems thus important to focus on children own behaviors and expectations in order to understand the potential impacts of social and ecological changes on Baka childhood.

Chapter IX

Conclusions

This study brings new empirical data to research on the dynamics of local ecological knowledge in a context of social-ecological change, and specifically on the acquisition of local ecological knowledge by hunter-gatherer children in a society facing rapid change. Overall, the major contributions of this dissertation are 1) showing that there is specific LEK during childhood (Chapter IV), 2) developing a method to assess how children's actual behaviors and engagement in different daily activities and with different people might shape their acquisition of local knowledge (Chapters V and VI), and 3) providing evidence that children's choice of daily activities is related to contextual social changes (Chapter VII and VIII). Results from this work contribute to fill theoretical and methodological gaps highlighted in previous research on hunter-gatherer childhood (Barry S. Hewlett, 2014a), on the acquisition of local ecological knowledge (Ellen, 2012; Zent, 2013), and on the study of change in indigenous societies (Zent, 2013). In this last Chapter I bring together the theoretical and methodological contributions of this work highlight its main caveats and limitations. I also suggest directions for further research on the topic and present the policy implications of my results.

1. Theoretical contributions

Through this dissertation, my main aim has been to contribute to the literature on the impact of social-ecological change on the dynamics of local ecological knowledge

acquisition, using as a case study children living in a small-scale societies. To dig up on the topic, I chose to focus on the context in which LEK acquisition takes place, and not on the precise content of knowledge held. Specifically, this work brings new empirical elements for the literature related to 1) the process of LEK acquisition on hunter-gatherer societies (developed in Chapters IV-VI); 2) the impact of social changes on hunter-gatherer's livelihood (Chapter VII - VIII); 3) hunter-gatherer childhoods (Chapters IV-VIII); and 4) the existence of a children's peer culture in relation to LEK (Chapter IV).

The first theoretical contribution this work relates to the process of LEK acquisition during middle childhood and adolescence, both periods of the lifespan to date underexplored among hunter-gatherer societies (Barry S. Hewlett, 2014a). Results from this dissertation showed that among the Baka LEK seems to be acquired early in life (Chapter IV), as also reported in other settings (Demps et al., 2012; Gurven & Kaplan, 2006; Schniter et al., 2015; Zarger, 2010), presenting a sexual differentiation in the content of knowledge acquired already since middle childhood. Moreover, my results dovetail with the idea that LEK acquisition is largely reliant on the process of embodiment and enskilment (Downey, 2010; Marchand, 2010b), as supported by the importance of daily subsistence activities for settling the context of children's learning (Gaskins & Paradise, 2010; Rogoff et al., 2007; Zarger, 2010) (Chapters V-VI). Moreover, results from Chapters V and VI showed that the processes of LEK acquisition vary according to the sex and the age of the children and according to the different domains of LEK. Furthermore, this dissertation compiles empirical evidence of the presence of a high diversity of learning strategies during middle childhood and adolescence (Chapter VI), which vary according to the sex, the age and the domain of LEK considered. Finally, my results showed the weak importance of vertical

transmission during daily activities of children (5 to 12 years old) (Chapter VI), a finding in accordance with previous research in other settings (Barry S. Hewlett et al., 2011; Reyes-García, Broesch, et al., 2009).

The second theoretical contribution of this work relates to the impacts of social-ecological changes on small-scale societies and, specifically, on their local ecological knowledge. Firstly, results shown here provide evidence that social changes are not impacting uniformly the whole Baka society. As shown in Chapters VII and VIII, Baka adults are adopting different livelihood strategies, which suggests that individuals' or household's answers to social changes are not similar (for similar results see Bird-David (1992)). More importantly, despite the apparent diversification of livelihood strategies among the Baka, my results suggest that the way in which children's daily life is impacted by social changes is not related to their parents' livelihood. I have argued that those overarching changes are equally affecting all members of the society by changing overall perceptions towards Baka livelihood and culture. Moreover, an important finding of this work is that children's participation in newly introduced activities (such as soccer playing and listening to modern music) might be impacting their acquisition of LEK. In that sense, Chapter VIII brought new insights to our understanding on the impact of social changes on children's daily life and LEK acquisition by highlighting individual's expectations towards cultural knowledge and skills. Specifically, it reports the change of expectations occurring among the Baka, with new generations increasingly valuing cash-generating daily activities, and thus knowledge related to them.

The third theoretical contribution of this work relates to hunter-gatherer's childhoods. Specifically, by presenting data on children's daily activities, this work strives to contribute to refine our understanding on hunter-gatherer childhood and child

development. It also brings elements to improve our understanding of middle childhood and adolescence as important periods on their own (rather than as transitional periods towards adulthood). In this sense, my results show that among Baka children the sexual differentiation of daily activities occurs from an early age, and support the idea of the predominance of subsistence activities and play among hunter-gatherer children's daily life, in accordance to data reported among other hunter-gatherer societies (Boyette, 2013; Ruiz-Mallén et al., 2013). Overall, the results presented here also support the notion, already reported by previous scholars (Barry S. Hewlett, 2014a), that hunter-gatherer children are highly autonomous and independent. It is interesting to note the reduced participation of adults during children's daily activities, suggesting that Baka children seem to be able to choose between potentially different activities, without being told by adults (Chapter VI). On the same line, my results brought new insights on the role played by parents in children's daily activities. Results of Chapter VI highlight not only the almost complete absence of parents in children's daily activities, but also the low correspondence between parental livelihood activities and children's daily activities. In this sense, this work helps understand children's actual behaviors, which are arguably shaped more by the overall community cultural setting than by the specific parental behavior. Chapter VI provides evidence of the high variability of children's social settings when performing subsistence activities. Such result bring new features, such as the importance of groups of peers, rarely reported in previous hunter-gatherer research (Barry S. Hewlett, 2014b), and bring details on the composition of mixed-aged groups during daily activities. This relevant finding, which challenges previous research results, illustrates how children's social organization changes as a previously mobile society get settled in large villages, where children are more likely to find peers to interact with than in their traditional forest camps.

Finally, the last theoretical contribution of this work relates to the concept of children's peer culture (W. Corsaro, 2014; Johanson, 2010). More than the autonomy of Baka children reported by the low engagement of adult in children's daily activities (Chapter V) and the low relation between parental livelihood and children's daily activities (Chapter VII-VIII), my results support the evidence of a 'children's culture', which is mirrored by the specificity of children's LEK system (Chapter IV). I found that Baka children do hold specific ecological practices and knowledge, that are not shared with adults. However, I showed that children's culture is not detached from adult's culture, especially when looking at the structure of children's LEK, as the sexual differentiation present among adults' LEK already appears since middle childhood.

2. Caveats and limitations

The more important caveats of this work relate to the measure of local ecological knowledge and the methodology used for assessing children's involvement in daily activities. First, although every effort was done to assess different domains of children's LEK (i.e., I studied knowledge related to game, medicinal plants and wild edibles) and at different types of knowledge (identification, naming abilities and etho-ecological knowledge), this work did not captured the integrality of Baka LEK. In this sense, I am aware that important components of local ecological knowledge (e.g., skills and beliefs) have not been adequately included. Moreover, this dissertation purposively excluded some knowledge related to specialists and specialized knowledge, such as knowledge held by traditional healers.

The second caveat from this study relates to the methodology used for assessing children's involvement in daily activities. During interviews, I asked children to

estimate the duration of their activities. However, as most Baka are not familiar with time measurements (i.e., hour and minutes), most of the estimations were highly inaccurate. Consequently, I had to discard the data, thus reducing my interpretation from calculations of use of time to frequency of activity performance. In other words, my data inform us on the frequency of the activities performed by children but not on their actual duration, an information that would have provided additional novel insights.

A third important gap in the results presented in this study relates to the settings in which data were collected. Indeed, most of the data collected come from interviews conducted while children were in the permanent villages, not in the forest camps. In this sense, my data can only be considered representative of children's daily life in the settlements, not of the patterns present when the Baka are in their forest camps. Although my ethnographic information suggests that there might be considerable variations between activities developed in both settings, logistical and budgetary reasons prevented me from collecting such data.

3. Methodological contributions

Despite of such limitations, this work also brings some important methodological contributions for the study of the impact of social-ecological changes on LEK acquisition, namely 1) the focus on children's daily life, 2) the inclusion of different domains of local ecological knowledge, and 3) the inclusion of individuals' behaviors and perceptions.

The first methodological contribution relates to the approach developed for assessing LEK acquisition. By focusing on children's behavior, this thesis compiles empirical data on the context in which LEK acquisition takes place, in contrast with

most previous research which has studied the topic by using interview-based data, i.e., asking children to report perceived sources of knowledge acquisition. The approach developed in this work allows for the collection of important complementary data and could be included in any work focusing in the processes of LEK acquisition.

The second important methodological contribution of this work relates to the use of multiple domains of knowledge. By considering several domains of LEK and different ways of knowing (i.e., naming abilities, identification, and also theoretical etho-ecological knowledge), I could show that LEK is not equally shared among children and that the process of LEK acquisition might vary according the domain of knowledge. This finding supports the previously highlighted importance of considering not only one, but several domains of LEK to accurately assess the process of LEK acquisition (Ellen, Lycett, & Johns, 2013; Reyes-García, Guèze, et al., n.d.; Schniter et al., 2015; Zent, 2013).

The third methodological contribution of this work relates to the approach chosen for assessing the impact of social ecological changes on LEK acquisition. By using data on both behavior and perceptions, my results highlight the correspondence between children's behavior and their preferences and expectations towards their daily life and the skills that are valued in a context of change. Moreover, by crossing data from both adults and children, I could report that social changes affecting Baka's perceptions vary across generations. In this sense, my work highlights the importance of assessing the process of LEK acquisition not only by independently looking to some domains of LEK or some groups of the society, or by looking only to what people do or what people say; but rather the methodological insights from this work suggest that one can get a broader overview of the process of knowledge acquisition by also considering what people do and what they perceive.

The last methodological contribution of my research is the use of child-focused approach. By looking at what children do and say about their lives, this work brings children to the central stage, thus considering them as key elements in anthropological research (Delalande, 2009; Johanson, 2010; Lenclud, 2003). The focus allows to search deeper in children's own culture, thus uncovering the central role children play as culture creators.

4. Further research

The work presented here provides several insights for future research. First, the data presented here might be considered an empirical baseline for future work in the area. Indeed, one of the main gaps in studies on knowledge acquisition is the lack of longitudinal data, that is the collection of data with the same individuals over a long period of time (Gravlee, Kennedy, Godoy, & Leonard, 2009). In this sense, data from this work will be available for further research so other researchers interested in longitudinal studies could use it as a baseline (<http://icta.uab.cat/Etnoecologia/LEK/>).

An important aspect to consider when looking at the impacts of social changes on the process of LEK acquisition relates to the specialized LEK and the LEK held by experts, such as traditional healers. Indeed, my ethnographic information suggests that such bodies of practices and knowledge are quickly changing. In this sense, further research should also address the impacts of social changes on these domains of LEK, not only in lay knowledge, as it has been done in this work.

Given the growing importance of newly introduced activities on Baka children's lives and their impact on children's daily life and children's perception towards their cultural knowledge, further research should address how such activities actually impact

LEK acquisition. Previous research on the topic has focused on the impact of one of those new activities (i.e., schooling) on LEK acquisition (McCarter & Gavin, 2011; Reyes-García et al., 2010), but results presented here suggest that other activities (i.e., watching TV, playing soccer) might be more popular, at least in the Baka context. In that sense, it seems important that future research explores the impact of such activities on LEK knowledge acquisition and in general on Baka culture.

The existence of a body of LEK specific to children calls for the development of methodological tools and interviews adapted to children, so to better capture their body of LEK. Rather than working and elaborating surveys based on adult's knowledge, we need to develop methods based on children's data to study children's own culture.

Finally, because adolescence is a key period for the acquisition of specific Baka cultural knowledge and the entrance into adulthood, as also highlighted in other settings (B. L. Hewlett & Hewlett, 2012; Barry S. Hewlett, 2014a) more studies have to explore such period of the lifespan in order to assess both processes of cultural transmission and impacts of social changes on small-scale societies.

5. Policy implications

I would like to end my dissertation by presenting some policy implications that I derive from the work presented here, and which especially relate to the importance of considering children in applied work (i.e., development or conservation projects) and in research, and particularly LEK research.

First, if Baka children have their own culture (Chapter IV) and are being affected by current social-ecological changes in ways that differ from the way their parents are being affected (Chapter VIII), then any development policy or applied

project should give differential consideration to middle childhood and adolescence. In this sense, it is essential that these initiatives focus on children's own habitus and perceptions, in order to develop strategies more adapted to the current impact of social-ecological changes on Baka societies.

In the same line, if Baka children hold specific bodies of LEK, it seems important to assess children's own knowledge, by differentiating them from adult's knowledge. Therefore, policies aimed at promoting LEK and cultural knowledge revitalization among small-scale societies in general, and among the Baka in particular, should take into account the children's LEK system. The corps of knowledge held by children is a part of the Baka cultural ecological knowledge and might not be mirrored by only assessing adult's LEK. Moreover, as children already show a sexual differentiation in both their daily activities and their LEK, it is also important to consider children's local ecological knowledge from a gender perspective.

Schooling has been signaled as one of the main factors which might affect the process of LEK acquisition among children (Reyes-García et al., 2010), so special attention should be put in schooling among the Baka. Although results of this work suggest the low impact of schooling in Baka children's daily life (Chapter III and V), it is worth noticing that –from experiences in other settings- any educational project should be considered to adapt to local livelihood of the Baka, as it seems essential that the acquisition of both knowledge taught at school and local ecological knowledge might occur in a complementary way. Thus, it seems essential to promote schooling programs which integrate local knowledge in their curricula, for example considering in their teaching methods the local forms of knowledge acquisition (such as participatory observation, contextualized knowledge acquisition by expedition in the field, active knowledge transmission between children), as well as considering the seasonal rhythm

of Baka livelihood, so to allow children performing the daily activities where LEK acquisition likely occur.

Finally, as money seem to be taking an increasingly relevant role in Baka life, due both to the arrival of external agents and to the message they convey, Baka children and young adults tend to value cash-generating activities, generally related to the extraction of natural resources (bushmeat, timber and non timber forest products).The extraction of such resources might represent a threat to both Baka subsistence (and thus, also their related LEK) and local biodiversity, so policies aiming at controlling the – generally illegal- market of natural resources in the area and to establish real collaborative strategies of development and conservation with local populations should be encouraged. In this sense, both development workers and conservationists should work together to promote the preservation of local livelihoods and resources. Awareness raising-programs providing alternative information on the possible long-term effects of the cash-generating activities based on natural resources extraction, would also help local populations to take informed decisions. By sharing such information with local populations, it would be then more efficient for such policies to develop participatory strategies for biocultural diversity conservation.

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Annex 1. Lists of items reported

Species scientific determination was not conducted by experts, but is based in bibliographic information (Brisson, 2010; Dounias, 1996; Hattori, 2006; Letouzey, 1976; Vivien, 2012). "Indeterminate" was used when we did not find in any scientific correspondence for the local name, followed by a clarification of the item when available (i.e., honey) or * when no other information was found.

a. By children

Local Name	Taxonomic Level	Occurrence					
		Number	Frequency	Summed Ranks	Average rank	Smith Index	Sutrop Index
Animals							
dèngbè	<i>Philotomba monticola</i>	22	84.62%	57	2.59	0.696	0.327
ngbòmù	<i>Cephalophus dorsalis</i>	21	80.77%	62	2.95	0.619	0.274
pàme	<i>Potamochoerus porcus</i>	20	76.92%	89	4.45	0.474	0.173
ngendi	<i>Cephalophus callipygus</i>	17	65.38%	51	3.00	0.480	0.218
mbòke	<i>Atherurus africanus</i>	14	53.85%	68	4.85	0.324	0.111
?eòòòò	<i>Gorilla gorilla</i>	14	53.85%	72	5.14	0.317	0.105
gbè	<i>Cricetomys emini</i>	12	46.15%	75	6.25	0.228	0.074
kokòlo	<i>Phataginus tricuspis</i>	12	46.15%	57	4.75	0.282	0.097
bèmbà	<i>Cephalophus sylvicultor</i>	9	34.62%	40	4.44	0.198	0.078
ya	<i>Loxodonta africana</i>	9	34.62%	60	6.66	0.129	0.052
sùà	<i>Panthera pardus</i>	8	30.77%	52	6.50	0.144	0.047
sèkò	<i>Pan troglodytes</i>	7	26.92%	44	6.28	0.125	0.043
kùnda	<i>Cynixis erosa</i>	6	23.08%	45	7.50	0.087	0.031
eku	<i>Cephalophus rufilatus</i>	5	19.23%	39	7.80	0.080	0.025
mbùlì	<i>Tragelaphus spekii</i>	4	15.38%	34	8.50	0.047	0.018
kema	Generic name for monkeys	4	15.38%	32	8.00	0.058	0.019
genke	Indeterminate*	3	11.54%	23	7.66	0.042	0.015
mbòkò	<i>Syncerus caffernanus</i>	3	11.54%	36	12.00	0.013	0.010
nganda	<i>Atilax paludinosus</i>	3	11.54%	30	10.00	0.032	0.012
emi	Indeterminate*	3	11.54%	32	10.67	0.031	0.011
mbòngò	<i>Tragelaphus euryceros</i>	2	7.69%	4	2.00	0.066	0.038
mboka	<i>Nandinia binotata</i>	2	7.69%	9	4.50	0.038	0.017
mbambe	<i>Varanus ornatus</i>	2	7.69%	12	6.00	0.049	0.013
kelepa	<i>Smutsia gigantea</i>	2	7.69%	17	8.50	0.037	0.009
pancomo	<i>Thryonomis sp.</i>	2	7.69%	15	7.50	0.019	0.010
akòlò	<i>Hyemoschus aquaticus</i>	2	7.69%	14	7.00	0.023	0.011
kpòd	Indeterminate (mouse)	2	7.69%	15	7.50	0.032	0.010

mònjombe	<i>Cephalophus nigrifrons</i>	2	7.69%	15	7.500	0.021	0.010
Birds							
tɛkɛ	<i>Ploceus spp.</i>	17	70.83%	40	2.353	0.524	0.301
sɛsɛ	Family of Somnimangus	13	54.17%	48	3.692	0.301	0.147
mángo	<i>Ceratogry maelata</i>	12	50.00%	32	2.667	0.367	0.188
etɔhɔ	Family of Picnonotidae	11	45.83%	42	3.818	0.238	0.120
kàta	<i>Bycanistes albotibialis</i>	9	37.50%	16	1.778	0.309	0.211
kulungu	<i>Corythaeola cristata</i>	7	29.17%	28	4.000	0.166	0.073
sanya	<i>Bycanistes fistulator</i>	4	16.67%	17	4.250	0.102	0.039
ada	Indeterminate*	3	12.50%	15	5.000	0.063	0.025
ngòliò	<i>Stephanoaetus coronatus</i>	3	12.50%	13	4.333	0.066	0.029
epeba	<i>Treron calvus</i>	3	12.50%	16	5.333	0.054	0.023
kukùlu	<i>Psittacus erithacus</i>	3	12.50%	10	3.333	0.076	0.038
eben	Indeterminate (eagle)	3	12.50%	19	6.333	0.026	0.020
sangango	<i>Nicator chloris</i>	2	8.33%	4	2.000	0.069	0.042
tchotcho	Indeterminate*	2	8.33%	6	3.000	0.049	0.028
Fishes							
ndéngɛ	Indeterminate	22	84.62%	52	2.364	0.669	0.358
káànjì	Indeterminate (shrimp)	21	80.77%	76	3.619	0.500	0.223
ɲtia	Silure	20	76.92%	45	2.250	0.637	0.342
ngbáàkà	<i>Haplochilus sexfaciatus</i>	19	73.08%	68	3.579	0.439	0.204
mbose	<i>Myomyrus macrodon</i>	17	65.38%	71	4.176	0.347	0.157
kálá	Indeterminate (crab)	13	50.00%	66	5.077	0.218	0.098
kusa	<i>Polycentropis abbreviata</i>	10	38.46%	53	5.300	0.173	0.073
gbìgbì	<i>Malapterurus electricus</i>	9	34.62%	45	5.000	0.166	0.069
ndoyo	Indeterminate (tadpole)	7	26.92%	39	5.571	0.104	0.048
mbongo	Indeterminate	6	23.08%	41	6.833	0.050	0.034
mótɔmbi	Indeterminate	5	19.23%	30	6.000	0.062	0.032
jààsɛlɛ	<i>Hepsetus odoe</i>	3	11.54%	9	3.000	0.090	0.038
Mice							
èsulu	Indeterminate	21	87.50%	32	1.524	0.770	0.574
kpòò	Indeterminate	18	75.00%	47	2.611	0.511	0.287

edchue	Indeterminate*	13	54.17%	41	3.154	0.311	0.172
màngèngè	Indeterminate	10	41.67%	41	4.100	0.177	0.102
bea	Indeterminate*	8	33.33%	25	3.125	0.181	0.107
bili a ye	Indeterminate	4	16.67%	16	4.000	0.091	0.042
ambunjo	Indeterminate*	4	16.67%	12	3.000	0.093	0.056
sende	Indeterminate	3	12.50%	7	2.333	0.092	0.054
mboko	<i>Protoxerus sp.</i>	3	12.50%	10	3.333	0.070	0.038
tenge	Indeterminate	2	8.33%	6	3.000	0.047	0.028
Caterpillars							
kanga	Indeterminate	25	96.15%	36	1.440	0.829	0.668
boyo	<i>Imbrasia oyemensis</i>	21	80.77%	51	2.429	0.512	0.333
pusu	Indeterminate	15	57.69%	43	2.867	0.309	0.201
menbamgoun	Indeterminate*	11	42.31%	40	3.636	0.166	0.116
mongete	Indeterminate	4	15.38%	11	2.750	0.095	0.056
pókele	Indeterminate	3	11.54%	9	3.000	0.069	0.038
taku	<i>Anaphe sp.</i>	2	7.69%	4	2.000	0.056	0.038
tube	Indeterminate*	2	7.69%	2	1.000	0.077	0.077
Fruits							
pekè	<i>Irvingia gabonensis</i>	17	70.83%	29	1.706	0.598	0.415
maḡe	<i>Baillonella toxisperma</i>	10	41.67%	25	2.500	0.265	0.167
payo	<i>Irvingia excelsa</i>	7	29.17%	21	3.000	0.128	0.097
sèngi	<i>Uapaca spp</i>	6	25.00%	10	1.667	0.188	0.150
bámbu	<i>Gambeya lacourtiana</i>	4	16.67%	13	3.250	0.104	0.051
ngbé	<i>Anonidium mannii</i>	4	16.67%	13	3.250	0.086	0.051
ngoyɔ	<i>Trichoscypha abut</i>	4	16.67%	15	3.750	0.089	0.044
ngimbà	<i>Afrostryrax lepidophyllus</i>	4	16.67%	14	3.500	0.064	0.048
pandɔ	<i>Tabernaemontana crassa</i>	3	12.50%	9	3.000	0.069	0.042
kanà	<i>Panda oleosa</i>	2	8.33%	5	2.500	0.061	0.033
Medicinal plants							
mbalaka	<i>Pentaclethra macrophylla</i>	7	25.93%	13	1.857	0.212	0.140
gùgà	<i>Alstonia boonei</i>	4	14.81%	10	2.500	0.114	0.059
pandɔ	<i>Tabernaemontana crassa</i>	3	11.11%	7	2.333	0.079	0.048

bòyo	<i>Entandrophragma cylindricum</i>	3	11.11%	11	3.667	0.062	0.030
bolù má	<i>Cylicodiscus gabunensis</i>	2	7.41%	8	4.000	0.024	0.019
mòtokotòkò	<i>Hunteria umbellata</i>	2	7.41%	8	4.000	0.037	0.019
pekè	<i>Iringia gabonensis</i>	2	7.41%	5	2.500	0.061	0.030
gòbò	<i>Ricinodendron heudelotii</i>	2	7.41%	16	8.000	0.013	0.009
ngòlù	<i>Terminalia superba</i>	2	7.41%	2	1.000	0.074	0.074
sèngi	<i>Uapaca spp</i>	2	7.41%	11	5.500	0.022	0.013
mbanda	Indeterminate*	2	7.41%	5	2.500	0.052	0.030
ètèngè	<i>Pycnanthis angolensis</i>	2	7.41%	9	4.500	0.033	0.016

Mushrooms

musele	Indeterminate*	22	84.62%	33	1.500	0.754	0.564
mòboli	<i>Termitomyces sp.</i>	21	80.77%	44	2.095	0.616	0.385
mòndùngùle	Indeterminate	12	46.15%	33	2.750	0.279	0.168
akpokpo	Indeterminate	11	42.31%	35	3.182	0.232	0.133
ndòbòlòbò	<i>Termitomyces sp.</i>	8	30.77%	26	3.250	0.179	0.095
tulukanga	Indeterminate	6	23.08%	21	3.500	0.114	0.066
toboli	Indeterminate	5	19.23%	13	2.600	0.107	0.074
tuludèngbè	<i>Termitomyces sp.</i>	3	11.54%	12	4.000	0.066	0.029
sakùsa	Indeterminate	3	11.54%	12	4.000	0.040	0.029
tulutìmi	Indeterminate	3	11.54%	17	5.667	0.030	0.020
yaoundé	Indeterminate*	3	11.54%	16	5.333	0.041	0.022
tuluyakayaka	Indeterminate	3	11.54%	15	5.000	0.050	0.023
mòmbùnjàmbùnjà	Indeterminate	2	7.69%	11	5.500	0.014	0.014
tulusákili	Indeterminate	2	7.69%	12	6.000	0.018	0.013

Wild edibles

ba	<i>Dioscorea sp</i>	15	55.56%	35	2.333	0.423	0.238
sapà	<i>Dioscorea praehensilis</i>	14	51.85%	41	2.929	0.332	0.177
poki	Honey	12	44.44%	30	2.500	0.320	0.178
dandu	Honey	10	37.04%	30	3.000	0.255	0.123
keke	Honey	10	37.04%	25	2.500	0.268	0.148
si	General term for fishes	5	18.52%	30	6.000	0.049	0.031
mopapele	Honey	5	18.52%	30	6.000	0.080	0.031

molengi	Honey	5	18.52%	19	3.800	0.106	0.049
pekè	<i>Irvingia gabonensis</i>	4	14.81%	13	3.250	0.115	0.046
ngimbà	<i>Afrostryax lepidophyllus</i>	4	14.81%	16	4.000	0.088	0.037
so	Generic name for animals	4	14.81%	10	2.500	0.100	0.059
èsumà	<i>Dioscorea semperflorens</i>	4	14.81%	21	5.250	0.084	0.028
njeenje	Honey	4	14.81%	17	4.250	0.074	0.035
pende	Honey	4	14.81%	18	4.500	0.066	0.033
mbì	<i>Dicranclipsis spp</i>	3	11.11%	19	6.333	0.031	0.018
kuku	<i>Dioscorea minutiflora</i>	3	11.11%	14	4.667	0.041	0.024
tulu	Generic name for mushroom	3	11.11%	14	4.667	0.059	0.024
ngùma	Generic name for item extracted from fishing	2	7.41%	4	2.000	0.064	0.037
ndóndo	<i>Dioscorea spp</i>	2	7.41%	6	3.000	0.045	0.025
pàpè	<i>Dioscorea sp.</i> (old state of "ba")	2	7.41%	12	6.000	0.017	0.012

b. By adults.

Original Name	Taxonomic Level	Occurrence Number	Frequency	Summed Ranks	Average rank	Smith Index	Sutrop Index
Animals							
pàme	<i>Potamochoerus porcus</i>	24	96.00%	124	5.167	0.710	0.186
mbòke	<i>Atherurus africanus</i>	22	88.00%	87	3.955	0.726	0.223
dèngbe	<i>Philotomba monticola</i>	22	88.00%	100	4.545	0.697	0.194
kelepa	<i>Smutia gigantea</i>	17	68.00%	175	10.294	0.318	0.066
ngbòmù	<i>Cephalophus dorsalis</i>	17	68.00%	61	3.588	0.583	0.190
ngendi	<i>Cephalophus callipygus</i>	16	64.00%	59	3.688	0.533	0.174
?ebofo	<i>Gorilla gorilla</i>	15	60.00%	117	7.800	0.356	0.077
sèkò	<i>Pan troglodytes</i>	14	56.00%	118	8.429	0.320	0.066
gbè	<i>Cricetomys emini</i>	13	52.00%	95	7.308	0.297	0.071
ya	<i>Loxondonta africana</i>	12	48.00%	103	8.583	0.246	0.056
kokòlo	<i>Phataginus tricuspis</i>	11	44.00%	111	10.091	0.225	0.044
kùnda	<i>Cynixis erosa</i>	10	40.00%	100	10.000	0.175	0.040
bèmbà	<i>Cephalophus sylvicultor</i>	10	40.00%	73	7.300	0.244	0.055
kpìnyà	<i>Orycteropus afer</i>	10	40.00%	139	13.900	0.113	0.029
kema	generic name for monkeys	9	36.00%	95	10.556	0.163	0.034
mbôngo	<i>Tragelaphus euryceros</i>	8	32.00%	71	8.875	0.164	0.036
bèà	<i>Hylochoreus meinertzhageni</i>	8	32.00%	94	11.750	0.119	0.027
mbùlì	<i>Tragelaphus spekii</i>	7	28.00%	91	13.000	0.077	0.022
mboka	<i>Nandinia binotata</i>	7	28.00%	91	13.000	0.093	0.022
mbambe	<i>Varanus ornatus</i> ?	7	28.00%	76	10.857	0.137	0.026

nganda	<i>Atilax paludinosus</i>	6	24.00%	50	8.333	0.135	0.029
mbòkò	<i>Syncerus caffernanus</i> ?	6	24.00%	72	12.000	0.110	0.020
emi	<i>Cephalophus leucogaster</i>	5	20.00%	57	11.400	0.078	0.018
mokoakele	Indeterminate (crocodile)	5	20.00%	89	17.800	0.029	0.011
ebie	Indeterminate*	5	20.00%	56	11.200	0.081	0.018
mònjombe	<i>Cephalophus nigrifrons</i>	5	20.00%	44	8.800	0.102	0.023
kàta	<i>Bycanistes tibialis</i>	4	16.00%	42	10.500	0.063	0.015
yoka	<i>Dendrohydrax dorsalis</i>	4	16.00%	65	16.250	0.038	0.010
mbùmà	<i>Bitis gabonica</i> ?	4	16.00%	26	6.500	0.109	0.025
màngo	<i>Ceratogy maelata</i>	4	16.00%	47	11.750	0.051	0.014
akòlò	<i>Hyemoschus aquaticus</i>	4	16.00%	49	12.250	0.056	0.013
dia	Indeterminate*	4	16.00%	40	10.000	0.057	0.016
buse	<i>Bdeogale nigripes</i>	3	12.00%	20	6.667	0.078	0.018
ngbaaka	<i>Haplochilus sexfaciatus</i>	3	12.00%	31	10.333	0.045	0.012
kala	Indeterminate (crab)	3	12.00%	36	12.000	0.017	0.010
sùà	<i>Panthera pardus</i>	3	12.00%	30	10.000	0.026	0.012
jàmà	<i>Genetta servalina</i>	2	8.00%	27	13.500	0.025	0.006
sányà	<i>Agapornis pullarius</i> + <i>Bycabistes sharpei</i> ?	2	8.00%	30	15.000	0.014	0.005
mbedi	<i>Ortholophus cassini</i> ?	2	8.00%	30	15.000	0.015	0.005
nu	Generic name for "bird"	2	8.00%	20	10.000	0.029	0.008
lèndè	Indeterminate (aquatic turtle)	2	8.00%	22	11.000	0.030	0.007
mbòsè	<i>Myomyrus macrodon</i>	2	8.00%	28	14.000	0.022	0.006
gbìgbì	<i>Malapteruruselectricus</i>	2	8.00%	34	17.000	0.009	0.005
kàlu	<i>Colobus guereza</i>	2	8.00%	27	13.500	0.022	0.006
kàànjì	Indeterminate (shrimp)	2	8.00%	17	8.500	0.035	0.009
ngbèè	Indeterminate (bat)	2	8.00%	8	4.000	0.053	0.020

mbonji	Indeterminate*	2	8.00%	27	13.500	0.027	0.006
mpoo	Indeterminate (mouse)*	2	8.00%	28	14.000	0.007	0.006
Birds							
mángo	<i>Ceratogymna atrata</i>	21	91.30%	35	1.667	0.828	0.548
kàta	<i>Bycanistes tibialis</i>	19	82.61%	43	2.263	0.679	0.365
sese	Family of Somnimangus	11	47.83%	73	6.636	0.248	0.072
teke	<i>Ploceus sp.</i>	9	39.13%	66	7.333	0.163	0.053
sánya	<i>Bycabistes sharpei</i>	9	39.13%	32	3.556	0.291	0.110
mókuyekuyε	<i>Nicator chloris</i>	9	39.13%	39	4.333	0.209	0.090
kulungu	<i>Corythaecola cristata</i>	8	34.78%	38	4.750	0.228	0.073
kukùlu	<i>Psittacus erithacus</i>	7	30.43%	44	6.286	0.172	0.048
ngòliò	<i>Stephanoaetus coronatus</i>	7	30.43%	55	7.857	0.135	0.039
etòhò	Family of Picnonotidae	7	30.43%	56	8.000	0.144	0.038
mópipìi	<i>Centropus monachus</i>	7	30.43%	60	8.571	0.114	0.036
mbedi	<i>Ortholophus cassini ?</i>	6	26.09%	30	5.000	0.148	0.052
epeba	<i>Treron calvus</i>	5	21.74%	32	6.400	0.117	0.034
tchotcho	Indeterminate*	5	21.74%	36	7.200	0.096	0.030
kanga	<i>Guttera sp.</i>	3	13.04%	17	5.667	0.066	0.023
mósalàlà	<i>Andropadus sp.</i>	3	13.04%	14	4.667	0.070	0.028
mbàngùmà	Indeterminate	3	13.04%	31	10.333	0.026	0.013
musala	Indeterminate*	3	13.04%	29	9.667	0.038	0.013
ndòkolokò	<i>Tockus erythrorhynchus</i>	3	13.04%	18	6.000	0.068	0.022
sangango	<i>Nicator chloris</i>	3	13.04%	18	6.000	0.067	0.022
koloka	Indeterminate*	2	8.70%	16	8.000	0.040	0.011
ebie	Indeterminate*	2	8.70%	19	9.500	0.034	0.009
sàkò	Indeterminate	2	8.70%	17	8.500	0.045	0.010

pòpòlo	Indeterminate	2	8.70%	24	12.000	0.037	0.007	
elonga	Indeterminate*	2	8.70%	28	14.000	0.028	0.006	
pungele	Indeterminate*	2	8.70%	18	9.000	0.041	0.010	
nuambo	Indeterminate	2	8.70%	9	4.500	0.054	0.019	
kèmbè	Indeterminate	2	8.70%	21	10.500	0.032	0.008	
Fishes								
ndéngé	Indeterminate	24	96.00%	54	2.250	0.804	0.427	
káànjì	Indeterminate (shrimp)	23	92.00%	73	3.174	0.676	0.290	
ngbáàkà	<i>Haplochilus sexfaciatus</i>	22	88.00%	74	3.364	0.625	0.262	
ntia	Indeterminate (silure)	20	80.00%	75	3.750	0.526	0.213	
mbòsè	<i>Myomyrus macrodon</i>	19	76.00%	77	4.053	0.475	0.188	
mótòmbi	Indeterminate	13	52.00%	93	7.154	0.182	0.073	
gbìgbì	<i>Malapterurus electricus</i>	12	48.00%	79	6.583	0.177	0.073	
kálá	Indeterminate (crab)	11	44.00%	60	5.455	0.211	0.081	
mbòngò	Indeterminate	10	40.00%	85	8.500	0.104	0.047	
jáàsèlè	<i>Hepsetus odoe</i>	7	28.00%	43	6.143	0.144	0.046	
kúsà	<i>Polycentropis abbreviata</i>	7	28.00%	52	7.429	0.114	0.038	
ndoyo	Indeterminate (tadpole)	7	28.00%	50	7.143	0.109	0.039	
toko	<i>Pelmatochromo sp.</i>	4	16.00%	30	7.500	0.051	0.021	
kpede	<i>Petrocephalus sauvagei</i>	4	16.00%	26	6.500	0.078	0.025	
ndíme	Indeterminate	3	12.00%	20	6.667	0.061	0.018	
mpee	Indeterminate	3	12.00%	24	8.000	0.039	0.015	
kpekeyo	<i>Trachyglanis minustus</i>	2	8.00%	12	6.000	0.024	0.013	
Mice								
èsulu	Indeterminate	14	77.78%	22	1.571	0.679	0.495	
màngèngè	Indeterminate	12	66.67%	56	4.667	0.287	0.143	

kpòd	Indeterminate	11	61.11%	27	2.455	0.485	0.249
bidchoue	Indeterminate*	9	50.00%	26	2.889	0.323	0.173
sende	Indeterminate (squirrel)	8	44.44%	38	4.750	0.212	0.094
bili a ye	Indeterminate	6	33.33%	27	4.500	0.187	0.074
tenge	Indeterminate	6	33.33%	31	5.167	0.157	0.065
bea	Indeterminate*	5	27.78%	24	4.800	0.154	0.058
mboko	<i>Protoxerus sp.</i>	4	22.22%	22	5.500	0.082	0.040
edchue	Indeterminate*	4	22.22%	9	2.250	0.178	0.099
wala	Indeterminate*	3	16.67%	23	7.667	0.039	0.022
ambunjo	Indeterminate	3	16.67%	12	4.000	0.086	0.042
pìsè	<i>Aethosciurus poensis</i>	2	11.11%	11	5.500	0.035	0.020
bogenge	Indeterminate*	2	11.11%	11	5.500	0.045	0.020
gbè	<i>Cricetomys gambianus</i>	2	11.11%	9	4.500	0.043	0.025

Caterpillars

kàngà	Indeterminate	17	100.00%	19	1.118	0.987	0.895
bòyo	<i>Imbrasia oyemensis</i>	15	88.24%	44	2.933	0.513	0.301
pusu	Indeterminate	12	70.59%	40	3.333	0.370	0.212
tàku	<i>Anaphe sp.</i>	10	58.82%	33	3.300	0.342	0.178
móngete	Indeterminate	8	47.06%	34	4.250	0.199	0.111
gbado	Indeterminate	4	23.53%	21	5.250	0.100	0.045
menbamgoun	Indeterminate	4	23.53%	17	4.250	0.087	0.055
koposulo	Indeterminate	2	11.76%	15	7.500	0.021	0.016

Fruits

pekè	<i>Irvingia gabonensis</i>	17	94.44%	30	1.765	0.826	0.535
maße	<i>Baillonella toxisperma</i>	12	66.67%	26	2.167	0.530	0.308
kanà	<i>Panda oleosa</i>	8	44.44%	24	3.000	0.322	0.148

ngimbà	<i>Afrostryax lepidophyllus</i>	7	38.89%	25	3.571	0.228	0.109
ngoyɔ	<i>Trichoscypha abut</i>	7	38.89%	35	5.000	0.186	0.078
bámbu	<i>Gambeya lacourtiana</i>	6	33.33%	32	5.333	0.145	0.063
pɔ	<i>Aichornea cordifolia</i>	6	33.33%	35	5.833	0.118	0.057
ngbe	<i>Anonidium mannii</i>	5	27.78%	19	3.800	0.145	0.073
payo	<i>Irvingia excelsa</i>	5	27.78%	19	3.800	0.172	0.073
kòmbèlè	<i>Irvingia robur or wombolu</i>	4	22.22%	16	4.000	0.122	0.056
mbalaka	<i>Pentaclethra macrophylla</i>	4	22.22%	11	2.750	0.148	0.081
makpa	<i>Carica papaya</i>	4	22.22%	24	6.000	0.106	0.037
gagendi	Indeterminate*	2	11.11%	12	6.000	0.039	0.019
kaso	Indeterminate	2	11.11%	13	6.500	0.038	0.017
mbì	<i>Dicranclepis spp</i>	2	11.11%	11	5.500	0.048	0.020
bɔkɔkɔ	<i>Klainedoxa gabonensis</i>	2	11.11%	14	7.000	0.042	0.016
mòngolà	<i>Trichoscypha patens</i>	2	11.11%	12	6.000	0.026	0.019
ndóndo	<i>Dioscorea spp</i>	2	11.11%	9	4.500	0.060	0.025
sapa	<i>Dioscorea praehensilis</i>	2	11.11%	11	5.500	0.045	0.020
Medicinal plants							
gùgà	<i>Alstonia boonei</i>	13	54.17%	40	3.077	0.442	0.176
bòyo	<i>Entandrophragma cylindricum</i>	11	45.83%	44	4.000	0.305	0.115
bolùmá	<i>Cylicodiscus gabunensis</i>	8	33.33%	34	4.250	0.239	0.078
mbalaka	<i>Pentaclethra macrophylla</i>	8	33.33%	35	4.375	0.209	0.076
ngólù	<i>Terminalia superba</i>	8	33.33%	27	3.375	0.231	0.099
tàndà	<i>Vepris louisii</i>	5	20.83%	19	3.800	0.116	0.055
pandɔ	<i>Tabernaemontana crassa</i>	5	20.83%	25	5.000	0.143	0.042
kanà	<i>Panda oleosa</i>	5	20.83%	25	5.000	0.101	0.042
mòndùmba	<i>Copaifera mildbraedii</i>	5	20.83%	11	2.200	0.164	0.095

ngbé	<i>Anonidium mannii</i>	4	16.67%	29	7.250	0.078	0.023
lândo	<i>Hylo dendron gabunense</i>	4	16.67%	16	4.000	0.125	0.042
bòkòkò	<i>Klainedoxa gabonensis</i>	4	16.67%	24	6.000	0.080	0.028
pìpi	<i>Microdesmis puberula</i>	4	16.67%	21	5.250	0.072	0.032
payo	<i>Irvingia excelsa</i>	4	16.67%	31	7.750	0.079	0.022
ngimbà	<i>Afrostryax lepidophyllus</i>	3	12.50%	23	7.667	0.077	0.016
mòlòmbò	<i>Pachypodanthium barteri</i>	3	12.50%	17	5.667	0.043	0.022
bòtungà	<i>Polyalthia suaveolens</i>	3	12.50%	18	6.000	0.067	0.021
bàngì	<i>Chlorophora excelsa</i>	3	12.50%	20	6.667	0.042	0.019
maðe	<i>Baillonella toxisperma</i>	2	8.33%	10	5.000	0.042	0.017
jombo	Indeterminate*	2	8.33%	16	8.000	0.050	0.010
kusa	Indeterminate	2	8.33%	27	13.500	0.013	0.006
ngoyò	<i>Trichoscypha abut ou acuminata</i>	2	8.33%	14	7.000	0.030	0.012
bàmbu	<i>Gambeya lacourtiana</i>	2	8.33%	19	9.500	0.038	0.009
sòlià	<i>Irvingia grandifolia</i>	2	8.33%	15	7.500	0.033	0.011
ngánda	<i>Millettia sanagana</i>	2	8.33%	15	7.500	0.031	0.011
gata	Indeterminate*	2	8.33%	24	12.000	0.035	0.007
jema	Indeterminate*	2	8.33%	6	3.000	0.056	0.028
monyòkù	<i>Cognoxia podolaena</i>	2	8.33%	8	4.000	0.048	0.021
pèke	<i>Raphia laurentii</i> or <i>mobuttorum</i>	2	8.33%	7	3.500	0.066	0.024
bondulu	<i>Klainedoxa microphylla</i>	2	8.33%	13	6.500	0.024	0.013
èlòndà	<i>Albizia ferruginea</i>	2	8.33%	12	6.000	0.050	0.014
pámbo	<i>Barteria fistulosa</i>	2	8.33%	32	16.000	0.012	0.005
bòsò	<i>Combretodendron macrocarpum</i>	2	8.33%	16	8.000	0.031	0.010
etenge	<i>Pycnanthis angolensis</i>	2	8.33%	17	8.500	0.024	0.010
ngèle	<i>Pterocarpus soyauxii</i>	2	8.33%	15	7.500	0.055	0.011

lɛmbɛ	<i>Diospyros crassiflora</i>	2	8.33%	12	6.000	0.038	0.014
panzel	Indeterminate*	2	8.33%	7	3.500	0.062	0.024
yàndo	<i>Alchornea floribanda</i>	2	8.33%	22	11.000	0.039	0.008

Mushrooms

mòbòlì	<i>Termocytes sp.</i>	19	100.00%	27	1.421	0.910	0.704
musele	Indeterminate	18	94.74%	36	2.000	0.785	0.474
mòndùngùlɛ	Indeterminate	16	84.21%	60	3.750	0.546	0.225
sakùsa	Indeterminate	9	47.37%	51	5.667	0.226	0.084
ndòbòlòbò	<i>Termocytes sp.</i>	9	47.37%	57	6.333	0.172	0.075
mòmbùnjambùnja	Indeterminate	7	36.84%	39	5.571	0.192	0.066
akpokpo	Indeterminate*	6	31.58%	25	4.167	0.226	0.076
dedele	Indeterminate*	6	31.58%	40	6.667	0.142	0.047
màwòluwòlù	Indeterminate	4	21.05%	22	5.500	0.080	0.038
jokabuka	Indeterminate*	4	21.05%	30	7.500	0.101	0.028
tuluyaka	Indeterminate	4	21.05%	22	5.500	0.089	0.038
akomanda	Indeterminate*	3	15.79%	14	4.667	0.059	0.034
tulusakili	Indeterminate	3	15.79%	26	8.667	0.056	0.018
majagba	Indeterminate*	2	10.53%	22	11.000	0.023	0.010
ngebe	Indeterminate*	2	10.53%	14	7.000	0.042	0.015
madeye	Indeterminate*	2	10.53%	8	4.000	0.065	0.026
tulukpasele	Indeterminate*	2	10.53%	22	11.000	0.025	0.010
kpoda	Indeterminate	2	10.53%	19	9.500	0.024	0.011
tòkpòlì	Indeterminate	2	10.53%	10	5.000	0.039	0.021
yaounde	Indeterminate*	2	10.53%	13	6.500	0.063	0.016
tuludèngbè	Indeterminate	2	10.53%	16	8.000	0.022	0.013

Wild edibles

pekè	<i>Irvingia gabonensis</i>	25	92.59%	78	3.120	0.794	0.297
ngìmbà	<i>Afrostryax lepidophyllus</i>	18	66.67%	56	3.111	0.528	0.214
maḃe	<i>Baillonella toxisperma</i>	17	62.96%	79	4.647	0.486	0.135
kòkò	<i>Gnetum africanum</i>	16	59.26%	146	9.125	0.307	0.065
payo	<i>Irvingia excelsa</i>	13	48.15%	50	3.846	0.376	0.125
kanà	<i>Panda oleosa</i>	12	44.44%	93	7.750	0.278	0.057
pòkì	Indeterminate (honey)	10	37.04%	76	7.600	0.228	0.049
ngoyò	<i>Trichoscypha abut</i>	9	33.33%	43	4.778	0.243	0.070
sapà	<i>Dioscorea praehensilis</i>	9	33.33%	61	6.778	0.198	0.049
ba	<i>Dioscorea sp.</i>	9	33.33%	62	6.889	0.195	0.048
ndóndo	<i>Dioscorea spp.</i>	8	29.63%	59	7.375	0.172	0.040
keke	<i>Dioscorea spp.</i>	8	29.63%	72	9.000	0.117	0.033
mbalaka	<i>Pentaclethra macrophylla</i>	8	29.63%	59	7.375	0.170	0.040
dàndù	Indeterminate (trigones' honey)	7	25.93%	74	10.571	0.140	0.025
mòḃolì	Termocytes sp.	7	25.93%	73	10.429	0.127	0.025
èsumà	<i>Dioscorea semperflorens</i>	7	25.93%	53	7.571	0.134	0.034
kútù	Indeterminate (mushroom)	7	25.93%	62	8.857	0.114	0.029
mbì	<i>Dicranclipsis spp</i>	6	22.22%	47	7.833	0.112	0.028
njàkàkà	<i>Dioscorea sp.</i>	6	22.22%	75	12.500	0.052	0.018
kata	Indeterminate	6	22.22%	64	10.667	0.106	0.021
mòlèngì	Indeterminate (trigones' honey)	5	18.52%	78	15.600	0.065	0.012
kuku	<i>Dioscorea minutiflora</i>	5	18.52%	48	9.600	0.069	0.019
pò	<i>Aichornea cordifolia</i>	5	18.52%	47	9.400	0.103	0.020
langa	<i>Entandrophragma utile</i>	5	18.52%	38	7.600	0.085	0.024
gòḃò	<i>Ricinodendron heudelotii</i>	4	14.81%	27	6.750	0.061	0.022

njénje	Indeterminate(<i>trigones' honey</i>)	4	14.81%	58	14.500	0.058	0.010
bòkòkò	<i>Klainedoxa gabonensis</i>	4	14.81%	25	6.250	0.102	0.024
mòndùngùlè	Indeterminate (mushroom)	4	14.81%	51	12.750	0.046	0.012
ngbé	<i>Anonidium manni</i>	3	11.11%	20	6.667	0.072	0.017
muese	Indeterminate*	3	11.11%	23	7.667	0.060	0.014
pènde	Indeterminate (<i>trigones' honey</i>)	3	11.11%	38	12.667	0.052	0.009
lembe	<i>Diospyros crassiflora</i>	3	11.11%	52	17.333	0.034	0.006
mòpapèlè	Indeterminate (<i>trigones' honey</i>)	3	11.11%	49	16.333	0.035	0.007
?èpange	<i>Dioscorea sp.</i>	3	11.11%	29	9.667	0.048	0.011
jàbùkà	<i>Manihot sp.</i>	3	11.11%	15	5.000	0.083	0.022
akpokpo	Indeterminate (mushroom)*	3	11.11%	32	10.667	0.056	0.010
musele	Indeterminate (mushroom)	3	11.11%	28	9.333	0.056	0.012
sakùsa	Indeterminate (mushroom)	3	11.11%	35	11.667	0.049	0.010
boboko	<i>Ataenidia conferta</i>	3	11.11%	35	11.667	0.022	0.010
mòngolà	<i>Trichoscypha patens</i>	2	7.41%	13	6.500	0.045	0.011
mòkò	Indeterminate (<i>trigones' honey</i>)	2	7.41%	33	16.500	0.025	0.004
túlú	Generic name for mushroom	2	7.41%	34	17.000	0.014	0.004
túlúkanga	Indeterminate (mushroom)	2	7.41%	31	15.500	0.029	0.005
baloko	Indeterminate*	2	7.41%	24	12.000	0.020	0.006
bámbu	<i>Gambeya lacourtiana</i>	2	7.41%	20	10.000	0.039	0.007
nakpo	Indeterminate*	2	7.41%	27	13.500	0.034	0.005
mbílà	<i>Elaeis guineensis</i>	2	7.41%	31	15.500	0.024	0.005
sèngi	<i>Uapaca spp</i>	2	7.41%	29	14.500	0.025	0.005
ngongo	<i>Megaphrynium macrostachyum</i>	2	7.41%	37	18.500	0.011	0.004
lìgò	<i>Cola acuminata</i>	2	7.41%	13	6.500	0.052	0.011
póli	Indeterminate (<i>trigones' honey</i>)	2	7.41%	40	20.000	0.009	0.004

ndɔbɔlɔbɔ	Indeterminate (mushroom)	2	7.41%	16	8.000	0.037	0.009
motokomboli	Indeterminate (mushroom)*	2	7.41%	18	9.000	0.042	0.008
motumbelumbe	Indeterminate (mushroom)*	2	7.41%	19	9.500	0.033	0.008
si	Generic name for fish	2	7.41%	13	6.500	0.027	0.011

Annex 2. Surveys on local ecological knowledge

Identification test

Format	Species	Local names	Sources
Animals			
Pictures	<i>Bycanistes albotibialis</i>	kàta	http://www.oiseaux.net/photos/daniel.giraud.elliot/calao.a.cuisses.blanches.0.html
	<i>Pan troglodytes</i>	seko	Gautier-Hion, A.; Colyn, M. & Gautier, J.P. (1999). <i>Histoire naturelle des primates d'Afrique Centrale</i> . ECOFAC (eds)
	<i>Corythaeola cristata</i>	kulungu	Borrow, N. & Demey, R. (2012). <i>Guide des oiseaux de l'Afrique de l'Ouest</i> . Delachaux et Niestlé (eds).
	<i>Crocodilus niloticus</i>	mokoakele	Animal Diversity Website of the University of Michigan. http://animaldiversity.ummz.umich.edu/
	<i>Bitis gabonica</i>	mbùmà	
	<i>Potamogale velox</i>	linje	KINGDON, J. 1997. <i>Field Guide to African Mammals</i> . A&C Blach Publishers.
	<i>Phataginus tricuspis</i>	kokòlo	
	<i>Tragelaphus euryceros</i>	mbôngo	
	<i>Cephalophus sylvicultor</i>	bèmbà	
	<i>Cephalophus callipygus</i>	ngbòmù	
	<i>Orycteropus afer</i>	kpìnyà	
	<i>Atherurus africanus</i>	mbòke	
	<i>Perodicticus potto</i>	katu	
	<i>Dendrohyrax dorsalis</i>	yoka	
	<i>Cephalophus monticola</i>	dèngbe	
	<i>Cricetomys gambianus</i>	gbè	
	<i>Nandinia binotata</i>	mboka	http://www.toujourspret.com/techniques/scoutisme/troupe/totemisation/N/nandinie.php DEPIERRE, D. & VIVIEN, J. 2012. <i>Mammifères sauvages du Cameroun</i> . Ngula Kerou. 316 pages.
Format	Species	Local names	Sources

Records	<i>Pan troglodytes</i>	seko	from the bbc's video "Planet Earth" Jungles (original title) (19 Nov. 2006). BBC documentary. Season 1, episode 8. TV Episode - 57 min
	<i>Dendrohyrax dorsalis</i>	yoka	Own recording
	<i>Colobus guereza</i>	kàlu	GAUTIER-HION, A. COLYN, M. GAUTIER, J.-P. (1999). <i>Histoire Naturelle des Primates d'Afrique Centrale</i> . ECOFAC. (with CD)

Format	Species	Local names	Sources
Wild Edibles			
Pictures	<i>Baillonella toxisperma</i>	maðε	http://www.arkive.org/moabi/baillonella-toxisperma/photos.html
	<i>Gnetum africanum</i>	koko	http://www.google.fr/imgres?imgurl=http://www.agfax.net/image/promoPicLge343.jpg&imgref=http://www.projetogap.org.br/en/noticia/ivory-coast-chimpanzees-in-the-wild/
	<i>Panda oleosa</i>	kanà	http://en.wikipedia.org/wiki/Elaeis_guineensis
	<i>Elaeis guineensis</i>	mbíla	
		mundungule	Personnal photography
Natural samples	<i>Anonidium mannii</i>	ngbé	Local assistant
	<i>Dioscorea semperflorens</i>	èsumà	
	<i>Ricinodendron heudelotii</i>	gobo	

Common structured questionnaire

	Mammals	Wild edibles
Specie 1	Where is resting <i>Cephalophus sylvicultor</i> during the day ?	How could you know that <i>Dioscorea semperflorens</i> is ready to be harvested ?
Scientific answer	It regularly used resting places under fallen trees, in dense undergrowth, or in root forms (ADW).	When the leaves become red/yellow
Specie 2	Where <i>Tragelaphus euryceros</i> uses to live ?	When could you harvest <i>Mundungule</i> ?
Scientific answer	In opening in the forest where it can find sunlight, bushes, herbs and bamboos. Bongos both feed and depend for cover on the bushes, herbs and bamboo found in these forested regions (Estes, 2012 : 185; ADW).	Nothing in the literature
Specie 3	Where does <i>Nandinia binotata</i> deliver ?	Where are <i>mòlèngi</i> bees making their hive/swarm?
Scientific answer	In a hole of a tree, or fallen tree, of leaf tangles on the ground (Estes, 2012).	Nothing in the literature

Animal Diversity Web (ADW), University of Michigan Museum of Zoology
[:http://animaldiversity.ummz.umich.edu](http://animaldiversity.ummz.umich.edu)
 ESTES, R., D. 2012. *The Behavior of African Mammals*. The University of California Press.

Annex 3. Publications

During my PhD I have participated as co-author in the following scientific publications (peer-reviewed articles and book chapters):

Reyes-García, V., & **Gallois, S.** (2014). How does social status relate to traditional ecological knowledge? in Albuquerque (eds) *Introduction to Ethnobiology*. Springer (Portugues)

Reyes-García V., **Gallois S.**, Demps K., (2016). A multi-stage learning model for cultural transmission: Evidence from three indigenous societies. in Hewlett B. and Terashima H., *Social Learning and Innovation in contemporary Hunter-Gatherers: Evolutionary and Ethnographic Perspectives*. Springer.

Reyes-García V, Díaz-Reviriego I, Duda R, Fernández-Llamazares Á, **Gallois S.**, Guèze M, Napitupulu T, Pyhälä A (accepted) Peer evaluation reliably measures local ecological knowledge. *Field Methods*. Accepted 21.03.2015.

Reyes-García V, Guèze M, Díaz-Reviriego I, Duda R, Fernández-Llamazares Á, **Gallois S.**, Napitupulu L, Orta-Martínez M, Pyhälä A (accepted) The adaptive nature of culture. A cross-cultural analysis of the returns of local environmental knowledge in three indigenous societies. *Current Anthropology*. Accepted 03.11.2015.

Reyes-García, V, Pyhälä A, Díaz-Reviriego I, Duda R, Fernández-Llamazares Á, **Gallois S.**, Guèze M, Napitupulu T, The Impacts of Schooling and Local Knowledge on Working Memory: A Study among Three Contemporary Hunter-Gatherer Societies. *PLoS ONE*. Submitted 30.08.2015.

