ENTOMOPHAGY IN THE AREA SURROUNDING LUIKOTALE, SALONGA NATIONAL PARK, DEMOCRATIC REPUBLIC OF THE CONGO

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ABSTRACT Recent research has highlighted the importance of edible insects as a protein source in the developed and developing world, both as a traditional food and a more sustainable alternative to conventional livestock. However, there is concern that traditional ecological knowledge (TEK) concerning wild-collected insects is in danger of being lost. The Democratic Republic of the Congo (DRC) is a country that encompasses many diverse cultures, many of which are known to include insects in their dietary repertoire, yet data on TEK related to edible insects across this region is scarce. This study records local knowledge and, where possible, scientific identification of the insects consumed by human communities in the area adjacent to LuiKotale, Salonga National Park. Information was gathered using interviews and first-hand observations. A total of 31 edible insects are identified by their local names, and of these 10 are identified to species level. Collection methods are recorded for seven commonly consumed species. This article contributes to the scarce body of research detailing entomophagy in the DRC.

Key Words: Democratic Republic of the Congo; Caterpillars; Edible insects; Entomophagy; Traditional ecological knowledge.

INTRODUCTION

Recent concerns about the sustainability of the global food system (Godfray et al., 2010) have prompted serious consideration of the value of edible insects in addressing issues of environmental, economic and health-related sustainability (van Huis, 2013). However, within this body of research it has been recognised that much of the knowledge regarding methods of identifying, collecting, preparing and managing edible insects on a commercial or even household scale is in danger of being lost (van Huis & Vantomme, 2014). As rural populations become increasingly subject to the pressures of developing a financial and communications infrastructure that is in line with the rest of the rapidly industrialising world, contemporary generations are growing up without fully comprehending the traditional ecological knowledge (TEK) that enabled their parents and grandparents to survive in the environment. TEK is knowledge that is local, shared, empirical and practical (Morris, 2010), and it includes the cultural knowledge of how wild resources are collected, processed and managed in a way that is safe and sustainable (Turner

et al., 2011). Therefore, TEK can be extremely useful in scientific and management contexts (Huntington, 2000), mainly because traditional methods of resource use tend to both utilise feedback responses from the environment itself, and also allow for the unpredictability of the natural environment (Berkes et al., 2000). To ensure future environmental sustainability, it is vital that TEK is accurately recorded.

The Democratic Republic of the Congo (DRC) is home to one eighth of the world's tropical rainforests, and this rich environment is in turn home to human inhabitants who have lived and thrived in the forests for many generations. A total of 70% of the inhabitants of DRC depend on forest resources for their livelihoods (Termote, 2012). However, against a backdrop of civil war and political unrest, indigenous peoples are increasingly marginalised and vulnerable to relocations to unfamiliar environments forced to make irrevocable changes to their traditional lifestyle (Barume, 2000). This unstable political climate therefore means that the TEK of the Congo basin, one of the world's prime biodiversity hotspots, is in serious danger of being lost. This article contributes towards the preservation of one important element of the TEK of the Congo basin: The collection and consumption of edible insects.

The Congo basin is home to one of the richest reservoirs of edible insect species, with at least 82 species identified according to a literature review compiled by De Foliart (2002). Insects are used as food by people in both urban and rural areas, and contribute a significant proportion of dietary protein intake (De Foliart, 2002; Takeda, 1990). Insect consumption varies between regions, but previous research has indicated that in at least six regions of the DRC, insects contribute 10% of total dietary protein intake, and one study found evidence of a monthly intake of up to 2.4 kg per person (van Huis, 2003). Although nutritional composition data on Congolese caterpillars is relatively scarce, past studies suggest that certain species are high in essential micronutrients (Paulian, 1963), and consuming them may be a culturally acceptable and effective means of combating seasonal malnutrition in the region (Bauseman et al., 2013). The majority of species consumed in remote forest regions are Lepidoptera in the larval stage, which are also dried and sold in both urban and rural markets (Latham, 2003; De Foliart, 2002; van Huis, 2003). In the DRC and other parts of Africa, TEK concerning edible caterpillars includes an understanding of their life cycle, methods of preparation that remove any toxicity, and their ecological associations with certain plants (Latham, 2003; Morris, 2010). Caterpillars in particular are often harvested according to traditional methods that may ensure species conservation (Mbata et al., 2002).

This article records local knowledge and where possible, scientific identification, of the insects consumed by human communities in the area surrounding LuiKotale, Salonga National Park, and their feeding plants. Our aim is to contribute to this limited but growing body of documented TEK concerning the collection and consumption of edible insects in the DRC, in the hope that this will inform public health nutrition and environmental conservation in this and other parts of the world.

METHODS

Study site

The research site of LuiKotale has been established in 2002 (Hohmann & Fruth, 2003). It is situated at the western fringe of Salonga National Park, south of the Lokoro river, with its camp LuiKotale located at 2°45.610 S, 20°22.723 E (Fig. 1). The dominant surrounding environment is primary lowland tropical rainforest with a small forest-savannah mosaic north of the Lokoro River. Human settlements are sparse. The transport infrastructure includes waterways and narrow dirt tracks, and there is no motorised transport.

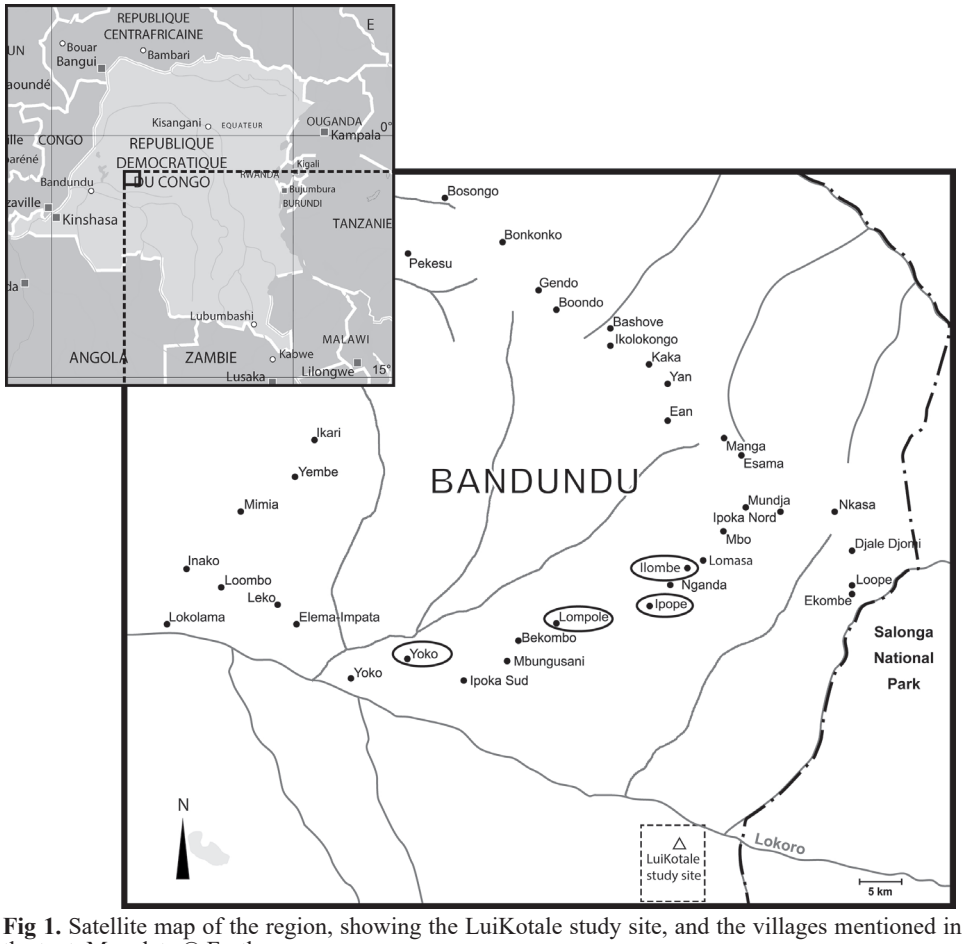

Fig 1. Satellite map of the region, showing the LuiKotale study site, and the villages mentioned in the text. Map data © Fruth

The data presented here represent TEK gathered from informants from four different villages across this region, and there are ecological differences between these sites. The village of Yoko is closest to the main flow of the Lokoro River (approximately 1 km) and therefore closest to areas bordering the river that are dominated by palm swamp. Common species in this area include the palm trees known locally as Bakolo and Bapeke. The villages of Lompole and Ipope are approximately 20 km and 25 km from the river respectively and are surrounded by a forest-savannah mosaic. Ipope is bordered by a notably large savannah. The village of Ilombe is furthest (approximately 30 km) from the Lokoro river and is not close to any major savannah areas. The forest surrounding Ilombe is said to be particularly abundant in the tree species *Bridelia atroviridis* known locally as Bodualonga.

RESEARCH METHODS

The data presented here are based on information gathered and recorded from a combination of informal and semi-structured interviews and first-hand observations from two periods. The first was a study conducted by BM (Bibiche Mato) for a dissertation within the framework of the "Project Cuvette Centrale" between August and September 2007, focusing on plants used either as vegetables or as resources of caterpillars used for food (Fruth, 2011). The second was a side-project conducted by CP (Charlotte Payne) during the course of an internship with the "LuiKotale Bonobo Project" between October 2012 and February 2013, which focused on bonobo habituation efforts. CP contacted knowledgeable people from villages adjacent to the study site (Fig. 1) for information, and asked for samples from both the forest and the fields. Local names are in Lonkundo language. The insects were identified using photographic evidence in Latham (2003). Original photos taken during the study period were then cross-checked independently by two experts (Fig. 2). Feeding plants were identified using the LuiKotale botanical database (Fruth, 2011). All interviewees were Nkundo, and from the following villages: Lompole (N = 4), Ipope (N = 1), Iyoko (N = 2) and Ilombe (N = 1). Interviews were conducted in Lingala or French.

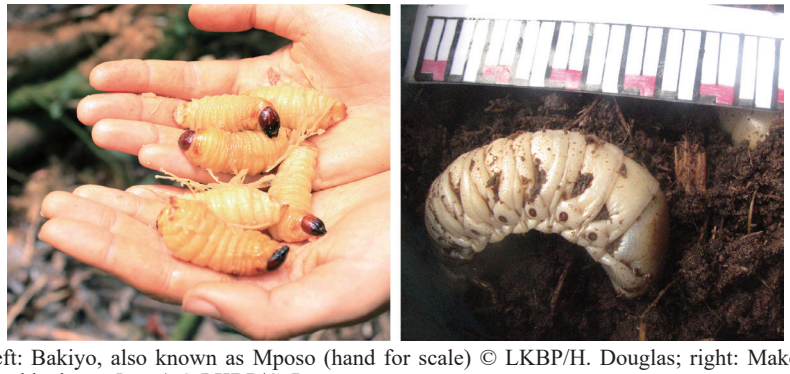

Fig 2. left: Bakiyo, also known as Mposo (hand for scale) © LKBP/H. Douglas; right: Makokolo, (scale: 1 white bar = 5 mm) © LKBP/C. Payne

Fig 3. left: Bapakala (scale: 1 white bar = 5 mm) © LKBP/C. Payne; right: Benkiyete © LKBP/C. Payne

Fig 4. left: Ndualonga (scale: numbers represent cm) © LKBP/C. Payne; right: Besaake © LKBP/B. Mato

Fig 5. Yilo (left) at a young life stage © LKBP/C. Payne, and (right) at a later life stage to show change in appearance (hand for scale) © LKBP/B. Fruth

Fig. 6. Bankonzo © LKBP/B. Mato

RESULTS

Table 1 summarises the edible insects, and, where relevant, their corresponding feeding plants. The table lists a total of 31 insects. Of these, 10 insects are identified to species level, representing 9 genera and 3 orders, 5 to genus level, and 16 by their local name only. Of these, 28 are Lepidoptera (known and/or assumed), 2 are Coleoptera and one is Isoptera. Data on feeding plants were available for 29 insects. The table also includes data on 32 local names for feeding plants associated with the insects. We were able to match 26 of these local names to 31 recognized species. Of the remaining 6 local plant names, we identified 4 to the family level, 2 local names for feeding plants could not be identified to any level.

Specific data on the collection and preparation methods of 7 insects is presented in Table 2. Methods for removing parts of the insect considered to be inedible are listed in the column “Processing”, as they differ for each species. The most predominant cooking method was the “liboke” (Table 2).

Table 1. Edible insects and their feeding plants

Insect					Feeding plant			
Order	**Local name**	**Family**	**Genus**	**Species**	**Local name**	**Family**	**Genus**	**Species**
Coleoptera	Makokolo[1]	Scarabaeidae	*Oryctes*	*rhinocerous*[5]	Bakolo[1]	Arecaceae		
	Bakiyo[1] (also 'Mposo')	Curculionidae	*Rhynchophorus*	*phoenicis*[4]	Bapeke[1]	Arecaceae		
					Bakolo[1]	Arecaceae		
Isoptera	Ndonge[1]	Termitidae	*Macrotermes*[6]		N/A – collected from the ground, as alates			
Lepidoptera	Baango[1]	Saturniidae	*Imbrasia*	*forda*[3]				
	Bankonzo[2]/ Pili ya Nguabi[2]				Elongo[2]	Mimosaceae	*Fillaeopsis*	*discophora*
						Fabaceae	*Milletia*	*eetveldeana*
					Booto[2]	Lecythidaceae	*Petersianthus*	*macrocarpus*
					Bosenge[2]	Euphorbiaceae	*Uapaca*	*heudelotii*
					Bokungu[2]	Mimosaceae	*Piptadeniastrum*	*africanum*
					Bokanga[2]	Caesalpiniaceae		
	Bapakala[1,2]	Saturniidae	*Imbrasia*	*obscura*[3]	Buamba/Bwamba[1,2]	Mimosaceae		
					Bokanga[2]	Caesalpiniaceae		
					Elongo[2]	Mimosaceae	*Fillaeopsis*	*discophora*
						Fabaceae	*Millettia*	*eetveldeana*
					Bongombidzi[2]	Rhamnaceae	*Maesopsis*	*eminii*
	Bekungu[1,2]				Bokungu[1,2]	Mimosaceae	*Piptadeniastrum*	*africanum*
	Belanga[1,2]				Bosenge[1,2]	Phyllanthaceae	*Uapaca*	*heudelotii*
						Phyllanthaceae	*Uapaca*	*guinensis*
	Bendjoji[1]/ Benzonzi[2]				Maku rouge[1,2]	Caesalpiniaceae	*Dialium*	*corbisieri*
	Benkiyete[1]				N/A - found in the savannah			
	Besaake[2]/ Bosake[1]	Nymphalidae	*Cymothoe*	*caenis*[3]	Saake[2]/Sake[1]	Flacourticeae	*Caloncoba*	*welwitschii*
	Beyao[2]/ Beyau[1]				Bofulu[2]	Fabaceae	*Pterocarpus*	*soyauxii*
					Bosimpango[1,2]	Mimosaceae	*Pentaclethra*	*eetveldeana*
	Bolanga[1]	Saturniidae	*Imbrasia*	*alopia*[3]				
	Bonianianga[2]				Bonianga[2]	Sapotaceae	*Autranella*	*congolensis*
						Euphorbiaceae	*Croton*	*haumanianus*
	Bonyonyo ou nyonya[2]/ Nionionia[2]				Boonya[2]	Sapotaceae	*Manilkara*	*malcoleus*
							Manilkara	*obovata*
	Dzooto[1,2]	Saturniidae	*Imbrasia*[3]		Ipaki[1,2]	Meliaceae	*Entandophragma*	sp. unknown
	Edjima[1]/ Edzima[2]	Saturniidae	*Imbrasia*	*petiveri*[3]	Bopeko[1]			

continued

	Insect				Feeding plant			
Order	**Local name**	**Family**	**Genus**	**Species**	**Local name**	**Family**	**Genus**	**Species**
					(various lianas)			
	Yiilo[1]/ Hiilo[2]	Saturniidae	*Imbrasia*	*epimethea*[3]	Boto[1]/Booto[2]	Lecythidaceae	*Petersianthus*	*macrocarpus*
					Bokanga[2]	Caesalpiniaceae		
					Shomba ya zamba[2]			
	Maamba/ Mbaamba[2]				Buamba[2]	Mimosaceae		
	Maanga[1,2]	Acrolepiidae	*Elaphrodes*	*lactea*[3]	Manga[1]	Caesalpinioideae	*Brachystegia*	*laurentii*[7]
	Mfoofu[1]/ Nfofu[2]				Bofu[1]	Sterculiaceae	*Cola*	*gigantea*
	Mpampale[2]/ Mpapale[1]				Bopale[1,2]	Dichapetalaceae	*Dichapetalum*	*schweinfurthii*
	Mpolollo/ Mpole	Notodontidae	*Antheua*[3]		Buwuta	Fabaceae	*Tephrosia*	*nana*
	Kobelanga							
							Tephrosia	*vogelii*
							Tephrosia	*barbigera*
					Tongosa ya esobe[1]	Fabaceae	*Eriosema*	*psoraleoides*
	Mpopomi[1,2]/ Popomi[2]				Bokomi[2]	Sterculiaceae	*Scaphopetalum*	*thonneri*
						Tiliaceae	*Desplatsia*	
					Bokanga[1]	Caesalpiniaceae		
					Epomi[1]	Caesalpiniaceae	*Erithrophloeum*	*suaveolis*
	Ndolongo[2]				Bolongo[2]	Clusiaceae	*Garcinia*	*epunctata*
						Guttifereae	*Symphonia*	*globulifera*
	Ndualonga[1,2]	Notodontidae	*Anaphe*	*panda*[3]	Bodualonga[1,2]	Phyllanthaceae	*Bridelia*	*atroviridis*[7]
	Nfofumu[2]				Bopfumo/Bompfumo[2]	Tiliaceae	*Grewia*	*pinnatifida*
	Nsombo'oto[1]/ Somboto[2]	Notodontidae	*Antheua*[3]		Ipambwa/Ipambua[2]	Anacardiaceae	*Sorindeia*	*zenkeri*
							Sorindeia	*gilletii*
	Nzengeyenge[1]/ Nzengenge[2]	Notodontidae	*Antheua*[3]		Wenge[2]	Fabaceae	*Millettia*	*laurentii*
	Sesenga[2]				Bosenga[2]	Myristicaceae	*Pycnanthus*	*kombo*
	Tetedzi[2]				Esese[2]	Moraceae	*Ficus*	*exasperata*

[1] CP interview data, collected 2012–2013. [2] BM interview data and personal observation, collected 2007. [3] Latham, 2003. [4] Ferry & Gomez, 2002. [5] De Foliart, 1993. [6] McGrew, pers.comm. [7] Fruth, pers.comm.

NB: All feeding plants were identified using the LuiKotale botanical database unless otherwise specified. All species-specific insect data was cross-checked with Paul Latham.

Table 2. Details of seven edible insects, collection and preparation by CP in 2012–2013

Local name	Species	Seasonality/geography	Processing	Cooking[1]	Commercialisation	Resource monopolization[2]
Ndonge	*Macrotermes* spp.	September/ mainly found in Lompole village	Alates collected, wings removed (by hand).	Boiled in pan with salt.	N	N
Bakiyo	*Rhynchophorus phoenicis*	Year round/ mainly found in Iyoko village	No processing.	Liboke/boiled.	Sold alive in Kinshasa for 100 CDF per larva	Plants are cut and left to rot, then returned to after a fortnight to harvest the larvae; Iyoko chief sometimes chooses to ban non-villagers from harvesting Bakiyo.
Makokolo	*Oryctes rhinocerous*	Year round/ mainly found in Iyoko village	Hard skin on head removed with a knife and stomach contents squeezed out.	Liboke, also stewed with tomatoes and onions.	Sold alive in Kinshasa for 50 CDF per larva	Unknown
Bapakala	*Imbrasia obscura*	June-August, February	Spikes singed over open fire, washed and split in half (stomach contents not removed).	Liboke.	N	Unknown
Benkiyete	Unknown	January/ found in the savannah	Washed.	Liboke.	N	N
Ndualonga	*Anaphe panda*	January-February/ mainly found in Ilombe village	Nest opened with knife, caterpillars singed in dry pan, washed.	Liboke, also smoked.	Sold by the nest (1000-2000 CDF per nest)	Colonies are collected in December and placed in handwoven baskets where they weave their nests
Yilo	*Imbrasia epimethea*	June-August	Washed, split open and stomach contents squeezed out (by hand).	Liboke.	N	Unknown

[1] Liboke: A traditional cooking method in which the caterpillars/larvae are placed and wrapped in leaves of Marantaceae (usually *Maranthochloa* spp.). Salt and water are added and the caterpillars/larvae wraps are smothered in the hot ash of the cooking fire for approximately 10 minutes or until cooked. [2] Unknown: Respondents discussed incidents in which a young caterpillar colony would be brought home and kept in a nearby tree until ready to eat, and also mentioned that some people had feeding trees in their vegetable plots and were therefore able to harvest the caterpillars every year. However, these discussions concerned general and social activities not focused on caterpillars, for example, their species.

DISCUSSION AND CONCLUSIONS

The number of genera and orders of edible insects documented in this paper represent a fairly broad repertoire for a single region. For example, Takeda's study undertaken during a three year period between 1975 and 1978 in the north of the DRC recorded only 21 edible insect species (Takeda, 1990). However, insects that are selected for consumption are known to differ between regions, and at least 163 species are consumed throughout the Congo basin (DeFoliart, 2002). In the present study, only 10 of the insects were photographed and could therefore be identified to species level. Records of other insects identified by their local names rely on word-of-mouth accounts. While this provided an efficient way of gathering a broad range of information within a limited time frame, it also meant that the figure of 31 known edible insects in this region represents a very preliminary estimate.

Regarding the data presented here on insects and their feeding plants, we acknowledge that some have also been identified in Bas-Congo (Latham, 2003). However, several of these ecological associations have not previously been recorded. These are the associations of *Elaphrodes lactea* with *Brachystegia laurentii*, and *Imbrasia obscura* with both *Fillaeopsis discophora* and *Millettia eetveldeana*. Furthermore, several species previously unknown to be important feeding plants for edible caterpillars could be recorded (Table 1). These are *Filleaopsis discophora*, *Piptadeniastrum africanum*, *Uapaca heudelotii/guinensis*, *Dialum corbisieri*, *Caloncoba welwitschii*, *Pterocarpus soyauxii*, *Autranella congolensis*, *Croton haumanianus*, *Manilkara malcoleus/obovate*, *Cola gigantea*, *Dichapetalum schweinfurthii*, *Scaphopetalum thonneri*, *Desplastia* sp., *Erithrophloeum suaveolis*, *Garcinia epunctata*, *Millettia laurentii*, *Pycnanthus kombo* and *Sorindeia zenkeri/gilletti*. In many cases the caterpillars in question have not been identified to the species level. Nevertheless the knowledge that these plants harbour food insects will be useful for the development of conservation strategies that preserve traditional resources in this area.

All of our informants agreed that the dry season (June–August) is generally recognised as the time in which most caterpillars are available in abundance in the region. Yet, edible insect species seem to contribute to the diet during all seasons. *Rhynchophorus phoenicis* and *Oryctes rhinocerous*, which are collected all year round, are the prime example of this, but in addition, many caterpillars are also collected as food on an opportunistic basis during the shorter dry season (late February–March). Both *Macrotermes* (September) and *Anaphe panda* (January–February) are available during months of the year that coincide with heavy rains.

Bonobos (*Pan paniscus*) are also present in the study region, but only two of the edible insects identified here are known bonobo foods: the palm weevil larvae *Rhynchophorus phoenicis* and *Oryctes rhinocerous* have been consumed by the bonobos at Wamba, in the Tshuapa district of the DRC (Furuichi, pers. comm.). However, bonobos at the LuiKotale site have not yet been observed to consume these insects. Both Lomako and LuiKotale bonobos were observed consuming caterpillars. At LuiKotale, bonobos were observed to consume *Achaea* sp. of the Erebidae family, and another, unidentified species thought to be of the Lasiocam-

pidae family (Fruth, pers. comm.), therefore showing no dietary overlap with species known to be consumed by humans.

In conclusion, this study presents preliminary data on the existence and identification of insects consumed by human communities living in the region adjacent to or north of the LuiKotale field site, Democratic Republic of the Congo, and identified 10 edible insects and 41 food plants to the species level. Further research will be necessary to determine the scientific identification of other insects consumed in this area, details of overlap with insect consumption by bonobos, and the traditional foraging techniques that determine methods of collection and preparation.

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