EXPLORING ENTOMOPHAGY IN NORTHERN BENIN

PRACTICES, PERCEPTIONS AND POSSIBILITIES

RIGGI L., VERONESI M., VERSPOOR R., MACFARLANE C. | *MAY 2013*

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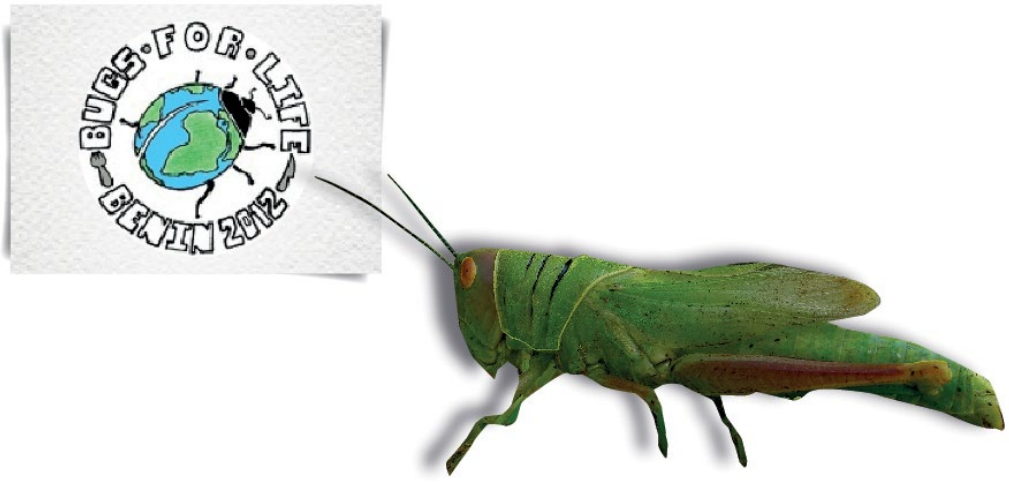

ABOUT US

The Bugs for Life project was created and carried out by four UK-based team members from different academic and professional backgrounds united by an interest in entomophagy and a drive to uncover sustainable solutions to problems such as food insecurity today.

The members include Laura Riggi and Rudi Verspoor, entomologists and evolutionary biologists, Mariangela Veronesi, a specialist in international development and sustainable planning, and Craig Macfarlane, an environmental science communicator.

The idea of undertaking a research project was made possible by establishing contact with Sévérin Tchibozo from the NGO Centre de Recherche pour la Gestion de la Biodiversité, who became our local partner is Benin. Funding was secured through grants by Imperial College Exploration Board, the Royal Entomological Society, along with crowd-funding via Indiegogo.

To contact us for further information on this research and other activities by Bugs for Life, or the possibility of undertaking future projects on entomophagy, please contact us at info@bugsforlife.com, or visit our website www.bugsforlife.com.

ABSTRACT

Food security is a critical issue for many low income countries across the African continent. In areas unsuited for intensive agricultural production, local natural resources can play an important role, particularly those which are sustainable and on which people have relied on for centuries. In many regions of the world insects have been consumed for generations, and represent a reliable source of animal proteins among populations that otherwise have limited access to meat. This work in Benin was motivated by the attempt to understand how edible insects could contribute in an area where food security is significant issue. Initially our work focussed on a case study of an insect-eating community in the Atakora region, in Northern Benin. Data on edible insects in the Wama communities of the district of Tanguieta were collected by conducting interviews, focus groups and insect collections in two Wama settlements, Kosso and Cotiakou. Eighteen edible insect species were recorded, predominantly Coleoptera (52%) and Orthoptera (29%). This project has found a further nine arthropod species eaten in the region including new groups of arthropods such as Hemiptera (family: Coreidae) and Acari (family: Ixodidae). Interestingly, insect collection and consumption was found to be an ancestral tradition in the Wama community, mostly carried out by children. In light of malnutrition in North Benin being a major problem in young age groups, promoting this tradition as well as exploring the potential of implementing small scale captive rearing of selected species could be a promising opportunity to further develop food security in the region and beyond. The opportunities and barriers of expanding entomophagy and rearing are discussed.

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I. INTRODUCTION

As the global population continues to rise, attempts to increase arable land area come into conflict with other land uses. When summed with food price volatility and changing climatic patterns, regional food shortages are becoming a recurrent and worrying phenomenon. In particular, food security is a critical issue for the inhabitants of low-income countries across the African continent. Chronic poverty, landlessness and land-grabbing, increasing environmental degradation, as well as the disruption of local alimentary culture by the Western imported food products and habits are all contributing factors (Primaletha *et al.*, 2011). Among nutritional problems, protein deficiency is one of the most pressing, and Sub-Saharan Africa has the lowest average animal protein intake per capita per day in the world (Grigg, 1995). In areas unable to sustain extensive agricultural production or livestock rearing, local food resources can assume an important role, particularly those which are sustainable and which people have relied on for centuries. In many regions of the world insects have been consumed for generations, and represent an important source of animal proteins among populations that have limited access to meat.

In fact, research has established that over a thousand insect species have been used as traditional foods by humans, and many still form an important part of the diet, economy and cultural heritage of different societies (Merle, 1958; Katya Kitsa, 1989; DeFoliart, 1995). Studies have also confirmed insects as a source of food with many advantages, mainly linked to their nutritional properties (high in protein, minerals and vitamins) and low environmental impact. Additionally, over the last two decades the potential of insects as a commodity has been increasingly recognised (DeFoliart, 1999; van Huis, 2003) and insects are now regarded as a class of mini-livestock (Hardouin, 1995, 2003). As a result, entomophagy has been attracting growing attention and support from international organisations such as the Centre Technique de Cooperation Rurale et Agricole (CTA) and the Food and Agricultural Organizations (FAO) for their potential to positively contribute to people's livelihood.

The consumption of insects is widespread throughout Sub-Saharan Africa, with some 250 species being consumed either as delicacies or as important components of the daily diet (van Huis, 2003) (Figure 1). In parts of the Democratic Republic of Congo, insects constitute up to 64% of the animal protein consumed by humans (Paulin, 1963; DeFoliart, 1999), while many populations in Zambia prefer winged termites to the meat of mammals (DeFoliart, 1999). Additionally, many agricultural pests - which cost billions of dollars to control and can cause serious environmental damage - are in fact edible and are utilised as food in certain countries (Ramos-Elorduy, 1997; FAO, 2008; Premalatha *et al.*, 2011). The potential of entomophagy is further illustrated through the mopane caterpillar (*Imbrassia belina*) industry in South Africa which forms the basis of a multi-

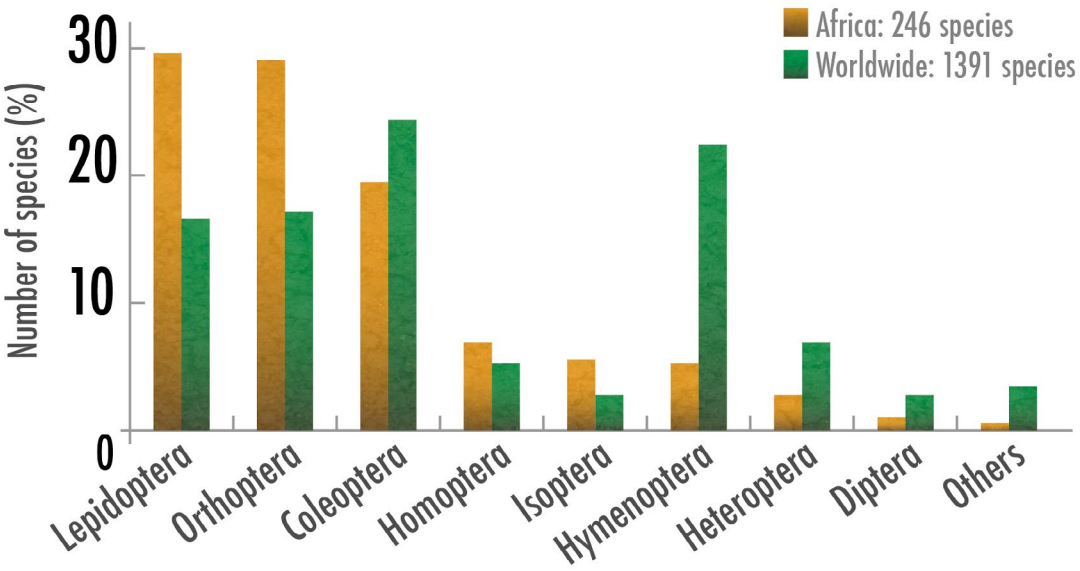


Figure 1: The percentage of insect species of each order eaten worldwide. (Source: van Huis, 2003)

million dollar trade in edible insects, providing livelihood for many harvesters, traders and their families (Dreyer and Wehemeyer, 1982; Munthali and Mughogho, 1992; Menzel and D'Aluisio, 1998; FAO, 2004). This industry shows that the potential income from sale of edible insects is significant.

Although insects have been and still are consumed in Benin, entomophagy is currently not very widespread. The biggest consumers of insects are the Nagot, Pobè, Kétou, Wama, and some Fon groups[1] (Tchibozo *et al.*, 2005). However, the edible insects of Benin have not been extensively documented so far, with only one preliminary study listing the insects consumed in some regions in South Benin (Tchibozo *et al.*, 2005). This work remarked that edible insects were an important source of animal protein in the South, improving the health and diet of children. While the potential benefits of entomophagy are recognised, little is known about how to realise the full development of insects as a substantial and reliable source of food across Benin.

The report focuses specifically food insecure Atakora region in Northern Benin, concentrating on the Wama ethnic group, whose insect consumption is understudied. The research was motivated by the attempt to understand whether the expansion of the use of edible insects could contribute to the alleviation of nutritional deficiencies in the region. The Wama group is also particularly interesting because the main consumers of insects are children, who are the main sufferers from issues of malnutrition.

The report is structured as follows: Chapter II will provide an overview of the benefits of insects as food, along with a geographic and social-economic contextualisation of our study; Chapter III will illustrate the materials and methodological approaches undertaken; and Chapter IV will expand on the results of our research, including the listing of the different species eaten regionally, along with collection and consumption methods. Subsequently, we will present a series of discussions relevant to our findings in Chapter V, including the significance of edible insects to people's livelihoods in the form of current subsistence collection or when envisaging insect farms and wider possibilities, followed by indentified potential barriers to the expansion of entomophagy in the region and beyond in Chapter VI. This will finally lead on to Chapter VII where conclusions and recommendations are presented.

1 Most of whom have lived in Nigeria

II. BACKGROUND INFORMATION

A. VALUE OF INSECTS AS FOOD

Current livestock production, including feed-crop production, occupies 70% of the world's agricultural land (or 30% of the earth's land), and consumes 77 million tonnes of plant or animal protein to produce just 58 million tonnes of protein for human consumption annually, proving to be quite inefficient (Pimental *et al.*, 1975). In addition, given the global distribution of wealth and resources, not all populations have regular access to these animal products, and many live off diets mainly based on moderately nutritious staple foods such as rice or maize. In contrast to comparatively resource intensive and expensive forms of food, insects offer many valuable benefits, especially when considering insect farming. In fact, van Huis (2003) mentions in his overview of insects as food that "insects are not inferior to other sources of protein such as fish, chicken or beef" (p. 1), as they can offer higher or similar properties (Table 1 and 2) (Ruddle, 1973; van Huis 2003; FAO 2010a,b). This is particularly interesting in the context of Africa, as insects

DAILY HUMAN REQUIREMENT Fraction met by:	THIAMINE 1.5 mg	RIBOFLAVIN 1.7 mg	NIACIN 20 mg
roasted chicken	5.4%	-	45%
baked beans	10.8%	-	3%
termites	8.7%	67.4%	47.7%
silkmoth larvae	224.7%	112.2%	26%
palm weevil	201.3%	131.7%	38.9%

Table 1: B-Vitamins in 100 g servings of chicken and beans dishes in comparison to the contents of some insects (From Premalatha, 2011).

generally provide protein, minerals and vitamins – all of which are major deficiencies in many regions. In addition, farming insects can prove to be quite a cost-effective solution to the supply of nutritious food, and therefore should be further explored in countries with limited economic possibilities. Low consumption of energy, natural resources and space needed when considering rearing (Lindroth, 1993; Nakagaki *et al.*, 1991), alongside high fecundity and a fast growth rate, make insect farming an appealing option that could prove to be particularly useful in a context of food insecurity and pressure on resources.

FOOD	PROTEIN, g	IRON, mg
beef (broiled)	22.3	2.9
silkmoth larvae	28.2	35.5
grasshoppers (fried)	61.1	-

Table 2: Protein and iron in 100 g servings of beef and of two insects (From Premalatha, 2011).

B. BENIN: COUNTRY OVERVIEW

I. POPULATION AND TRENDS

Benin has around 9.5 million inhabitants (CIA Factbook, 2012), with an increasing urban share now standing at 42% (BTI, 2012). It is a young country, with 44% of the population between the age of 0 and 14 (CIA Factbook, 2012), and an average life expectancy of 55 years – one of the lowest in West Africa (BTI, 2012). The country has significant regional variety in terms of culture and traditions, many of which are still passed on today, particularly in rural environments. Religion is also varied, with 27.1% of Catholics, 24.4% Muslim, 10.4% Protestants and 5.3% other Christian. Benin is also the birthplace of Vodoun, which is still practiced by 17.3% of the population along with other animist religions (2002 Census in CIA Factbook, 2012).

II. ECONOMIC PROFILE

Despite economic and social improvements over the last decade, characterised by a rise in development indicators and a GDP growth rates averaging 4% per annum (World Bank, 2012), Benin remains among the poorest countries in the world (ranked 167 of 187 Human Development Index (HDI)) with 51.6% of the population live on less than US$1 a day (BTI, 2012). The economy relies strongly on agriculture, which represents 32% of the GDP and employs 70% of the workforce, most of which is in the form of subsistence farming. The main cultivated food products are maize, millet, sorghum, rice, yams, cassava, fruits such as pineapples, mangos and oranges, vegetables such as tomatoes, aubergines and okra, and legumes such as beans and peanuts. Agricultural exports are dominated by cotton, which represents between 25 to 40% of total export activity (FCO, 2012), and is followed by products such as cashews, shea butter, and palm products (CIA Factbook, 2012). Due to a lack of diversified sectors, Benin is very vulnerable to external shocks and price volatility, and has suffered economically from the global economic crisis and from severe floods in 2010 which depressed agriculture and cotton exports (World Bank, 2012).

III. REGIONAL VARIATIONS

Poverty-related issues and food insecurity are not evenly distributed across the country. As a result of Benin spanning two very different climatic zones, the Northern region has always been poorer. The South is endowed with a tropical climate, with two rainy seasons, which result a in a lush landscape and fertile ground for agriculture, with the possibility of two harvests. In contrast, the North remains arid, and oscillates between an extensive dry season spanning from October to May and abundant rains from June to October, making agriculture significantly more unreliable. In addition, although the Southern ports thrive through import/export activities, the benefits and products from trade do not necessarily reach the rest of the country. As a result of these inequalities, nutritional deficiencies are far more severe in the North. The region lags behind in terms of agricultural diversification - and crop failures and limited access to affordable fortified products lead to widespread dietary inadequacies. The hardest period is called the *soudure* - the time before the first rains and the first harvest, between February and April, when food is becomes both scarce and expensive.

IV. FOOD SECURITY

Benin struggles to resolve poverty-related issues affecting the country, with food insecurity being no exception. Child malnutrition is a particularly worrying consequence, with studies over the last years showing that moderate and severe stunting linked to nutritional deficiencies is increasing (from 25% in 1996 to 27% in 2001 and then 35% in 2006) (UNICEF, 2006). To tackle these and other issues, the IMF and World Bank have pushed for the formulation of a 'Growth and Poverty Reduction Strategy' (IMF, 2011) to guide the country's development. Within this frame, food security and sovereignty via sustainable agriculture has to be achieved in order to insure long term poverty alleviation (Gangnibo et al., 2010) as so far the greatest increases in poverty levels between 2007 and 2009 were in fact recorded in the agriculture-livestock-fisheries-forest sector (5.46% increase) (INSAE, EMICoV, 2010, in IMF, 2011). Benin has also launched the 'Strategic Plan of Agricultural Sector Revival' in 2008 with the aim of making the country food secure by 2015 (MAEP, 2008, Gangnibo et al., 2010).

C. BACKGROUND TO THE AREA OF STUDY

I. THE ATAKORA AND THE COMMUNE OF TANGUIETA

Our study focused on the Atakora department, located in the North West of the country, bordering Burkina Faso and Togo, and home to the Atakora mountain range. It has a population of 550 thousand inhabitants (ANCB, nd), spread across nine *communes* (districts). This study specifically investigated the *commune* of Tanguieta. The main ethnic groups present in the area are Ditamnari, Berba, Wama, Natemba, Peulh and Gourmanché (UNIDEA, 2006). The landscape in the *commune* is composed of rocky mountains and scrub savannah to the North of Tanguiéta. Eighty per cent of the population depends on agricultural activities to support their households, consisting of either subsistence agriculture or cultivation as a source of income, mainly cotton. During the period of *soudure*, petty commerce and cattle selling are the main activities pursued to bridge the gap before the harvest (UNIDEA, 2006).

II. THE ISSUE OF NUTRITION

As stated previously, food insecurity and the consequent state of malnutrition is a major problem in

the area. A study conducted in the *commune* of Tanguieta by UNIDEA (2006), found that about 10% of the surveyed children under the age of five suffered from acute malnutrition, and up to 50% of the surveyed children presented signs of chronic malnutrition, with detrimental effects on growth rates, resulting in stunting. Twenty four per cent of these cases were categorised as severe stunting, whereby malnutrition significantly affected the child's development. Malnutrition was found to be most acute in the months where children depend on breast-feeding, which indicates that the mother's nutritional intake is also often inadequate. There is limited literature on the area, but Dr Aouanou Guy Basile, the director of the Centre for Nutrition, and Dr Priuli G.B. Fr. Florent, the Director of the Hospital Saint Jean de Dieu Fatebenefratelli of Tanguieta confirmed that food insecurity – linked to crop failure, excessive costs and other factors - is a significant problem and has often resulted in widespread famine. Nutritional deficiencies are also linked to lack of information and health education, and to certain traditional practices that prohibit the consumption of certain nutritious products such as eggs or meat by children.

III. THE WAMA SETTLEMENTS OF KOSSO AND COTIAKOU

The research was conducted in the town of Cotiakou and the village of Kosso, both under the *arrondissement* (municipality) of Cotiakou. These are both Wama settlements. They mainly live off non-mechanised subsistence agriculture and livestock rearing, while selling surpluses in Tanguieta. Most of their land is rocky and poor for agriculture, but allows for a secondary source of income: the breaking of rocks, which are sold to construction. While Cotiakou has a health centre, a church, a primary school, and has opened a secondary school in 2010, Kosso does not have such facilities, and both settlements are without electricity. A large part of the adult population has not been to school or has had limited exposure to the formal education system, especially in Kosso. Nonetheless, indigenous knowledge is extensive in terms of agricultural practices and the uses of plants and animals for medicinal and practical uses. Current school attendance is high at primary school level, and is improving at secondary school level since the facilities were opened in Cotiakou. In addition, some children walk to Tanguieta to attend school there. The population is mainly Catholic, but animism is intertwined with religious beliefs to varying degrees.

The Wama are strongly attached to traditions transmitted from one generation to the next. Family bonds are considered extremely important, and the houses are built so that family groups live next to each other, surrounded by their fields. Housing is organised in *concessions*, each owned by one head of family, which are composed of a series of circular rooms built out of mud and straw, along with pens and granaries, all connected in a circle by a mud and straw wall. Their diet is largely composed of rice, maize products, yams and sauces, while meat and eggs are scarce, and imported fortified products remain unaffordable and are unusual in their diet.

III. MATERIALS & METHODS

The information presented in the results section was collected by field interviews, focus groups and participatory insect collection conducted during the months of October and November 2012. The interviews concentrated on the traditional, nutritional and other uses of arthropods for consumption[2]. Two Wama villages were visited, Kosso and Cotiakou, situated between Tanguieta and Natitingou (Fig2). The initial contact with the Wama was made through our local partner, Séverin Tchibonzo, who had previously worked in Kosso. Interviews were mostly lead with the *délégué* or administrative representative of Kosso, the director of the secondary school of Cotiakou and his pupils, and other interviews and focus groups were held with certain members of the communities - mostly men between the ages of 25 and 45, generally involved in agricultural activities. Communication occurred either in French or by means of translation.

Collections of insects were carried out by the children as it is custom in the Wama. In addition to the traditional "hunting" of insects, a trap with fermenting fruits (pineapple, bananas) was used to attract some Coleoptera. This technique consisted in hanging a bucked filled with fermenting pineapple and bananas with water to a high branch of a tree; the bucket was then collected the following day. Where possible, four specimens of each insect were kept and killed using ethanol and then pinned. The location, local name, host plant, habitat and temporal distribution of each morphospecies were noted. Where possible, specimens were subsequently identified by a specialist at the IITA (International Institute of Tropical Agriculture) Research Institute in Cotonou. Specimens were also kept to document preparation, cooking, and eating.

To investigate the potential of developing entomophagy in Benin various specialist were interviewed. The Director of the Hospital Saint Jean de Dieu of Tanguieta Fatebenefratelli and the Director of the Centre for Nutrition of the hospital were both interviewed on the question of nutritional deficiencies and food insecurity in the region. In addition, food scientists at the University of Abomey Calavi (UAC) of Cotonou and specialist agricultural economists of the IITA were approached about how the production of selected insects can be enhanced, how communities can be involved, and how existing barriers can be overcome.

Limitations of the project include the length of time we were in the area, which allowed the collection of most but not all insects due to seasonal variation in abundance. For example, the termites winged stage

2 While insects are used for honey production and to a small degree for animal feed, only insects used for direct human consumption are dealt with in the report.

are only observed and collected in August. This problem was addressed through interviews which helped us create of a calendar of species availability throughout the year.

Language and cultural barriers also occasionally created misunderstandings, but through repeated visits and by approaching more interviewees the significance of this problem reduced considerably with time. Initially camera equipment was distracting, especially for young children, and could have affected the way the collections were carried out; however over time this curiosity noticeably decreased. The research could be influenced by a gender bias, as it was very hard to interact with the women due to the nature of the Wama societal organisation.

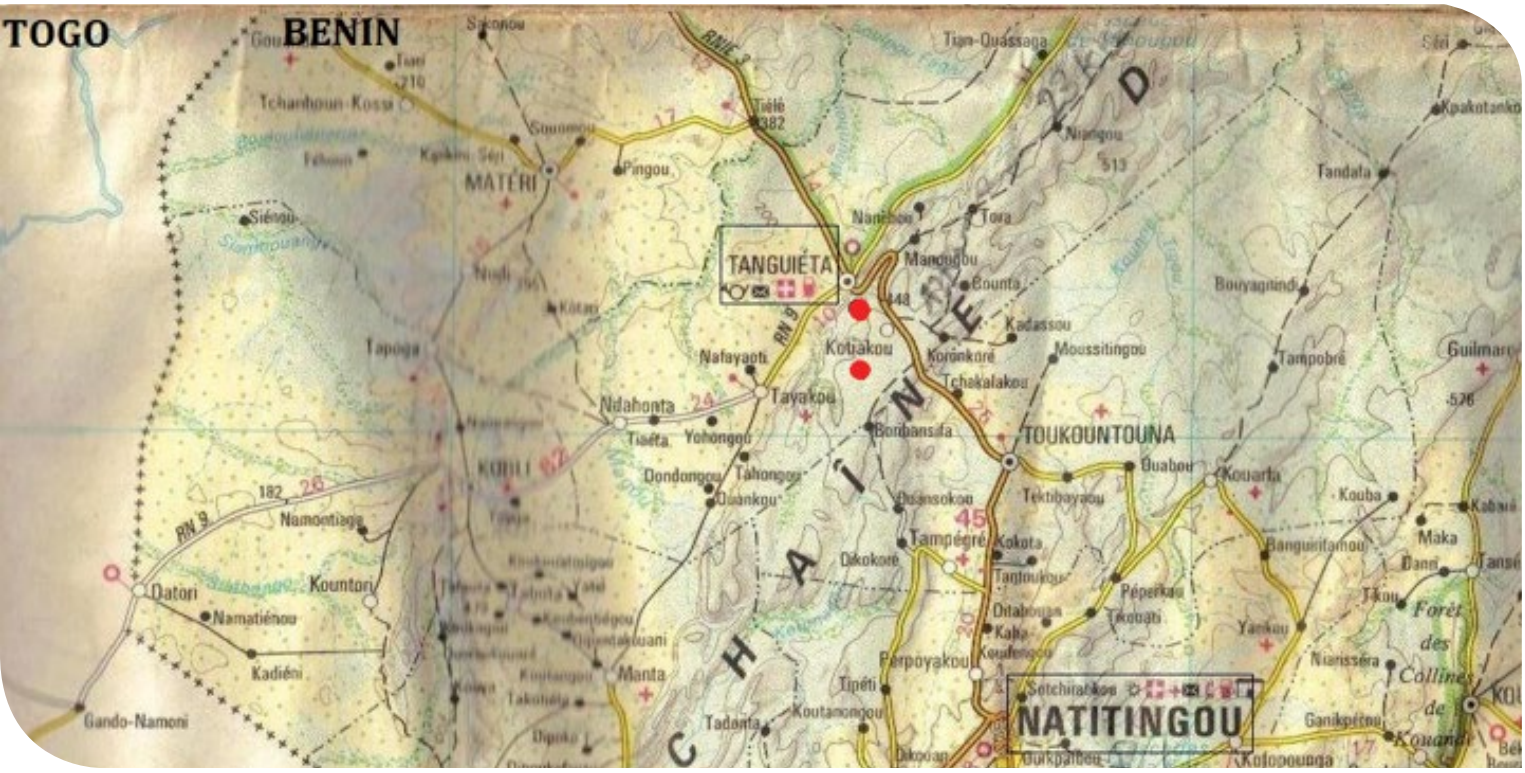


Figure 2: Map of the Atakora Region (scale 1:600000). The red dots represent the locations of Kosso and Kotiakou.

IV. RESULTS

A. WHICH INSECT SPECIES ARE EATEN?

Previous research by Tchibozo *et al.* (2005) had found that the Wama communities consumed nine species of insects (Table 3). This project identified nine additional arthropod species that are or were recently eaten. These include new groups of insect such as Hemiptera (family: Coreidae) and Acari (family: Ixodidae) in addition to several new species of Coleoptera from the Cetoniinae family. One insect documented of particular interest was the bush cricket, *Gymnoproctus sculpturatus*, which was the first recorded presence in Benin and is usually considered to be found in Kenya. With the present record, there are only three genera and species of this group of bush cricket to be known in West Africa. Table 3 fully lists the arthropods consumed by the Wama communities, while Figure 3 shows the temporal distribution of the recorded arthropods. Although some can be found all year round, most of the eaten insects are seasonal - such as many Orthopterans and all Coleopterans. Amongst the Wama, our findings indicate that the most abundant and preferred insects for their taste were the Coleoptera (52%), especially *Pachnoda cordata*, followed by the Orthoptera (29%). Comparing our data on edible insects to the percentage data worldwide (Ramos-Elorduy, 1997) and of Sub-Saharan Africa (van Huis, 2003) we can find similarities in the fact that Coleoptera and Orthoptera are in the top three major eaten groups. However, Hymenoptera and Lepidoptera, which are both frequently recorded by both authors, are not present in our data. In addition, our findings suggest a very different insect diet between the North and the South of Benin (Tchibozo *et al.*, 2005) linked to the presence of different species as well as cultural preferences. In the North, we can find a greater diversity of consumed insects than in the more developed South.

The Wama mostly consume insects that can be gathered in the fields, high grasses and trees around their village, predominantly species feeding on vegetation. Some of them are potential crop pests such as grasshoppers (*Hieroglyphus africanus, Acanthacris ruficornis citrina, Ornithacris turbida cavroisi*) and crickets (*Brachytrupes membranaceus, Gymnoproctus sculpturatus*), - who can be major defoliators of crops - and chafers (*Pachnoda cordata*) - whose larvae live in the soil and damage to cereal and sugarcane roots. The table below gives further information on the species collected and previously found to be eaten by the Wama. Two interesting exceptions to the insects collected on high grasses are that of edible ticks found on cattle and the water beetles of the family Hydrophilidae. These are particularly interesting because to our knowledge this is the first record of their consumption in Africa.

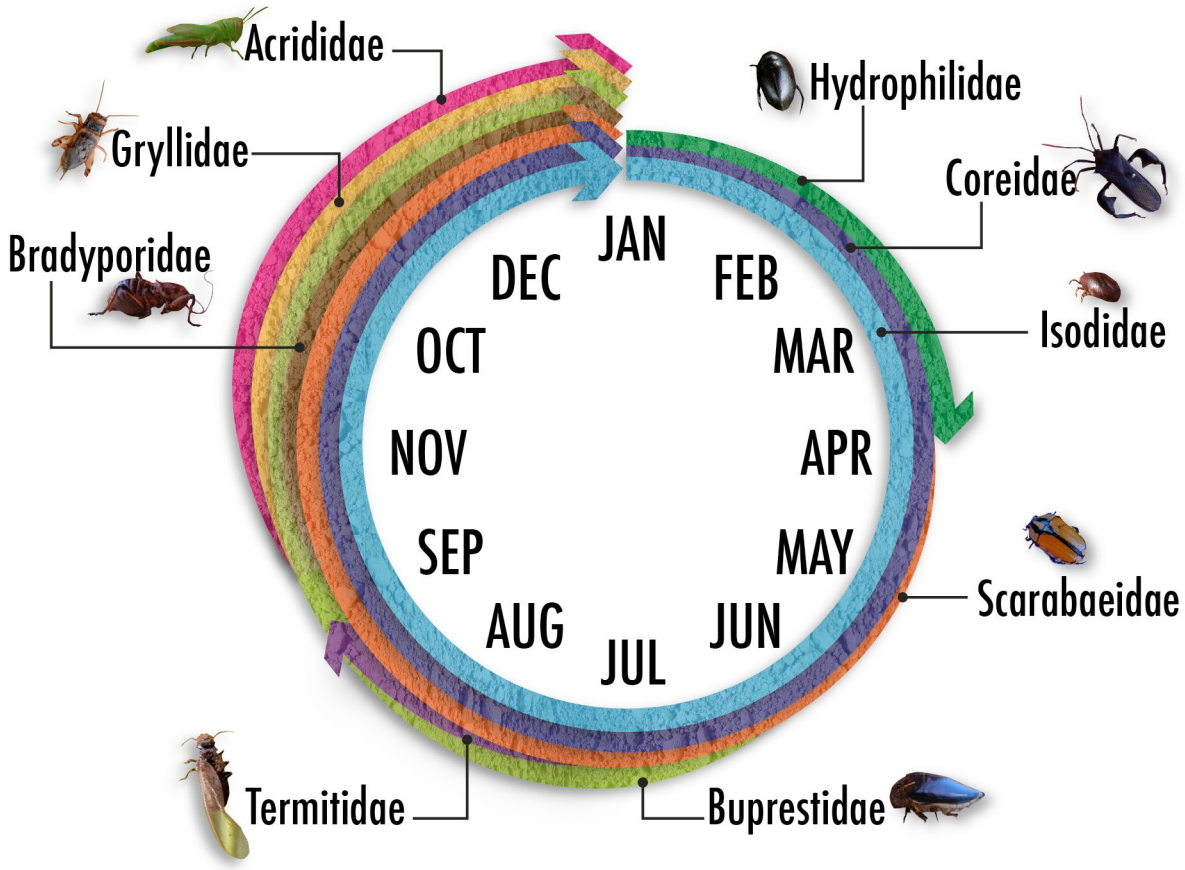


Figure 3: Seasonal distribution of the recorded arthropods in Wama communities.

The Wama do not own cows themselves, as traditionally it is the Peulh[3] who are the major cattle herders in the region, and they often travel with their cows from pasture to pasture. When the Peulh pass through Kosso or when they head back from the grazing to Cotaikou where some of the Peulh have settled, the Wama visit them to collect the blood filled ticks that have been feeding on the cows. These will then be fried and eaten by the Wama – like a mini black pudding. The Peulh do not eat the insects themselves, and this collaboration with the Wama serves as a sort of parasite control which minimises the ill effect of ticks on cows. However, this arrangement is increasingly being abandoned due to the introduction of subsidised treatments to prevent these ticks settling on the cattle. The water beetles, on the other hand, are collected in pockets of stagnant water when the streams dry at the beginning of the dry season, and are eaten roasted. Similarly, in Asia the giant water bug (Belostomatidae) is collected by the farmers and consumed as a delicacy (Srivastava *et al.*, 2009).

In addition, the medical use of a species of leaf footed bug from the family of Coreidae was also documented. Traditionally, the stink bug is mixed with spices, turned into a powder and then eaten to cure migraines. However, the bad smell of this arthropod and the existence of alternative methods to deal with migraines caused it to loose popularity, and currently it is rarely consumed. Therefore, the use of the leaf footed bug as medicine, although interesting, will not be discussed with further.

3 Also known as Fulani

B. COLLECTION OF EDIBLE INSECTS

Insects in the Wama communities are collected and cooked mainly by children between the age of 5 and 15 who practice this activity, mostly in groups (Fig 4). Insect hunting is principally carried out in the mornings and, less frequently, in the evenings, when temperatures are low and the insects are less active. Children generally use their hands - and sometimes sticks - to move the vegetation or to dig the ground to collect different insects. The insects are caught alive, and often their legs are removed to avoid them escaping easily. They are kept in containers such as empty bottles or jars, and are brought to the *concessions* where they are prepared for consumption. Processing is minimal: the less appetising parts - such as the legs, wings, head or the stomach content - are removed depending on the species. They are then cooked all together in a pan with shea butter, chilli and salt, or grilled directly on charcoal. Insects are shared amongst the group and are also distributed to smaller kids that did not necessarily participate in the collection.

The insect hunt is seen as a game, and as a way to perpetuate ancestral traditions and maintain the Wama cultural heritage. The catch is considered mainly as a snack rather than a meal as such. Insects are not viewed as comparable to other animal proteins such as chicken, beef or guinea fowl, by adults or children. This is not the case in other African regions, such as areas of Southern Nigeria where edible insects are conceived as a proper meal and source of nutrients, or among the Pedi of South Africa who prefer certain of their traditional insects to meat (Banjo *et al.*, 2006). Additionally, this activity has suffered from the shift towards prioritising primary school attendance, as children have less the time to pursue insect collections, which are now only possible on Wednesdays afternoons and on weekends when school is closed.

This form of entomophagy linked to childhood is in sharp contrast with many Sub-Saharan countries, where insect gathering is mostly an adult female activity (van Huis, 2003). One exception to the gathering of insects by children in the Wama groups is when the catch is considerable, as is the case for the emergence of the winged termites in August[4]. Here, both women and men collect the insects using mass collection techniques (van Huis, 2003) involving leaving large buckets of water under a light source at night. The winged termites are attracted to the light, but remain stuck to the water as they fall in the bucket. The collectors then dry them, prepare them, and often integrate them into sauces. A share of the catch is sold on the market.

No methods of mass collection are used for insects other than termites in the Wama communities. Although in the nineties the CRGB (Centre de Recherche et de Gestion de la Biodiversité) had introduced a technique to catch chafers using buckets of pineapple, bananas, and palm wine, this method was dropped over time because of the cost and the unavailability of such Southern products in the North of Benin. In addition, it was seen as excessively time consuming given that insect collection was becoming a more sporadic activity.

In conclusion, while being an important transmissible tradition and a defining element of the Wama identity - insect eating and preparation remains mostly localised, with only termites being commercialised and sold to non-Wama groups both in rural and urban centres.

4 Termites are also collected throughout the year as food for poultry. This is done by breaking the mounds found among the farmers' fields, where the arthropods cause damage to the millet and corn. The termite-filled earth from the mound is then brought back to the concession in a bucket for the chicken and guinea fowl.

LOCAL NAME
Locality
Family
Species Name
Collected from

NAGITASAMBI
Kotiakou
Bradyporidae
Gymnoproctus sculpturatus
Bush Grass, Millet

CHAUBAFRANCA
Kosso & Kotiakou
Acrididae
Truxalis spp.
Bush Grass

BAGA
Kosso
Grillydae
*Brachytrupes membranaceus**
Under mango trees

PIPIRU
Kosso & Kotiakou
Scarabaeidae
*Pachnoda cordata**
Bush Grass, Maize, Millet

FAPIPIRU
Kosso
Scarabaeidae
Gnathocera impressa
Bush Grass, Maize, Millet

KOKOUARÉ
Kosso
Buprestidae
*Sternocera interrupta**
Acacia trees

KOKOUARÉ
Kosso
Buprestidae
*Steraspis castanea**
Acacia trees

COTONDOUSRE
Kosso
Hydrophilidae
*Cybister sp.**
In still water pools

SOSORÉ
Kosso & Kotiakou
Acrididae
*Hieroglyphus africanus**
Bush Grass

MANCHOUGOU
Kosso & Kotiakou
Acrididae
*Acanthacris ruficornis citrina**
Bush Grass, Okra

MANCHOUGOU
Kosso & Kotiakou
Acrididae
*Ornithacris turbida cavroisi**
Bush Grass, Okra

FAPIPIRU
Kosso & Kotiakou
Scarabaeidae
Rhabdotis buchardi
Bush Grass, Maize, Millet

SOPIPIRU
Kosso & Kotiakou
Scarabaeidae
Gnathocera varians
Bush Grass, Maize, Millet

PIPISAE
Kosso & Kotiakou
Scarabaeidae
Pachnoda vossi
Bush Grass, Maize, Millet

PIPIRUNDI
Kosso
Scarabaeidae
Chondrorrhina abreviata
Bush Grass, Maize, Millet

NAGKOPTA
Kotiakou
Ixodidae
Unknown
On cattle

IIRIIRI
Kosso
Termitidae
*Macrotermes falciger**
Termite mounds

COMO COMO
Kosso & Kotiakou
Coreidae
Unknown
Bush Grass

Table3: List of arthropod species consumed by the Wama in North Benin (* species previously collected by S. Tchibozo, all the others are new specimens)


SAMSUNG

V. DISCUSSION

In the following section, we will explore several issues that were born out of the Wama case study in the in relation to extending entomophagy.

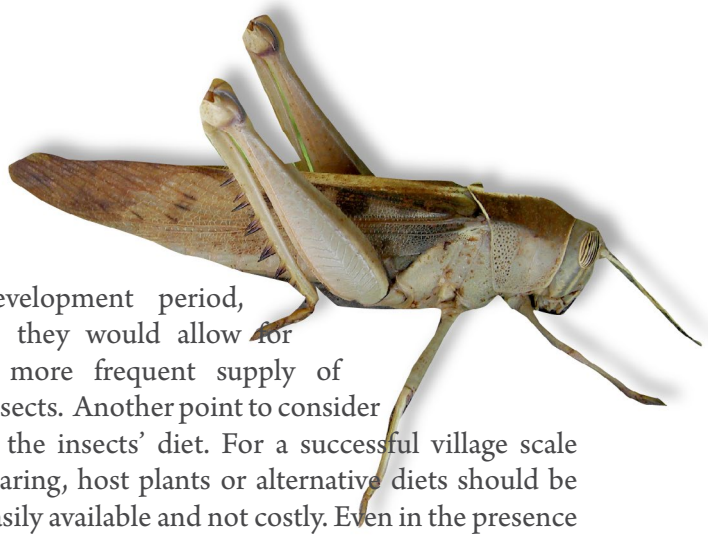
A. REVIEW OF REGIONAL PREFERENCES

Local preferences within groups that consume insects are strongly embedded, and have to be closely considered when working on the expansion of entomophagy. In fact, from the data collected across Benin we can observe that different ethnic groups have different consumption patterns. In the South the main insects consumed across different localities are larvae of *Oryctes spp* and *Rhynchophrus phoenicis* (Tchibozo *et al.*, 2005). In both cases the larvae are directly collected by the adults in palm trees. In contrast, the Wama from the North have a much more varied assemblage of edible insects, although they avoid eating any larvae for which they show a strong aversion (despite this being the most nutritious stage of the insect (van Huis, 2003)). These preferences could be related to the differences in climate between the North and the South of Benin, with grasshoppers and crickets being more common in the North of Benin, where high grass and bush savannahs dominate the landscape; whereas palm trees are only found in the less arid South.

Despite differences, similarities exist across Benin as well as across Africa. One such example is termites (*Macrotermes falciger*). Termites have been part of the human diet since prehistoric times (van Huis, 2003), with their sexual winged forms being the most popular today (Fig 5). Fried or dried termites contain 32-36% proteins (van Huis, 2003), they are also high in fat (48%) and iron (5.80 mg/100g) (Mumba and McDonald, 2006). The widespread practice of eating termites by different ethnic groups, as well as their high nutritional value, would make them a good starting point to expand the use of edible insects in the area, as their promotion could contribute to increasing the popularity and acceptability of entomophagy[5]. Nonetheless, when considering which insects are suitable for promotion, practical aspects also have to be considered, as explained in the following section.

5 Interestingly, in East Africa, termite mounds are often owned and protected by individual families (van Huis, 2003). Ownership of termite mounds could be an interesting prospective to explore in Benin. However care should be taken to avoid conflicts over the catch, and a good understanding of how many termite mounds are in the area and how to sustainable harvest them is essential as termite mounds are related to trees and deforestation could affect them.

B. INSECT REARING



In terms of promoting entomophagy, edible insects are to contribute to the alleviation of nutritional deficiencies, one must ensure the sufficient quantities are made available. The development of rearing methods for edible insects, rather than relying on natural harvesting would have the advantage of allowing for a continuous and abundant supply of insects, and thus permit a better integration of this rich source of nutrients into the daily diet. In fact, although Wama children consume insects and generally seem overall healthier than children from other villages, there are no studies that confirm that insects are consumed in adequate amounts or frequency to have a significant effect on their nutritional and health status.

Methods to mass rear insects in captivity already exist in many fields, including biological control (*Macrolophus spp*), waste management (*Hermetia illucens*), genetic research (*Drosophila spp*) and for pet food (*Tenebrio molitor, Zophobas morio, Galleria mellonella, Acheta domestica*), and lessons can be learned from these and be adapted to the Beninese context. Nonetheless, not all species are suited for rearing, especially with a moderate budget. For example, the seasonality of the preferred stage of termites and their ecology would make these insects unpractical to rear, despite the other advantages. In fact, certain factors have to be taken into account when evaluating what species would be successfully farmed. Firstly, life history of the insect is an important point to consider. Holometabolous development (complete metamorphosis) - common in coleopterans (*Chafers, Buprestidae*) - means that the adult stage and the offspring will not have the same ecological niche. These insects will require more investment to rear in captivity compared to hemimetabolous insects that have no pupae stage (*Orthopterans, Hemiptera*). For example, farmers in Thailand use cement tanks or wooden containers covered with a nylon nets filled with sandy loam soil and grasses and weeds for cricket farming (Gahukar, 2011). All stages are mixed together and adult crickets are partly harvested to keep the rearing going. Secondly, insects with short life cycles will also be more suitable for rearing than insects with a long development period, as they would allow for a more frequent supply of insects. Another point to consider is the insects' diet. For a successful village scale rearing, host plants or alternative diets should be easily available and not costly. Even in the presence of an artificial diet, such as is the case for the South American palm weevil (Cerda *et al.*, 2001), the cost of buying or manufacturing it will not be viable for many villages in Africa. Therefore ease of access to the insect diet is a necessity. Orthopterans are mostly generalist phytophagous who can feed on organic waste as well as wild gasses and weeds and offer an interesting avenue to pursue small scale farming. A third important point to consider is the seasonality and abiotic factors that may affect the fecundity and growth of the insects. Insects are typically seasonal due to food availability and temperatures. To successfully rear seasonal insects and have a continuous supply rather than relying on natural harvest it is therefore essential to know what is the range of temperatures the insect can sustain. This information will allow the rearing facilities in to be developed (indoors/outdoors).

Finally, nutritional value and consumer preference should be considered before implanting captive rearing projects. As mentioned above ethnic preference can vary at a very fine scale, and therefore these should be considered before implementing such programs. For example, if we consider developing rearing facilities with the Wama communities, since they do not consume larvae or caterpillars, the focus could be on Orthopterans for which low cost mass rearing technologies have already been developed in China, Korea, and Thailand (FAO 2010b, 2012) as well as in Europe and in the United States by pet food companies. Small scale farming of one of the three species of grasshoppers (*Hieroglyphus africanus, Acanthacris ruficornis citrina* and *Ornithacris turbida*) eaten by the Wama could be considered. However, because orthopterans tend to be generalist defoliators care should be taken to secure rearing and to avoid any escape into crops where they could become serious pests. In addition, not all insects offer the same

nutritional quality, and protein content may vary significantly between groups and species (Banjo *et al.*, 2005; Mumba and McDoald, 2006) (Fig6). Therefore it is important to promote traditional insect gathering on top of captive rearing of one species to offer maximum variety. Development of rearing facilities should not replace traditions and become the sole source of edible insects, as lack of diversity in the diet as well as quantity is the main cause of deficiencies in Benin (UNIDEA, 2006).

Nonetheless, although we have established that rearing insects could be an option to address food security issues, a lot of work has to be done to ensure that the views of the community are taken into account when envisaging such plans. In fact, their input is essential to the success of an insect rearing initiative, as it would allow the development of a scheme that would fit well with their lifestyle. This does not only concern the choice of insects, but also how and if they see the rearing of insects benefit them, the design of the cages so that it is user friendly and possibly replicable using local materials, the location for the cages so that they fit spatial arrangements within the community, the management of the rearing between people, the integration into diets of children and possible expansion into that of adults, etc. Implementers must remember that the communities are the main beneficiaries and known more about their context of living, and therefore must inform how the development of rearing will take place. They have to be willing to take up such scheme and to guide the implementation so that it becomes a sustainable solution, otherwise it will be abandoned with time, as we have learned with the fruit bucket technique.

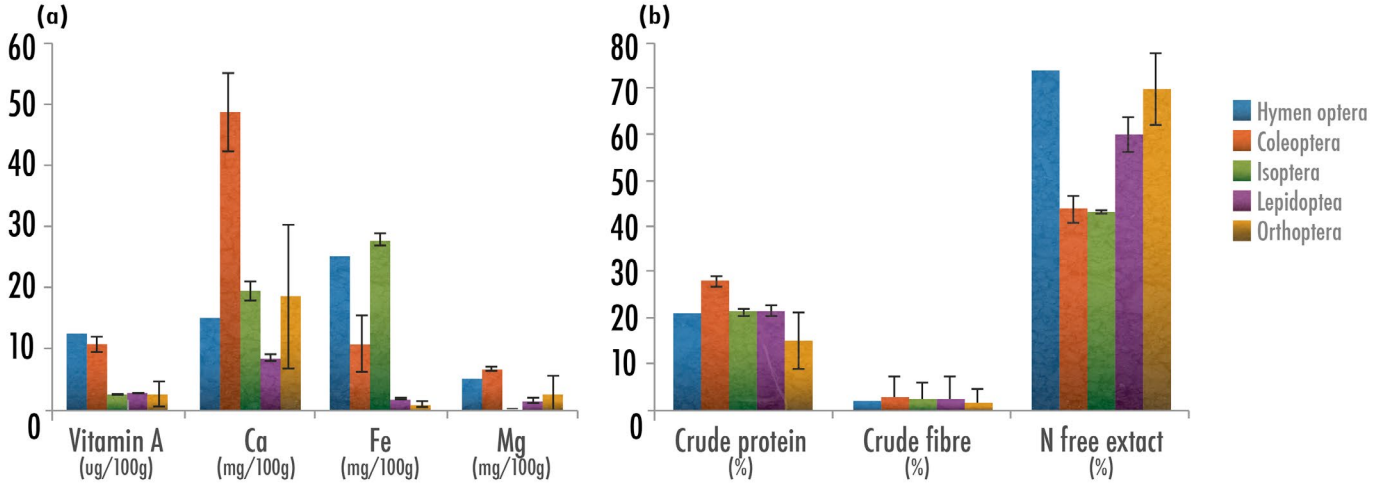


Figure 6: (a) Average Vitamin and mineral content and (b) Average proximate analysis (%) of major insects groups consumed in Nigeria (±1SE)(Hymenoptera n=1; Coleoptera n=3, Isoptera n=2; Lepidoptera n=5 and Orthoptera n=3) (Data modified from Banjo et al., 2005).

C. POTENTIAL APPLICATIONS

If entomophagy and, in particular, mini-livestock rearing is established in Benin, it is important to assess the most valuable applications, the actors to involve, the design and location of pilot projects, and how they could be replicated within the wider context. These issues are discussed in the following sections.

I. EDIBLE INSECTS AS A RESPONSE TO FOOD INSECURITY, PARTICULARLY CHILD MALNUTRITION

Edible insects can be seen as a way to respond to the problem of inadequate nutritional intake at different levels, with small scale and large scale propositions.

At the small community level, there are two solutions that could be encouraged. The first one is to develop awareness campaigns in order to maintain the tradition of entomophagy where it already exists. In fact, it would seem that entomophagy is practiced as a tradition, with limited knowledge of the nutritional benefits of the insects – although in the Wama communities there was a general belief that the insects were 'good for the children' and especially 'good for their growth'. These awareness initiatives can take the form of seminars or focus groups directed to the mothers, such as the focus groups concerning nutrition which are currently being established in Cotiakou by the Peace Corps. They could be designed to include the transmission of knowledge concerning the benefits of edible insects, hopefully translating into encouragement of entomophagy. Educational campaigns can also be addressed to children directly at school, in relation to subjects such as nutrition, health and/or traditions.

The second possibility could be to develop captive rearing facilities as stated above, in order to support consumption at local level. This could for example be supported by the Faculty Agronomy, in the department of Nutrition and Food Sciences of the University of Abomey Calavi (UAC), which is interested in developing small scale projects, or under national or international entities aiming to expand entomophagy for local consumption. Nonetheless, this solution does not necessarily fit all insect consuming communities as they function today. For example, currently developing rearing facilities was not a pressing priority for the Wama people of Kosso and Cotiakou. Dr Gbangboche of the Faculty of Agronomy of the UAC suggests that it would be appealing to start pursuing these small scale projects in communities which have shown an interest in insect rearing, as has been found in the area of Lokoli, South of Benin. These could serve as pilot projects to demonstrate the feasibility of localised insect farms, and lessons learned from these experiences could inform future projects in other areas.

On a larger scale, there is an opportunity to establish a more developed insect industry. This would include steps such as a conducting a market research on the insects that would work better for expected and targeted consumers in order to fit different preferences. Hence, specific species would be considered on the basis of the extent to of their acceptance by the consumers in terms of taste, appearance, and cultural acceptability. This aspect is particularly important, since the main adversity to insect is usually to its presentation as something that is unusual to their diets, as explained by Dr Gbangboche from the UAC. Based on these results, certain products can be designed, produced, packaged, marketed and distributed. Developing a supply chain of edible insects would be a complex issue, and would have to be complemented by a successful campaign promoting edible insects to overcome issues of perception, as discussed further on.

Nonetheless, there also has to be a choice of products to develop in accordance with the established target groups. Will the establishment

of an industry aim to serve the general population, or will it have specific objectives such as combating child malnutrition? For example, one of the most appealing suggested products aimed at malnourished children is insect flour conceived to be integrated into the maize based gruel which is given in health clinics re-establishment of the children. The gruel available today is fortified with minerals and vitamins, and certain mothers are taught to add little fish or peanuts to their child's food to make it more nourishing, but this could be replaced or complemented by protein-rich insect flour. This is one of the ideas that might be pursued by the IITA, which has an interest in establishing an edible insect industry in the scope of combatting food insecurity. The flour would be sold or distributed to hospitals and medical centres. Hypothetically, hospitals could also have their own insect rearing and processing units. This idea nonetheless depends on whether the costs of the new insect flour or setting up the rearing facilities would be competitive.

II. EDIBLE INSECTS AS A MEANS FOR AGRICULTURAL DIVERSIFICATION

On a small scale, collecting or rearing insects can be a source of agricultural diversification, and provide an additional source of income, as is demonstrated by the case of the termites. As described previously, termites are the only insect currently sold in the *commune* of Tanguieta, and are found in many other places. On top of their culinary properties, they are also a source of income for the household, contributing to economic diversification. In fact, termite sellers do not depend solely on this activity, but this forms a complementary source of profit when available.

This is particularly beneficial because winged termites appear in a period where crops are not yet ready for harvesting. This is made possible due to the fact that they are found in abundance, and therefore the volume of the termites collected is large enough to be sold at markets. Therefore, for economic benefits to be made from edible insects, quantity is essential, which once again points in the direction of insect farming.

Edible insects can also be a source of revenue at the industry level, hence allowing some economic diversification in a country that strongly suffers from over-reliance on few sectors. Nonetheless, for this to be profitable, economies of scale have to be achieved, which calls for mass production, along with the possibility of preserving the products, and adequate storing facilities. This calls for large scale investments to cover the initial start-up costs. Fortunately, other countries, for example neighbouring Burkina Faso where insects can be found in supermarkets in the region of Bobo Dioulasso, have proved that the commercialisation of edible insects in Africa is possible and can be remunerative. It is therefore important for the private sector to get involved, in addition to other interested institutions, as the profitability of the project could generate a push for investment and innovation.

III. EDIBLE INSECTS AS A PEST MANAGEMENT SOLUTION

In the literature entomophagy has been claimed as a potential means to help manage pests on agricultural crops. An example of pest management through - or complemented by - entomophagy is that of eating locusts, as occurs in many African countries where the sale of harvested and marketed locusts (*Locusta migratoria*) may yield more revenue for farmers than millet (van Huis, 2003). Another case is found in Thailand, where the Patanga locust (*Patanga succincta L.*) is one of the best known and most popular consumed insects. Consequently, this species is no longer a major pest for farmers, the high demand and price for Patanga locust led some farmers to grow maize to feed this insect, rather than to harvest the maize (FAO, 2010b).

In the case of the Wama settlements, although most of the insects consumed were pests, these did not seem to be considered a major problem. None of the pests damaged crops to a significant extent; this is probably due to the mosaic structure and small scale of the local agriculture. When asked whether the insects where eaten in order to keep the numbers down, the answer was negative. In fact, one interviewee explained that, on the contrary, there had to be an effort to keep

enough insects alive so that there can be enough to consume in the future. In the past the insect population had dwindled, and this had been seen as a problem by the community. Therefore, the Wama consider insects as a resource to be protected, and is managed communally by restraining depletion.

When asked whether the Wama had experienced locust invasions, the *délégué* of the village was not familiar with the French word for locusts, but seemed said that 'very big crickets' had arrived in large quantities only rarely in his lifetime[6], and had not been eaten. Although locust invasions have been documented in other areas and Locusta migratoria is eaten in Pénélan (locality in central Benin) (LINCAOCNET, 2012), it would seem that locust invasions are not frequent enough in the Atakora to have developed a transmissible tradition around it. Hence, entomophagy as a pest control system does not seem to be applicable in the case of Northern Benin, other than for the ticks that affect the Peulh discussed previously.

6 In fact, Benin escaped the Desert Locust invasion in 2004 which caused significant damage across West Africa, including neighbouring countries (IRIN, 2004)

VI. BARRIERS TO THE DEVELOPMENT OF ENTOMOPHAGY

A. LOSS OF TRADITION WITHIN INSECT-EATING COMMUNITIES

One of the barriers to consider is the tendency of many people in Benin to detach themselves from traditions which are not seen as 'modern'. As the majority of Benin's population does not practice entomophagy, there is a certain degree of stigmatisation attached to the consumption of insects. It is seen as a 'rural' or 'backwards' practice, born out of times of poverty and isolation from 'modern life'. Van Huis (2012) describes the phenomenon of not being proud of certain traditions, whereby certain cultures look up to Western lifestyles and hope to discard local practices. Interviewees claimed that, although in the village people felt comfortable eating insects, they did not necessarily feel at ease in telling non-insect consumers. As urbanisation increases, insect-eating is often dropped when people migrate to the city. Out migration of young men is high within the Wama settlements, either to other Beninese cities or to neighbouring countries, mainly Nigeria, as there is not enough food to support all members of the family. This means that many will live in non-Wama communities, and might not educate their children to eat insects, either in the fear of attracting prejudice, or due to the lack of ownership or availability of fields and land where collection can take place.

B. CULINARY HABITS AND LACK OF FAMILIARITY WITH EDIBLE INSECTS AMONG OTHER GROUPS

As mentioned above, entomophagy is not practiced by the majority of the population, and many feel a certain aversion to the idea of eating insects. Even in the areas where entomophagy is practiced, each ethnic group is very specific about what species of insects they are willing to eat and in which way. Hence, there are significant cultural barriers preventing the expansion of edible insects. Nonetheless, there are examples of countries where entomophagy has gained in popularity when appropriate approaches were followed (FAO, 2010b). It has been found that public demonstrations and trials of edible insects can be quite an effective way to promote these practices. For example, Dr Gbangboche of the UAC speaks of a very successful event held in Lokoli (South Benin) in the occasion of the International Woman's Day, where the group that ate *Rhychorphorus larvae* demonstrated of how they were collected and cooked, and were then made available for public to try. This attracted attention not only locally, but led different government members to follow up on the UAC's project on entomophagy. Currently, there is a lack of educational programs and information campaigns aimed at popularising edible insects, but these could prove to be effective means to increase interest.

Raising awareness on nutritional factors needs to be coupled with elements that make the products appealing. Benin is undergoing many changes, and in the last years has seen a vast range of new products enter the market. The successful ones were those that managed to meet expectations while remaining compatible with culinary uses. With detailed market research, appropriate products can be designed and promoted, to ensure coherent and successful results.

C. INSUFFICIENT RESEARCH

The research today on edible insects in the region remains insufficient, as more funding, stimulation and facilitation of cooperation with experts from different fields, such as entomologists, nutritional specialists, anthropologists, and economists is required. An up-to-date inventory of edible insects is needed, and would involve working with communities to learn more on which species they consider edible, as well as information on their biology, their collection, their preservation and their preparation. Risks, rearing options, nutritional properties and other relevant aspects for the insects which are specific to Benin also have to be evaluated. Additionally, there is an urgent need to document information and traditional stories because of the loss of local knowledge.

Finally, international collaborations remain quite scarce. Nonetheless, these could prove very useful, not just to advance research on insects but also on how to approach and involve communities, and develop economically viable and sustainable options. For example, the establishment of a global bank of edible insects may be the occasion for knowledge sharing and open new avenues in research and development, ultimately proving advantageous for food security projects.

D. LACK OF GOVERNMENT INVOLVEMENT

There is a considerable lack of investment and focus on edible insect by the government. For example, insects are completely absent from policies and initiatives aiming at improving food security. Nonetheless, for entomophagy to reach its full potential on a national scale, public support would be an effective push. Public authorities at different scales could play a significant role in promoting research, designing appropriate policies, formulating legislation, raising awareness and encouraging partnerships around the handling of edible insects. For instance, certain edible insect experts we met in Benin pointed to the need for greater public-private partnerships. The government could formulate adequate regulatory frameworks and provide incentives to investors that come up with business ideas on the production, transformation, and marketing of edible insects[7], or encourage local development of small scale insect farms by collaborating with NGOs[8].

7 For example, in Australia the government has funded research on the breeding of the exotic snail Helix aspera for the restaurant trade and for personal consumption (Begg, 2006).

8 For example, in Laos, regulatory authorities and universities encourage local farmers to develop on-farm insect rearing by teaching them how to build low cost mass rearing facilities

VII. CONCLUSION

The consumption of insects is not a major component of the diet in Benin today. It is confined to some groups, where it is in decline due to changing lifestyles as illustrated by this case study. The Wama eat a diverse and rich assembly of insects; however these are not fully integrated into their diet as they are considered a children's snack rather than a meal.

Although entomophagy as it stands has only a limited and localised impact on food security and nutritional deficiencies, there are enormous opportunities to develop and expand entomophagy in Benin. Most edible insects are difficult to collect in large numbers, are unpredictable in their occurrence and inappropriate harvesting could result in significant damage to both their population numbers and their habitats, therefore mass rearing of edible insects could be an appealing solution to increase their availability. This could result in applications such as (a) the human consumption of selected species; or (b) the use of insects to develop products such as a nutritive supplement in food for humans, especially for malnourished children. These initiatives would necessitate further research on raising insects from different habitats and working with specific communities or target groups. In fact, community participation in the design of such schemes, and the establishment of pilot projects among groups that demonstrate an interest in insect farming, are crucial elements to ensure the success of precedent setting initiatives. Additionally, the promotion of the sustainable harvesting, rearing and preparation of edible insects could benefit from, but also engender, further cross-continental collaboration on finding alternative food solutions, which is quite a topical area at the moment. In the meanwhile, there is an urgent need to document current practices in Benin, due to the progressive decline of traditional local knowledge that could eventually be lost forever. There could be more edible species, and it is necessary to learn how the various groups view, find, collect, cook and consume them.

In conclusion, through constructive partnership and collaborations between different stakeholders, and with the support of increased funding and interest, there is a scope for Benin to become another country that has successfully leveraged on the potential of entomophagy as a way to promoting livelihoods and sustainable forms of food. The Wama case study has shown the importance of edible insects in traditional lifestyles in a food insecure region – but also allowed us to formulate discussions pointing to many possible ideas that could make entomophagy a more durable and widespread reality.

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