CONTRIBUTION OF AUGOSOMA CENTAURUS BEETLE TO RURAL LIVELIHOODS IN THE EAST REGION OF CAMEROON

STUDY REPORT

FOGOH John MUAFOR

Philippe LE GALL

Patrice LEVANG

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ABSTRACT

This report describes the level to which forest dependent people in the East region of Cameroon rely on the consumption of *Augosoma centaurus* beetle (*Dynastidae*) for food security and rural livelihood. In total, 14 villages and 2 small towns, comprising of 9 ethnic groups in 10 sub-divisions were surveyed using quantitative and qualitative socioeconomic approaches. From the results of this study, both the larvae and adult individuals of the Augosoma beetle are traditional delicacy in most parts of East Cameroon. About 37% of respondents appreciate the consumption of the Augosoma beetle more than any other group of protein (other edible insects, meat and fish), while 24% and 39% respectively derive the same satisfaction or appreciate less the consumption of Augosoma, compared to other sources of protein. Regarding the period of occurrence of the Augosoma beetle, its abundance and its non destructive mode of harvesting, the gathering of this beetle for food constitutes a non negligible source of protein that can be valorized as a good alternative in efforts to solve the problem of poverty, poaching and hunger in the East region of Cameroon.

1- INTRODUCTION

1-1 Background

Edible insects are important forest resources that contribute to livelihood in most regions across the world. Though forest insects are usually less mentioned amongst the precious Non Timber Forest Products (NTFPs), they play a great role in livelihood improvement in most developing countries (Muafor et *al*., 2012). Apart from the fundamental contribution of forest insects in pollen dissemination and forest ecosystems stability, they constitute an important source of protein to forest dependent people in many parts of developing tropical countries (FAO, 1995; Stack et *al*., 2003). Some insects are also used as medicine in many traditional medical and/or sometimes modern medical practices (Lupoli, 2010). In Africa, Asia and Latin America, hundreds of forest insect species are used as human food (Banjo et *al*., 2006). In some parts of these regions where many poor people can hardly afford for ordinary sources of protein like meat and fish, forest dependent people rely on insects to fulfill their protein needs.

Though it is generally accepted that forest insects can contribute enormously to rural livelihood in Sub Sahara Africa, authors however, have different views on the extent to which forest people rely on insects for food. According to FAO (1995), forest insects are important NTFPs that are mostly gathered by poor people for food, particularly women and children. De Foliart (1992) considers forest insects as an occasional delicacy that is used as food replacement in times of shortages, droughts, floods or war. These views are completely different from that of Banjo et *al*. (2006), who reported that forest insects are ordinarily not only gathered by the poor or used as emergency food during shortages, but are included as a planned part of the diet throughout the year or when seasonally available.

Many groups (taxa) of forest insects are eaten in the Sub Sahara African region, amongst which, grasshoppers, crickets, caterpillars, palm beetle grub and termites are the most popular. Some studies have been done on rural dependence on edible insects in Central Africa. Yet, little has been documented on the exact number of edible insect species. Consequently, information on many edible insect species in Central Africa is still very poorly known and their contribution to food security and poverty alleviation are still very inadequately studied. However, few studies indicate that edible forest insects play an

important role in rural livelihood in Central Africa. Malaisse (1997) gives an overview of the nutritional values of various caterpillar species. N'Gasse looks at the contribution of commercial caterpillars to food security in Central African Republic (N'Gasse, 2003). Tabuna (2000) reports on the quantity of *Imbrasia spp.* (caterpillar) that is annually imported from the Democratic Republic of Congo to France and Belgium. Dounias (1999), reports on people dependence on the white palm beetle grub *Rhynchophorus phoenicis* in Cameroon. De Foliart looked at the human use of insects as a food resource in Central Africa and Vantomme et *al*. (2004) looked at the contribution of forest insects, notably caterpillars to food security and forest conservation in Central Africa.

Apart from the palm beetle grub (*Rhynchophorus phoenicis*), none of these studies look at the role of beetles in rural subsistence in Central Africa. Yet, many beetles are gathered for food in this part of the world. In the East region of Cameroon for example, both the larvae and adults of the *Augosoma centaurus* beetle are cultural delicacy which are highly gathered in periods of availability.

1-2 Problem statement

The welfare of human population is one of the most important aspects of sustainable forest management. To this effect, forest management has recognized the role of NTFPs in rural livelihoods and actions to valorize and sustainably manage diverse NTFPs have been undertaken by different actors (conservationists, policy makers, civil societies, etc.). In most cases, the recognition of the NTFPs and their uses is the fundamental action towards sustainable management. Though much has been done to recognize and valorize the NTFPs of the forests of Cameroon, only a few of these actions deal with forest insects. However, few studies on edible forest insects focused on caterpillars, the palm/raffia beetle grub, crickets and termites (Dounias, 1999; De Foliart 1992; Balinga, 2003; Vantomme et *al*., 2004).

A number of forest insects with good potential are poorly known and/or yet to be valorized. Amongst these are different species of beetles which are exploited for food and/or income. Little is known of endemic beetles like the white forms of *Goliathus goliatus* and *Fornasinius aureosparsus* which are exploited in the Southwest region of Cameroon for trade in the international market (Muafor et *al*., 2012), or the *Augosoma centaurus* which are highly consumed in the East region of Cameroon. Consequently these periodically available and

beneficial beetles are usually not listed amongst the important NTFPs of Cameroon. With increasing need for alternatives to tackle the world major problems (poverty, food security, biodiversity erosion, climate change, etc.), the potentials of forest insects as NTFPs need to be reconsidered. Therefore, useful forest insects must be identified and valorized to increase the scope of resources that could serve as rural alternative in a participative forest management approach. This report provides information on the level to which forest dependent people in the East region of Cameroon rely on the gathering of the *Augosoma centaurus* for livelihood.

1-3 Objectives

The general objective of this report is to provide information on the level to which forest dependent people in the East region of Cameroon rely on the gathering of *Augosoma centaurus* beetle for their livelihood. Specifically, the report provides information on:

- The different areas where *Augosoma centaurus* beetle is eaten in the East region of Cameroon;
- The period of availability, harvesting and processing of the *Augosoma centaurus* beetle for consumption;
- The possible local market for the *Augosoma centaurus* beetle in the East region and beyond;
- The possible ecological niche of the larvae stage of the *Augosoma centaurus* beetle.

2- CONTRIBUTION OF EDIBLE INSECTS TO FOOD SECURITY

2-1 Edible insect taxa in the world

The number of insects that are actually eaten as food is yet to be fully described, but many authors have provided estimates that are quite enthralling. According to DeFoliart (1997), about 1000 species of insects are eaten worldwide. The number of species of edible insects in Africa is particularly high, for example 30 species of insects are eaten in Congo, 22 in Madagascar, 36 in South Africa, 62 in the Democratic Republic of Congo and 32 in Zimbabwe (DeFoliart, 1997). According to Ramos-Elorduy (1997), about 1391 species of insects are eaten worldwide, of which 524 are eaten in 34 countries of Africa, representing 38% of all species consumed. Amongst the known most important countries where insects are eaten in Africa, the Central African Republic tops the list with 185 species, followed by the Democratic Republic of Congo with 51 species and Zambia with 33 species (Ramos-Elorduy,

1997). Out of the 1391 edible insect species listed by Ramos-Elorduy (1997), 24% belong to the *Coleoptera* order, 22% belongs to the *Hymenoptera*, 17% are *Orthoptera*, 16% are *Lepidoptera*, 7% are *Heteroptera*, 5% are *Homoptera*, 3% are *Isoptera*, 2% are *Diptera* and others 4%. These estimates are very conventional, since very little research has been conducted on human entomophagy in sub-Saharan Africa (Van Huis, 2003). In countries where intensive research has taken place, the numbers of edible insect species are impressive (Van Huis, 2003). In Mexico for example, Ramos-Elorduy (1997) listed 348 species of edible insects, while Malaisse (1997) listed 38 different species of caterpillars that are consumed in the Bemba region of Zambia, D.R. Congo and Zimbabwe.

2-2 Nutritional value of forest insects

Forest insects are nutritionally very rich and can effectively serve as substitute to meat and fish in periods of availability. Some edible insects are very rich in proteins, fat and energy values, while others are rich sources of important vitamins and minerals (Dreyer and Wehmeyer, 1982). Compared to beef and fish, insects have almost the same proportion of proteins, fat and energy value (Malaisse, 1997). They are also rich in vitamins such as VitB1, VitB12, VitB6 and mineral salts, especially iron and calcium (De Foliart, 1992). Research has shown that 100 grams of cooked insects provide more than 100 percent of the daily requirements of the respective contained vitamins/minerals (De Foliart, 1992). A comparison of the nutritive value of some edible insects and other sources of protein like meat and fish is given in table 1 below:

Table 1: Comparison of the nutritive value of some edible insects, meat and fish

Foods	Moisture (%)	Proteins (g)	Fat (g)	Carbohydrates [g]	Energy value [kcal]
Fresh caterpillars	81.1	10.6	2.7	4.2	86
Dried caterpillars	9.1	52.9	15.4	16.9	430
Fried caterpillars	20.4	62.3	4.6	6.5	333
Fresh, semi-boiled beef	63.1	18.2	17.7	0	273
Dried, salted beef	29.4	55.4	1.5	0	250
Cooked beef	68.5	22.6	8.0	0	172
Fresh fish	73.7	18.8	2.5	0	103
Dried, salted fish	13.8	47.3	7.4	0	269
Cooked fish	82.1	16.6	0.3	0	74

Source: Wu Leung, et al. 1970.

Proteins from insects are low in specific amino acids such as methionine and cysteine, but are very high in lysine and threonine (De Foliart, 1992). According to Dreyer and Wehmeyer, proteins from insects are relatively of lower quality than those of vertebrate animal due to the presence of chitin (Dreyer and Wehmeyer, 1982). However, depending on the species, insects are richer in different minerals (K, Ca, Mg, Zn, P and Fe) and/or vitamins, like thiamine/B1, riboflavin/B2, pyridoxine/B6, pantothenic acid and niacin (Dreyer and Wehmeyer, 1982). According to Malaisse (1997), the daily consumption of 50 grams of dried caterpillars meets the human needs of riboflavin and pantothenic acid as well as 30 percent of the need for niacin.

However, although insects are quite rich and are highly appreciated by many forests dwelling people, some could be toxic if improperly prepared. The consumption of caterpillars with hairs containing toxic substances can be very dangerous if consumed without properly removing the hairs (Tango Muyay, 1981). In order to prevent the toxicity of hairy caterpillars, the caterpillars are first grilled to remove the bristles, which otherwise would cause an intense and disagreeable itching (Tango Muyay, 1981). When grasshoppers and locusts are consumed without removing the legs, intestinal constipation may equally occur, caused by the large spines on the tibia (Bouvier, 1945). Surgical removal of locust legs is then often the only remedy. Autopsy of dead monkeys during locust invasions also showed that the consumption of locusts proved to be fatal for the same reason (Van Huis, 2003).

3- MATERIAL AND METHODS

3-1 Description of the study area

The study was conducted in selected villages and small towns in the East region of Cameroon (Figure 1). The East region is the largest region in Cameroon, with a total surface area of about 109,011 km². It is bordered to the east by the Central African Republic, to the south by Republic of Congo, to the north by the Adamawa Region, and to the west by the Centre and South Regions. Historically, the peoples of the East have been settled in Cameroonian territory for longer than any other of the country's many ethnic groups, the first inhabitants being the Baka (or Babinga) pygmies. The climate of this region is of wet equatorial type (Guinea climate type). Temperatures are high (24˚C on average), with four seasons; a long dry season from December to May, a light wet season from May to June, a short dry season

from July to October, and a heavy wet season from October to November. Humidity and cloud cover are relatively high, and precipitation averages 1500–2000 mm per year except in the extreme eastern and northern portions, where it is slightly less. The soil of the East is predominantly ferrallitic, rich with iron and red in color. The southern three quarters of the region consists of metamorphic rock such as gneiss, schist, mica, and migmatite. However, starting at about the level of Bertoua and going north, granite becomes the major soil component.

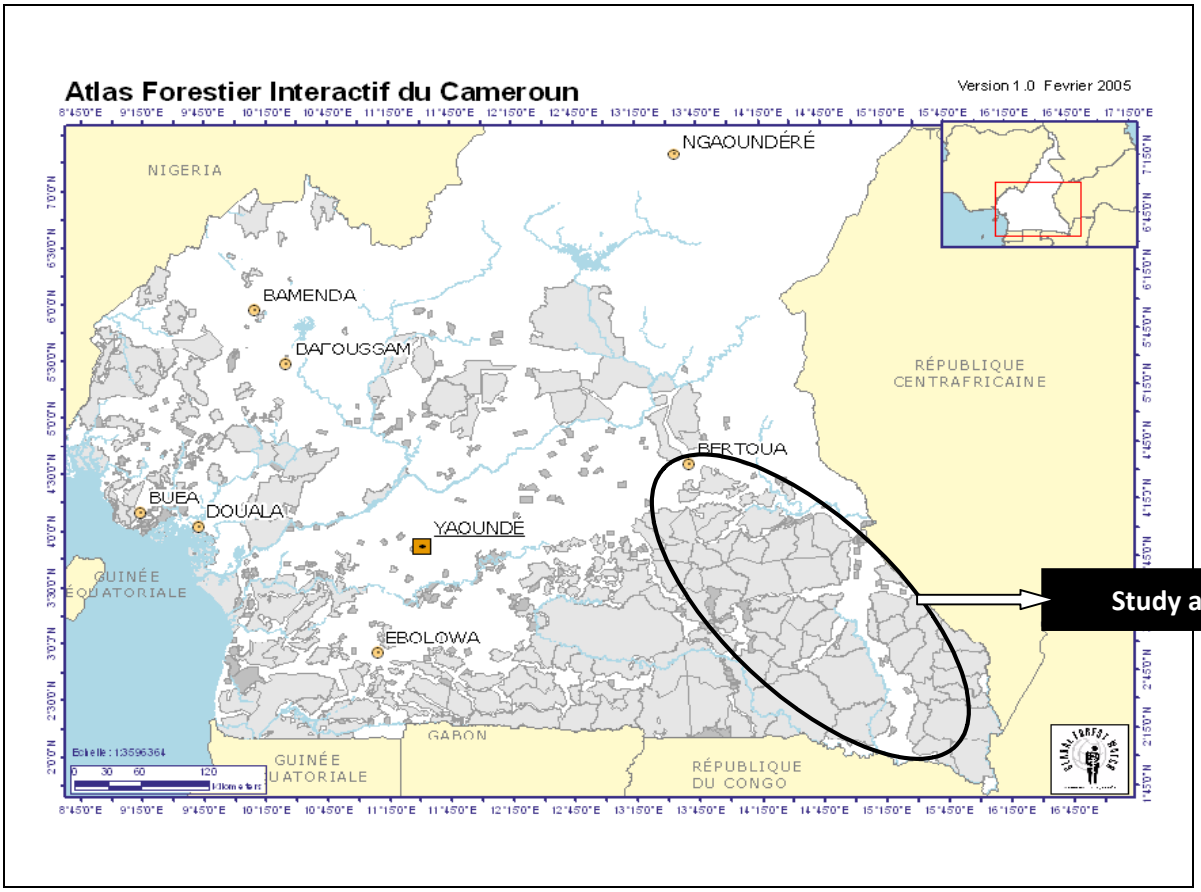

Figure 1: Map of Cameroon, showing the study area.

Almost the entire territory of the East Province lies on the South Cameroon Plateau that forms the southeastern half of the country. The elevation varies thus between 200 and 1000 meters above sea level. The region contains several river systems, amongst which the Nyong, which drains the central-western area, the Dja in the southwest, the Lom in the northeast, the Kadéï (Kadei), which drains the northwest, the Boumba in the centre and southeast, and the Sangha and Ngoko, which drain portions of the southeast and form the border with the Central African Republic and Congo respectively. The Lom and Nyong rivers flow into the Atlantic Ocean, while all the others form part of the Congo River basin. The vegetation of the area is

predominantly that of a rain forest type. The forests are dominated by hardwood evergreens species, some of which grow to heights of 70 meters or more, such as Ayous (*Triplochyton scleroylon*), Sapelli (*Entandrophagma cylindricum*), Fraké (*Terminalia superba*), Tali (*Erytrophleum ivorense*), Kotibé (*Nesogordia papaverifera*), Kossipo (*Entandrophragma candolei*), Dibetou (*Lovoa trichilioides*), Padouk rouge (*Pterocarpus soyauxii*), Eyong (*Eribloma oblogum*) and Diana (*Celtis zenkeri*). Nonetheless, the portion of the region between Bertoua and Batouri is dominated by humid, wooded savanna. Trees here are sparser, but still may grow to be as tall as 20 meters.

3-2 Description of the biological material

The genus *Augosoma* (Figure 2) comprises forest insects of the order *Coleoptera (*beetles) and family *Dynastidae.* They are the biggest *Dynastidae* species in Africa and they measure between 40 mm to 90 mm in length. The males show cephalic and thoracic horns which are exceptional in African beetles and specific of the tribe *Dynastini*. The females are similar to the males, except that they have no horns and the length of the anterior tibia which are shorter than in the males. This genus is the only representative of the *Dynastini* tribe in Africa. The genus is represented by two species:

- *A. centaurus* whis has been described by Fabricius in 1775, largely distributed all over the tropical Africa from 10° N to 10° S, especially in the forested western part of that area in Guinea, Ivory Coast, Ghana, Togo, Bénin, Nigeria, Cameroon, the Congos.
- *A. hippocrates* which was described in 1995 by Milani from Gabon, where it seems endemic.

In most cases, *Augosoma centaurus* occurs in very large numbers and can constitute a major pest to some forest plant species, especially palm trees, coconut trees and eucalyptus trees (Venard-Combes & Mariau, 1983; Diabangouaya, 1994). The adults of this beetle are attracted to the apical buds and the phloem producing stems of theses tress. These parts of the trees constitute an important source of food for the *Augosoma* beetle feed and they can constitute a major pest to these plant species. Though this beetle has been reported to constitute a major pest of some palm tree species, the larvae of other big *Dynastidae* beetles equally live in the stems of palms and it is at times difficult to distinguish the different larvae

by a non specialist. Adult are usually attracted to light in villages at the forest edge, where they are easily gathered by simple hand-picking.

Figure 2: A couple of the Augosoma centaurs beetle

They occur generally at the beginning of the dry season, constituting therefore a potential source of protein at a period when other groups of edible insects like caterpillars and termites are no longer available.

3-3 Field methods

Data were collected by four field investigators for a period of 7 days from November 14th to November 21st 2012. Both quantitative and qualitative social science methods were used in collecting data (Acharya, 2005). In total, 14 villages and 2 small towns were surveyed, comprising of 9 ethnic groups in 10 sub-divisions in the East region of Cameroon (Table 2).
Direct observations were equally done in each of the households to find out if a stock of Augosoma or any other insect had recently been gathered for consumption. In either approach, questions were asked on the consumption, trade, harvesting methods and host plant species of Augosoma (larvae and adults) and other edible insects. The villages and towns were randomly selected and surveyed through the help of participatory rural appraisal (PRA) tools like semi-structured questionnaires, interviews and field observations. In each of the village, 10 semi-structured questionnaires were randomly distributed to men and women of age above 18 years.

Table 2: Villages sampled for the Augosoma beetle consumption in the East region of Cameroon

VILLAGE	TRIBES	SUB DIVISION	DIVISION
Ngatto	Konabembe	Yokadouma	Boumba and Ngoko
Salapoumbe	Baka and Bagando	Salapoumbe	Boumba and Ngoko
Wesso	Kakor	Gari Gombo	Boumba and Ngoko
Yokadouma	Mbimo	Yokadouma	Boumba and Ngoko
Mbwam	Makaa du Nord	Diang	Lom and Djerem
Belabo	Bobilis	Belabo	Lom and Djerem
Essendjiane	Bobilis	Belabo	Lom and Djerem
Ndemba II	Bobilis	Belabo	Lom and Djerem
Tikonde	Kakor	Batouri	Kadei
Ngotto	Kakor	Ndellele	Kadei
Ndoumbé	Baya	Mandjou	Lom and Djerem
Mboulaye I	Baya	Mandjou	Lom and Djerem
Ngounté	Baya	Mandjou	Lom and Djerem
Adingkal	Baya	Mandjou	Lom and Djerem
Kwen	Bakoum	Dimako	Upper Nyong
Petitpaki	Bakoum	Doumé	Upper Nyong

In total, 160 semi-structured questionnaires were distributed in all the 16 villages. After filling the questionnaires, 10 households were equally visited and the occupants interviewed orally.

Figure 3: Data collection by questionnaires, interview and group discussion

3-4 Data analysis

Collected data were analyzed using Excel 7.0 and SPSS software. In order to facilitate the analysis, themes emerging from the interviewee responses were coded. For each question, a separate running list of codes was reserved and new codes created as new themes emerged. To eliminate conceptual redundancies, the same codes were used for similar themes or issues. This coding process allowed the answers given in narrative form to be listed in the form of one word or a short phrase in order to facilitate analyses.

4- RESULTS AND DISCUSSION

4-1 The range and level of *Augosoma centaurus* consumption in East Cameroon

The Augosoma beetle is considered as a delicacy in the East region of Cameroon. Both the larvae and adult individuals of this beetle are consumed in most parts of the East region. Within the context of this study, a number of villages have been identified as important zones for Augosoma beetle consumption in the East region of Cameroon (Figure 4).

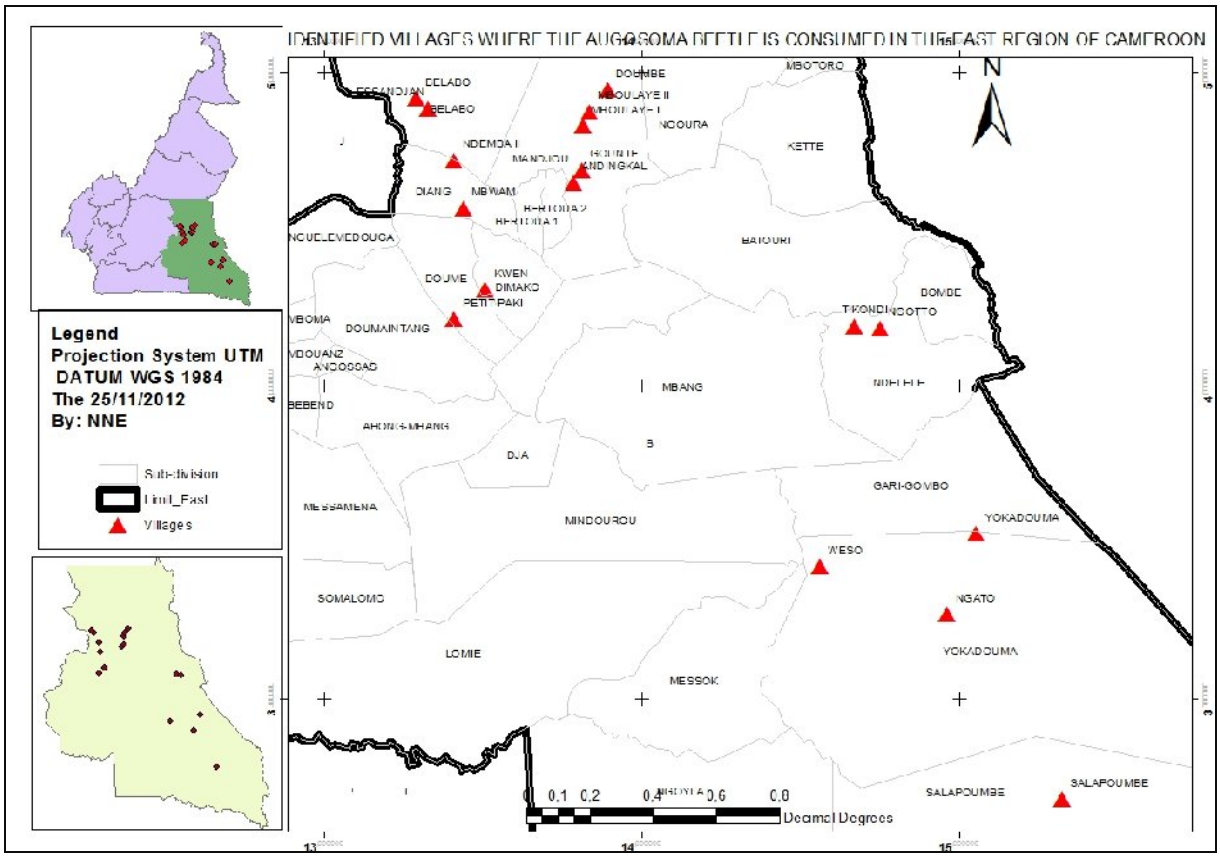

Figure 4: Identified villages where the Augosoma beetle is consumed in East Cameroon

The western part of this province (Messamena, Somalomo and Lomie) was not surveyed and no information is available on whether the Augosoma beetle is eaten in these areas. Other areas which were not surveyed but which were equally reported to be important zones for Augosoma beetle consumption include the Doumaintang, Mboma, Angossas and Moloundu neighborhoods. In the areas studied, both the adult and the larvae stage of the Augosoma beetle have vernacular names (Table 3).

Table 3: Vernacular names of Augosoma larvae and adult in the villages and tribes of East Cameroon

Villages	Ethnic group	Local name of adult Augosoma beetle	Local name of Augosoma beetle larvae
Salapoumbe	Baka	Angombo	Kpulu
Yokadouma	Mbimo		Gogoro
Ngatto	Konabembe	Angombo	Penbe
Kwen	Bakoum	Kouala	Bekouala
Petitpaki	Bakoum		
Ndemba II	Bobilis	Goubla	Bikuta
Belabo	Bobilis		
Essendjane	Bobilis		
Tikonde	Kakor	Angomkumbo	Kwatto
Ngotto	Kakor	Angiyong	Nakumbe
Weso	Kakor		Kuru
Mbwam	Makaa du Nord	Goubla (Bola)	Mekuma
Mboulaye I	Baya	Abankubu (Agwankubu)	Andossi
Ndoumbé	Baya		
Adingkal	Baya		

In some tribes, the vernacular appellation of either the adult or larvae Augodoma is the same in all the villages, while in some tribes, the vernacular appellation of this beetle varies slightly from one village to the other.

Apart from the Augosoma beetle, other forest insects which are equally consumed as cultural delicacy in the east region of Cameroon include caterpillars, palm beetle grubs, termites, grasshoppers and crickets. The vernacular appellations of these edible insects in the different tribes are given the Table 4 below.

Table 4: Vernacular names of other edible insects in East Cameroon

Common Names	Ethnic groups							
	Konabembe	Baka/ Bagando	Makaa	Bobilis	Mbimo	Kakor	Baya	Bakoum
Palm beetle grub	Upos	Poseh	Poushe	Nyol	Ping	Kuru (Kwatto)	Andossi	Nyol
Caterpillars	Mikoh	Kopoh	Kong	Kong	Kong	Kong	Dok	Kong
Termites	-	Bandi	Chumli	Somli	Bandi	Ndongoh	Doule (deuille)	Pel
Crickets	-	-	Lanli	Nyandombe	Agara	-	Corbongo	Ambasana
Grasshoppers	-	-	Nyadombeh (Ebileh)	Tamkunda		Anoli	Nguiri	Tamtole

4-2 Consumption preference of Augosoma beetle

The consumption of insects is an old habit in East Cameroon. Amongst the insects that are highly appreciated, the Augosoma beetle (both larvae and adult stage) is one of the most widely consumed. In all the villages, the number of respondents that eat the Augosoma beetle was quite higher than those who do not eat the beetle (Figure 5).

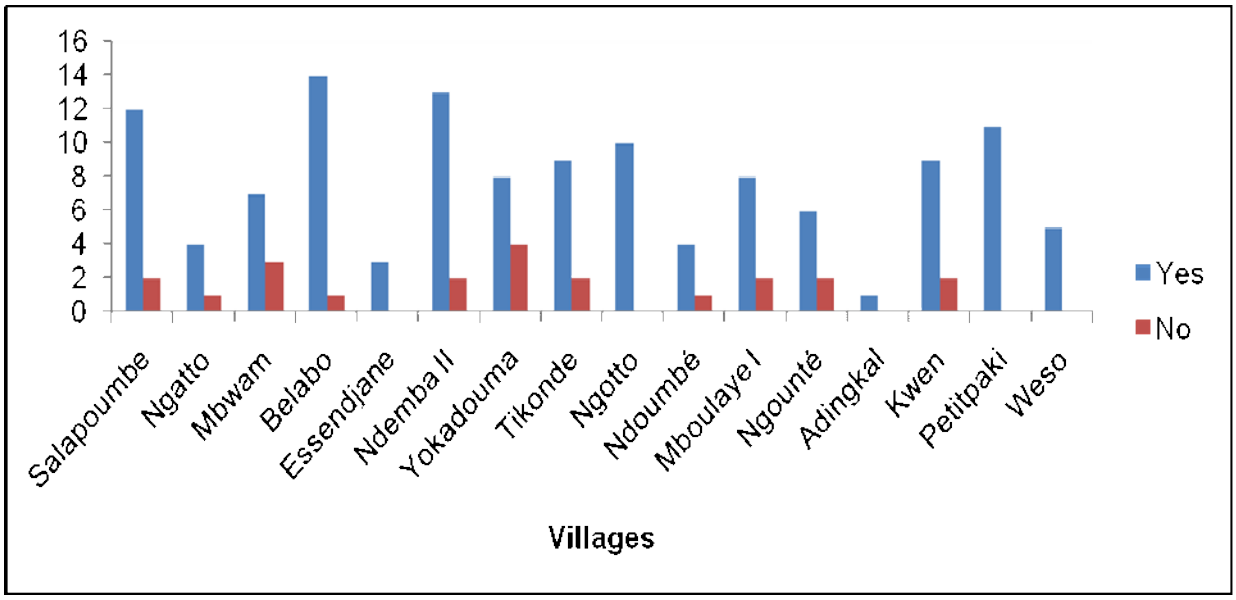

Figure 5: Number of respondents that consume the Augosoma beetle in each village sampled

In terms of preference, the opinion of respondents varies globally. Some consumers consider the Augosoma beetle to be of the same value as other sources of protein (meat, fish and other edible insects), while others appreciate less the consumption of Augosoma beetle to other protein sources. Figure 6 gives indication on local appreciation of the Augosoma beetle consumption, compared to other sources of proteins.

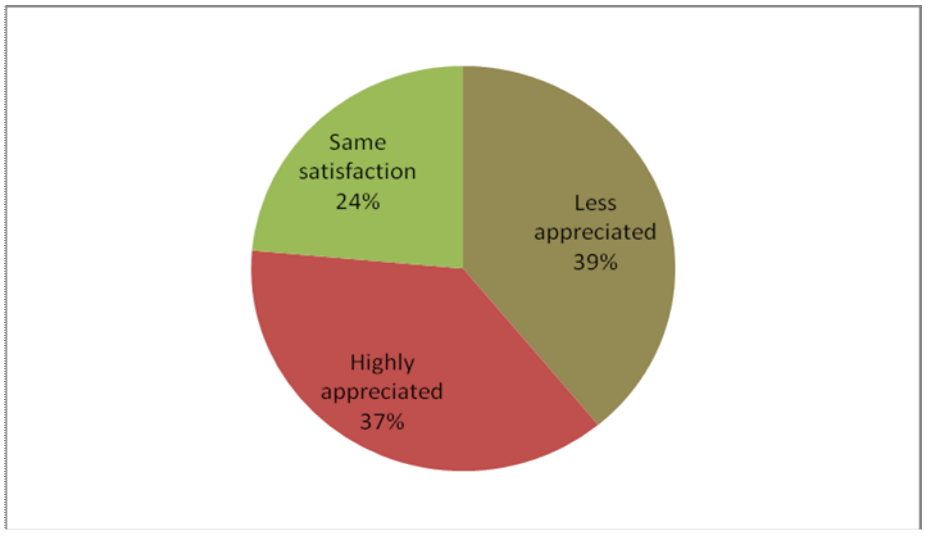

Figure 6: Level of appreciation of Augosoma beetle consumption in the East region

About 37% of respondents appreciate the consumption of the Augosoma beetle more than any other source of protein (other edible insects, meat and fish), while 24% and 39% respectively either derive the same satisfaction or appreciate less the consumption of Augosoma, compared to other sources of protein. Though the proportion of people that appreciate the consumption of Augosoma beetle is high, the preference of Augosoma larvae and adult is however not the same in the different villages and ethnic groups. In some villages/groups, people prefer consuming the Augosoma larvae (grub), while in others, the adult beetle is highly appreciated. Figure 7 gives details on how the different groups prefer the consumption of the Augosoma beetle.

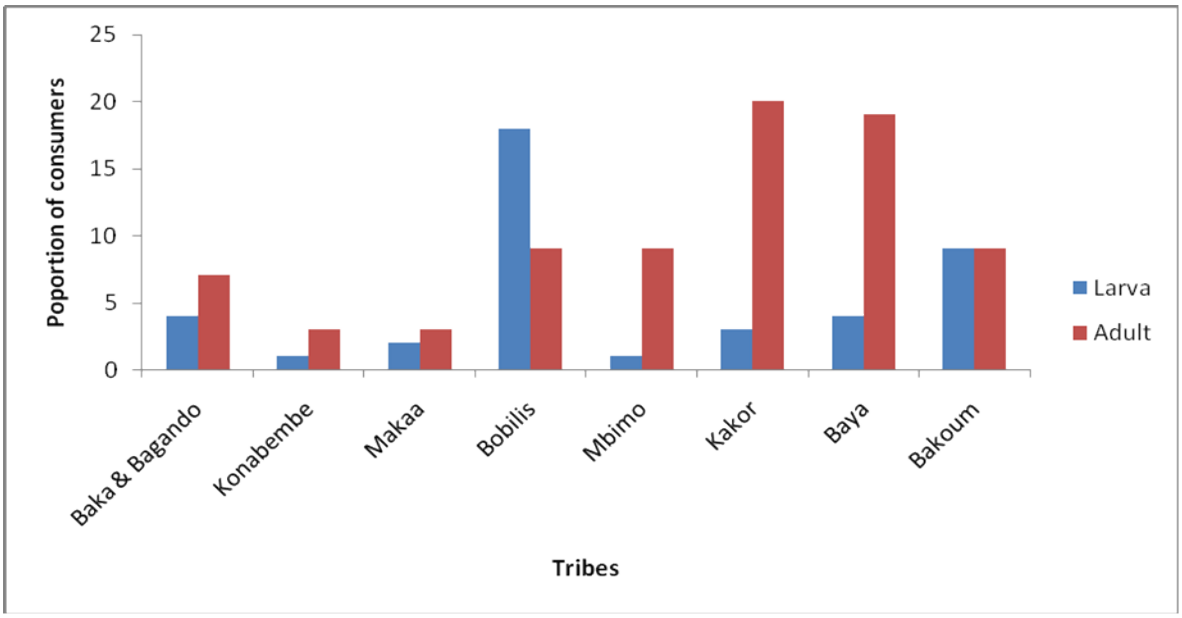

Figure 7: Consumption preference of Augosoma larvae and adult in the different groups

Villages of the Kakor, Baya, Mbimo, Konabembe, Makaa du Nord, Bagando and Baka ethnic groups consume more the adult Augosoma beetle, while the Bobilis and the Bakoum like more the larvae stage of the beetle. Globally, the people of the Bobilis groups are the highest consumers of the Augosoma beetle (larvae and adult included). Figure 8 below compare the level of consumption of the Augosoma beetle in the different groups.

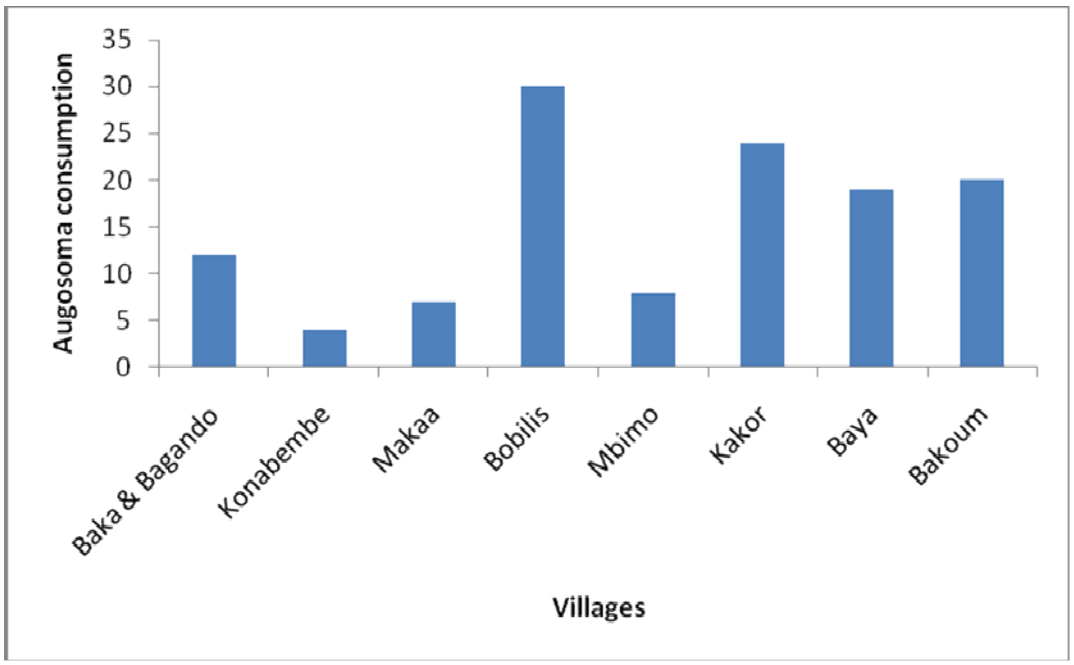

Figure 8: Comparison of the level of Augosoma consumption in the different groups.

The level to which people from the different ethnic groups consume the Augosoma beetle depends directly on the abundance of this beetle. In villages around the Bobilis tribe, this beetle occurs in very large numbers, compared to villages of the Konabembe groups where the population of the Augosoma beetle is relatively low.

4-3 Period of availability, harvesting and processing of Augosoma for consumption

4-3-1 Period of occurrence or availability of the Augosoma beetle

The adult Augosoma beetle is occurring seasonally. However, the abundance of this insect varies widely from year to year due to natural factors. According to respondents, there is an outbreak of this beetle every two years. Whatever, adult Augosoma are usually gathered between the months of November and December. The larvae of the Augosoma beetle are available throughout the year. When someone is in need of the Augosoma larvae at any instant, the person simply goes to the swampy forest and harvests the larvae from dead stems of raffia or pandanus plants. The exploitation of Augosoma beetle constitutes an important source of alternative protein in the east region, considering the fact that like the palm beetle grub, it provides opportunity for insect protein source at periods when most edible insects are not available (Table 5).

Tableau 5: Periods of availability of edible insects in the East region of Cameroon

Common names	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Caterpillars												
Palm beetle grub												
Adult Augosoma beetle												
Augosoma larvae												
Termites												
Grasshoppers												
Locusts												

Harvested Augosoma beetle are hardly preserved for a long period of time, as it is the case of caterpillars and termites. Consequently, almost the totality of harvested Augosoma is consumed during the harvesting period.

4-3-2 Harvesting of the Augosoma beetle

Adult Augosoma beetles are harvested on public street lights at night and on locally known Augosoma attractive (host) plant species. In electrified villages, this beetle is attracted to light during seasons of occurrence. As the beetles arrive on electrified spots, they settle on the ground or on objects around the electrified environment and are gathered by simply picking by hands (Figure 9). Large amounts of the adult Augosoma beetle are collected by this method, especially in forest logging areas where good public lamps have been installed by logging companies. In seasons of occurrence, local people spend a greater part of their nights on electrified spots in order to gather adult Augosoma beetles attracted by light. In very favorable seasons, gatherers can fill a bucket of 5 liters capacity with the Augosoma beetle for a single night of effective gathering.

Figure 9: Augosoma centaur beetles attracted to light at night

In areas where electricity is limited, this beetle is harvested on Augosoma attractive (host) plant species, mostly Raffia (*Raphia hookeri*) and Pandanus (*Pandanus candelabrum*). These plants are all adapted to swampy areas, where they form a colony and occur in large numbers (Fig 10). The adult beetles feed on the apical buds and the phloem producing stems, while the larvae bore into the stems of these plants.

A B C

Figure 10:Hostplant species of Augosoma centaurs beetle (A= old colony of Pandanus, B= young colony of Pandanus and C=raffia)

In order to collect the Augosoma beetle, local people walk across the swampy forest of raffia or Pandanus and observe the buds and stems of each of the plants present. Once a beetle is seen on a plant, it is collected by simple hand-picking technique (Figure 11).

Figure 11: A Baka child with a couple of Augosoma beetle caught from a young Pandanus plant

This technique of harvesting however, does not allow for large stock gathering, considering the fact that the plant species are at times very tall and collectors cannot easily reach the height at which the beetles are situated. It can however, allow collectors to gather on average 10 individuals of the adult Augosuma beetle per day. According to respondents, close to 77% of adult Augosoma beetles are gathered from electrified spots at night, while 23% are harvested from Augosoma attracted (host) plant species.

The Augosoma beetle larvae (grub) are principally collected on dead stems of Raffia and Pandanus. Swampy forests in some parts of the East region are dominated by Raffia and Pandanus species. During the gathering process, local people identify dead stems of Raffia and Pandanus. The identified dead plant stems are split out to collect the larvae (white worms). A single person can collect an average of 35 Augosoma beetle grubs a day, but the activity is quite difficult and requires a lot of time and effort. Figure 12 below shows a stock of Augosoma larvae gathered for consumption by a household in East Cameroon.

Figure 12: A stock of Augosoma larvae harvested from a raffia forest

In areas where the population of raffia and Pandanus are few, the larvae are equally collected from decaying tree trunks and sawdust (around wood processing mills). However, the quantity of larvae harvested on decaying trunks and sawdust is relatively less in number as compared to raffia and Pandanus.

4-3-3 Preparation of the Augosoma beetle for food

Both the larvae and the adult Augosoma beetle are cooked before consumption. The cooking process for adults begins by the removal of undesired parts (legs, elytra, wings and abdominal waste). After removing the undesired parts, the adult beetle is lightly crushed, washed and boiled. For the larvae, the waste content of the abdomen is equally removed and the beetle is boiled briefly. After the brief boiling, the beetle (adult or larvae) is washed for the second time and fried with spices or cooked in a soup. The cooked beetle is usually accompanied with plantains, cocoyam or cassava fufu. Though the Augosoma larva is highly appreciated by many people in some parts of the east region, the skin of this larva is hard and elastic. This

makes the chewing of the cooked larvae difficult and some people simply chew to extract the sweet taste but do not swallow the chaff.

4-4 Marketing of Augosoma beetles

The Augosoma beetle is not marketed at a very large scale as is the case for some caterpillars, grasshoppers, termites and the palm beetle grub. However, both the larvae and the adults of the Augosoma beetle are sold for local consumption in each of the villages surveyed. They are either sold raw or cooked. Adult Augosoma beetles are sold at 25 FCFA (0,038€) a piece on average when raw and 50 FCFA (0,076€) a piece when cooked in most villages, while the larvae are sold at 100 FCFA (0,15 €) for 6 pieces raw on average and 4 or 5 pieces cooked. In some villages along the Yaoundé-Bertoua highway for example, the larvae of the Augosoma beetle are commonly sold alongside the palm beetle grub in the form of brochette. Though the market chain of the Augosoma beetle is not as large as that of other groups of edible insects, local market prices of the Augosoma beetle are quite high, compared to the prices of other groups of commercialized edible insects like the palm beetle grub and caterpillars for example (Table 6).

Tableau 6: Local market prices of some edible insects in the East region of Cameroon

EDIBLE INSECT	QUANTITY	LOCAL MARKET PRICE (IN FCFC)	LOCAL MARKET PRICE (IN EURO)
Palm beetle grub	1 glass full (about 20 pieces)	300 - 500	0,46 - 0,76
Caterpillars	1 glass full (about 15 to 45 pieces)	200-300	0,30 – 0,46
Augosoma beetle	1 piece (un cooked)	25	0,038
Augosoma larvae	6 pieces (un cooked)	100	0,15

4-5 Possible ecological niche of Augosoma beetle larvae

The ecological niche of the Augosoma beetle was identified by considering the object or plant from where these larvae are harvested for consumption. According to respondents, the larvae stage of the Augosoma beetle develops on dead decaying plant species and sawdust. In the upper Nyong and Lom and Djerem divisions, the larvae of the Augosoma beetle are reported to live in dead raffia (*Rafia farinifera*) and Pandanus (*Pandanus candelabrum*). In these areas, the larvae of the Augosoma beetle, commonly called Kouala by the Bakoum tribe in the Upper Nyong division and Bikuta by the Bobilis tribe in the Lom and Djerem division are harvested uniquely on dead raffia and Pandanus. In the Kadei and Boumba and Ngoko

divisions, the Augosoma beetle larvae, commonly called Kuru, Nakumbe or Kwatto by the Kakor tribe, Gogoro by the Mbimo tribe and Kpulu by the Baka pygmies equally live in dead raffia and Pandanus, as well as in decaying forest tree trunks and sawdust. From the analysis of the responses of interviewees, about 61% of the Augosoma larvae are found in dead raffia, 33% in Pandanus, 4% in other decaying tree trunks and 2% in decaying sawdust (Figure 13).

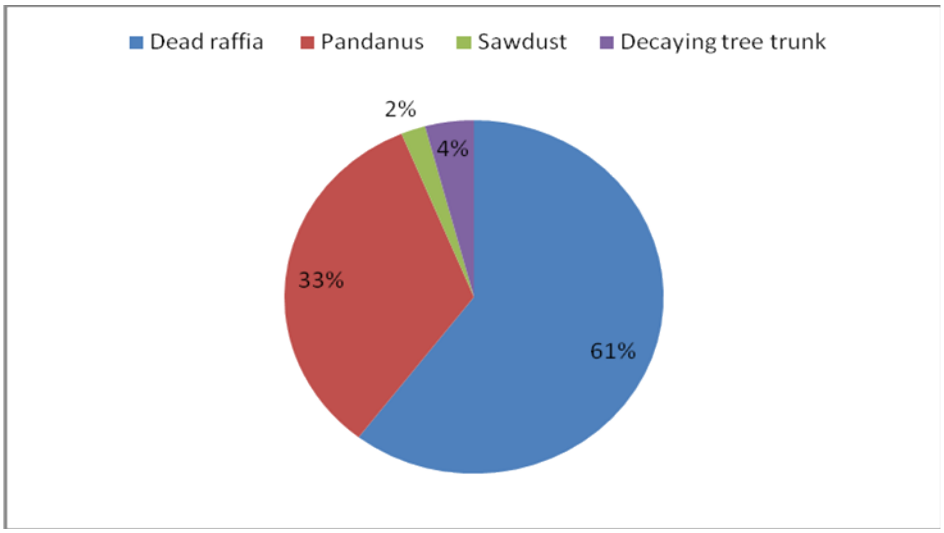

Figure 13: Possible ecological niches of the Augosoma larvae

The Augosoma beetle spends a greater part of its live span in the larvae stage and only come out when they are matured. Due to the fact that there is an outbreak of this beetle every two years, the larval stage of this beetle lasts more than two years (Venard-Combres & Mariau, 1983). The availability and abundance of the adults of this beetle however differ in different the ecological zones, and if in the East Cameroon they fly only every two years, they fly annually in the South and South West Cameroon (Le Gall, pers. obs.). More studies need to be conducted on the ecology and biogeography of *Augosoma*, before concert conclusion are made.

5- POTENTIALS OF ENTOMOPHAGY ON FOREST ECOSYSTEMS STABILITY IN THE EAST REGION OF CAMEROON

5-1 Impact of entomophagy on insect pest effect

Most species of edible insects feed on forest tree species. In most cases, phytophagous insect attacks cause the defoliation or deterioration of forest tree species. Most foresters thus consider edible insects as pests that need to be eradicated to ensure forest sustainability. The

defoliation of many commercial trees like Ayous (*Triplochyton scleroylon*), Sapelli (*Entandrophagma cylindricum*), Fraké (*Terminalia superba*) in East Cameroon for example are caused by edible caterpillars. These attacks cause temporarily confined growth on the economic valued trees, though the trees usually respond by producing a second growth of leaves (Reeler et *al*., 1991). The Augosoma beetle nourishes principally on raffia and pandanus tree species. Their attacks bring about morphological changes that reduce the vitality/growth or cause the death of raffia and Pandanus plant species. In most cases, Augosoma attacks on raffia are coupled with that of the raffia/palm weevil (*Rhynchophorus phoenicis*). Raffia and Pandanus plants play an important role in maintaining the ecological functions of swamp forest ecosystems. Raffia in particular is of exceptional socioeconomic and cultural importance in the East region. It offers various products and sub-products which are valorized in different ways for the benefit of local communities, especially the poor. The leaves, stems, bamboo and sap of the raffia are traditionally harvested as NTFPs for various uses. Augosoma beetle attacks on raffia constitute therefore a major pest that affects the health of swampy raffia forest and might in long term affect rural livelihood in the East region. Vernard-Combres and Mariau (1983) reported important damages on industrial plantations of Coconut trees in West and Central Africa. In Cameroon, they observed a 20% lost due to the impact of a combined feeding and reproductive activities of *Augosoma* and *Rynchophorus* beetles on coconut trees. They stated that the only efficient solution for controlling *Augosoma* adults would be the manual collection or light trapping which also fit well with the use of adults for human consumption.

Augosoma and other edible insects are usually harvested in large quantities and this constitutes a major means of fighting against the insect pest effect, while providing opportunity for improved rural livelihood. Insect gathering allows for the biological control of forest insect population, thus preventing the possible use of chemicals that can be toxic to other taxa in the forest. In order to demonstrate the biological control potentials of edible insect exploitation, Dounias (1999) used as example the plentiful occurrence of *Augosoma centaurus* and *Rhynchophorus phoenicis* on *Raphia sese* and *Elaeis guineensis*. The extensive harvest of these insects contributes in maintaining the population of the insects below threshold and reducing the pest effects of the insects. Such a practice results in the reduction of pesticides, while creating new economic opportunities for local people (De Foliart, 1990).

5-2 Potentials of entomophagy on biodiversity conservation in East Cameroon

The exploitation of edible insects contributes to food security, poverty alleviation and improved livelihood in the East region of Cameroon. It equally contributes to biodiversity conservation in the region, considering the fact that local people exploit insects as alternative sources of protein and income. In most part of this region, local people substitute meat and fish with edible insects when they are seasonally abundant. Consequently, bush meat harvest and pressure on wildlife are likely to reduce in seasons when edible insects are harvested. The consumption of Augosoma in particular can be considered as a potential alternative in rural livelihood in forest management in the East region, considering the fact that both the larvae and adult individuals of this beetle is a delicacy, they are periodically abundant, the adults are easily gathered in electrified areas and the larvae are harvested on dead plant stems. The harvesting process of this beetle (both adult and larvae) is less destructive to the forest and it helps in reducing the pest effect of the Augosoma beetle. The larvae of the Augosoma beetle are available all long the year, while the adults are available in periods when other edible insects are no longer available. The integration of local gathering practices of the Augosoma beetle and other forest insects to sustainable forest management practices will reinforce forest sustainability in the East region and Cameroon as a whole.

In some parts of Africa, edible insects are fully integrated in the participative forest management practices. In Malawi for example, farmers adjacent to Kasungu National Park, are allowed to harvest edible insects at certain times in the Park to diversify their income. So doing the Park management wins the support of resident communities for wildlife conservation programs (Munthali and Mughogho, 1992). By allowing rural people to use protected areas in this way in the East region, the preservation of the country's biodiversity will be enhanced, since developing the consumption of forest insects will sustain the socioeconomic and ecological functions of forest ecosystem, thereby reducing anthropic impact on global biodiversity.

CONCLUSION

Both the larvae and the adult of *Augosoma centaurus* beetle are a cultural delicacy in the East region of Cameroon. A vast majority of inhabitants of this region gather the adults of this beetle during periods of availability or all year long (larvae) for food. The consumption of this beetle contributes to food security, poverty alleviation and improves the livelihood of forest

dependent people in the East region of Cameroon. Consequently, the gathering of this beetle can serve as an important alternative to enhance sustainable forest management and biodiversity conservation in East Cameroon. It is therefore important to develop and integrate the consumption of insects to forest management strategies. It is equally important to attempt captive breeding of edible insects or put in place agroforestry practices that can sustain a continuous and long term production of Augosoma beetle and other edible forest insects for food in local communities. Edible insects should equally be processed and the sales promoted to increase the scope of their consumption. This way, edible insects might constitute an ample solution to some of the world current problems and crisis.

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ANNEX

QUESTIONNAIRE INSECTES COMESTIBLES DANS L'EST CAMEROUN

1) Date……

2) Identification de la personne enquêtée

i) Nom…… iii) Age…….…….....

ii) Sexe: Homme ☐ Femme ☐

iii) Statut matrimonial: Marié ☐ Célibataire ☐

iv) Nombre d'enfants :…….

v) Village (ville)/groupe ethnique :……..

vi) Arrondissement/Département :…….

3) Quelle est la taille estimative du village (ville)? .....

4) **Quelles sont vos activités principales ?** i)…….ii)…….

iii)……vi)……..v)……

5) Mangez-vous des insectes ? Oui ☐ Non ☐

6) Quelles sont les insectes que vous mangez? i)……..……ii)……

iii)…….……iv)……v)……

7) Comment appelez-vous chacun des insectes cités ci-dessous en langue locale ?

i)……..……....……ii)…….…….……iii)……

iv)……..v)……

8) Connaissez-vous particulièrement l'*Augosoma centaurus*? Oui ☐ Non ☐

9) Mangez-vous particulièrement l'*Augosoma centaurus*? Oui ☐ Non ☐

10) Quelle proportion de la population du village (ville) mange ces insectes ?

Personne ☐ ≤1/4 ☐ 1/2 ☐ 3/4 ☐ Tout le monde ☐

11) Quelle proportion de la population du village (ville) mange l'*Augosoma centaurus*?

Personne ☐ ≤1/4 ☐ 1/2 ☐ 3/4 ☐ Tout le monde ☐

12) A quel stade mangez-vous l'*Augosoma centaurus ?* Stade larvaire ☐ Stade adulte ☐

13) Quel stade de l'*Augosoma* est le plus sollicité? Stade larvaire ☐ Stade adulte ☐

14) Quelles sont les raisons pour lesquelles les insectes sont mangés?

……
……
……...

15) Quels groupes de personnes récoltent les insectes?

Les Hommes ☐ Les Femmes ☐ Les Enfants ☐ Les Pauvres ☐ Tout le monde ☐

16) Comment récoltez-vous les adultes de l'*Augosoma centaurus ?*

……
……...
……...
……

16) Comment récoltez- vous les larves de l'*Augosoma centaurus ?*

……
……...
……...

17) Sur quelle(s) plante(s) récoltez-vous les espèces d'insectes mentionnés ci-dessous :

Insectes	Plantes	Remarques

18) Quelle est la période de collecte des différents insectes ci-après ?

INSECTES	MOIS											
	Jan	Fev	Mar	Avr	Mai	Jun	Jul	Aou	Sep	Oct	Nov	Dec

19) Comment préparez- vous les adultes de l'*Augosoma* avant la consommation ?

……...
……...
……..
…… ..

20) Comment préparez-vous les larves de l'*Augosoma* avant la consommation ?

……...
……...
……..

21) Vendez-vous les insectes cités ci-dessous ? Oui ☐ Non ☐

22) Est-ce-que les *Augosoma collectés se vendent ?* Oui ☐ Non ☐

23) Comment vendez-vous les insectes ? Crus ☐ Préparés ☐

24) **Combien vendez-vous les *Augosoma*?**

LARVE CRUE		LARVE PREPAREE	
Quantité	**Prix unitaire**	**Quantité**	**Prix unitaire**
ADULTE CRU		**ADULTE Préparé**	
Quantité	**Prix unitaire**	**Quantité**	**Prix unitaire**

24) **Combien vendez-vous les autres insectes?**

……...
……...
……...

25) Comment considérez-vous les insectes comestibles par rapport aux autres sources de protéines telles que la viande et le poisson?

……...
……..…..

26) Comment appréciez-vous la consommation de *l'Augosoma* par rapport aux autres insectes comestibles?

……
……
……

27) Est-ce-que la quantité des insectes comestibles disponibles, notamment l'*Augosoma,* est satisfaisante ?
……
……

28) Est- ce-que la quantité des insectes récoltés diminue avec le temps? Oui ☐ Non ☐

29) Si la quantité des insectes récoltés diminue avec le temps, quelles en sont les raisons?
……
……..
……...……
..……

30) Que proposez-vous comme solution à ce problème
……...…
……...
……..
……..……

31) Connaissez-vous les ethnies qui mangent aussi des insectes dans votre département/région
……
……
……

32) Connaissez-vous les ethnies qui mangent aussi des Augosoma dans votre département/région

……
……
……
……

33) La consommation des insectes pourrait éviter ou traiter certaines maladies

Oui ☐ Non ☐

34) La consommation des Augosoma pourrait éviter ou traiter certaines maladies

Oui ☐ Non ☐

35) Quelle sont les maladies qui pourraient être traité par la consommation des insectes

……
……
……

36) La consommation des insectes/ Augosoma pourrait-elle donner les maladies, si oui, les quelle

……
……
……