Making a living with forest insects: beetles as an income source in Southwest Cameroon

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SUMMARY

This paper describes the use of beetles (forest insects) as an income source in the Southwest region of Cameroon and the contribution of this activity to rural livelihood improvement. Data was obtained through interviews conducted in 96 households in 6 villages. We found that the beetle trade provides complementary household income to forest dependent populations who rely on agriculture, hunting and gathering for their livelihoods. Income obtained from insect trade supports basic household needs and facilitates the acquisition of some farming inputs, but the sector remains informal. Considering the socioeconomic importance of this sector, insect trade should be formalized in order to manage the resource sustainably, increase benefits from their exploitation and concomitantly foster their impact on poverty alleviation and community-based conservation of the relic forest patches in the region.

Keywords: non-timber forest products, beetles collection, livelihoods, forest conservation

Gagner sa vie avec les insectes de la forêt: les insectes en tant que source de revenus au Cameroun du sud ouest

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Ce travail décrit l'utilisation des coléoptères (insectes forestiers) comme source de revenus dans la région Sud-Ouest du Cameroun et la contribution de cette activité à l'amélioration des conditions de vie rurales. Les données ont été obtenues grâce à des enquêtes conduites auprès de 96 familles dans 6 villages. Nous avons observé que le commerce des coléoptères procure des revenus complémentaires pour ces populations inféodées à la forêt et qui dépendent de l'agriculture, de la chasse et de la cueillette pour leur subsistance. Les revenus du commerce des insectes couvrent les besoins de base des familles et facilitent l'acquisition de certains intrants agricoles, mais le secteur reste informel. Au vu de l'importance socio-économique de ce secteur, le commerce des insectes doit être formalisé afin de mieux gérer la ressource durablement, d'augmenter les bénéfices de cette exploitation et ainsi d'accroître l'impact de cette activité sur la réduction de la pauvreté et la conservation des reliques forestières par les communautés autochtones de la région.

Ganándose la vida con insectos del bosque: escarabajos como fuente de ingresos en el suroeste de Camerún

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Este artículo describe el uso de escarabajos (insectos del bosque) como fuente de ingresos en la región suroeste de Camerún y la contribución de esta actividad a la mejora de los medios de subsistencia rurales. Los datos se obtuvieron a partir de entrevistas realizadas en 96 hogares distribuidos en 6 pueblos. Encontramos que el comercio de escarabajos aporta ingresos adicionales a los hogares de aquellas poblaciones dependientes del bosque, las cuales cuentan con la agricultura, la caza y la recolección como medio de subsistencia. Los ingresos obtenidos del comercio de insectos contribuyen a las necesidades básicas del hogar y posibilitan la adquisición de insumos agrícolas, pero el sector sigue teniendo un carácter informal. Teniendo en cuenta la importancia socioeconómica de este sector, el comercio de insectos debería formalizarse para que el recurso pueda ser gestionado de manera sostenible, aumenten los beneficios de su explotación y se incremente a la vez el impacto en la reducción de la pobreza y la conservación de fragmentos de bosques relícticos de la región por parte de las comunidades.

INTRODUCTION

The dependence of forest people on non-timber forest products (NTFPs) in developing countries cannot be underestimated, especially regarding their contribution as food, medicine and income sources (Arnold and Ruiz Pérez 1999, Belcher *et al.* 2005, Vantomme *et al.* 2004). In recent years, forest management has recognized the role of NTFPs in livelihoods and numerous actions to valorise and ensure the sustainable exploitation of these resources have been undertaken by various actors (conservationists, policy makers, civil societies, etc.). However, only a few of these actions deal with forest insects (De Foliart 1992). Most studies on tropical forest insects focus on their distribution, abundance and the environmental goods and services they provide to humans (Barbault 1997, Hunter 1999). While the fundamental contribution of forest insects to pollen dissemination is well known, their contribution to the livelihoods of both rural and urban people has often been acknowledged, but proper assessments are rare (De Foliart 1992, FAO 1995, Stack *et al.* 2003). Nevertheless, few works on the socioeconomic importance have centred on edible insects. Edible insects have long been used as source of food in human nutrition across the world. Some edible insects have nutritional value that can be compared with that of meat and fish, while others have higher proportion of proteins, fat and energy value (De Foliart, 1992; Malaisse, 1997). In West and Centre Africa, insects are not used as emergency food to strive against starvation, but are included as a normal part of the diet throughout the year or in seasons of occurrence (Banjo *et al*. 2006).

Apart from the contribution of forest insects in food security, they also constitute an important source of income. In Papua New Guinea, the Queen Alexandra's birdwing butterfly is strongly exploited for rural income (Cranston 2009). In order to increase the value and to better conserve this forest insect species, it was classified and listed as endangered in Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1966 (Cranston 2009). In 1978, the Papua New Guinean government created an Insect Farming and Trading Agency (IFTA), which controlled the conservation and exploitation of this species. This agency acted as a clearinghouse for trade in Queen Alexandra's birdwings and other valuable butterflies (Gullan & Cranston 2004). Legally captured dead specimens of the birdwing butterfly in good condition command more than US$2000. About 450 village farmers have associated with IFTA to farm butterflies by planting appropriate host plants that provide food plants for the birdwing and other butterfly species. Wild adult butterflies emerge from the forest to feed and lay their eggs; hatched larvae that feed on the host plant until pupation, when they are collected and protected in hatching cages. According to species, the purpose for which they are being raised, and prevailing conservation legislation, butterflies are exported live, as pupae, or dead as high-quality collector specimens (Gullan & Cranston, 2004). IFTA, sells about $400,000 worth of insects yearly to collectors, scientists, and artists around the world, generating an income for a society that struggles for cash (Cranston 2009). In addition to this financial benefit, local people recognize the importance of maintaining intact forests as the source of the parental wild-flying butterflies for their farmed stock. In this system, the Queen Alexandra's birdwing has acted as a flagship species for butterfly conservation and conserves additional biodiversity under an umbrella effect, as well as attracts external funding for survey and establishment of reserves (Cranston 2009).

In Cameroon, some forest insects like beetles and butterflies are harvested for trade. Beetles in particular are gathered by many forest-dwelling people in Southwest region of Cameroon for export to Europe, Asia and America, through internet business negotiations. The beetle trade in Cameroon started in the early 1980s when the first European insect collectors arrived and trained few Cameroonians on beetle collection techniques. They collected interesting species of insects which back in Europe attracted other collectors to Cameroon. The arrival of Asian insect collectors in the late 80s led to increased competition that pushed the collectors far into the interiors in quest of new zones where they could get large quantities of required insect species. The trade gradually expanded across the country, creating series of confidential middlemen. With increasing access to technologies, many middlemen living in big cities started negotiating deals on the internet and became exporters of insects. Beetles collected are either exported life or dead, at times in very unsustainable quantities, since there are no specific legislation that regulates the collection and trading of insects in Cameroon. Though this activity provides village dwellers with complementary income, its actual contribution to livelihoods has never been evaluated and almost nothing has been documented on this sector. Insect lovers are generally attracted by beetles, because of their very high diversity, very attractive colour and the ease of conserving them. This group of biodiversity is the most diversified amongst all living organisms in the terrestrial ecosystems and constitute about 24% of the global biodiversity (WCMC 1992). Adult beetles have extremely variable lifespan (from weeks to more than a year), depending on the species (Geertsema and van den Heever 1996) and can constitute an important source of income if properly valorised and conserved. However, adequate information is lacking to alert conservation stake holders on the need to effectively integrate beetles and other forest insects to conservation and poverty reduction strategies. Through the study of the trade chain, this paper aims at assessing the socioeconomic potential of the beetle trade, its actual contribution to the livelihoods of forest dependent households, and its impact on the enhancement of community-based conservation of relic forest patches in the Southwest region of Cameroon.

MATERIALS AND METHODS

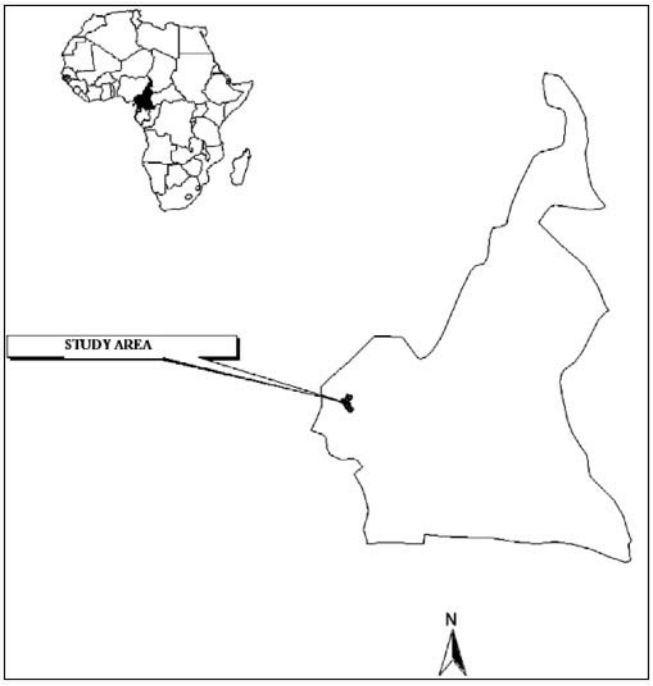
Description of the study site

Six villages where insect trade is currently being practiced in Southwest region of Cameroon were selected for the study.

These villages include: Nyasoso, Mbulle, Ebonemin, Konye, Ediki and Attuleh. In total, three divisions out of six in the region were studied. Nyasoso (4°57″N and 9°34″E), Mbulle (4°58″N and 9°36″E) and Ebonemin (5°00″N and 9°45″E) are found in the Kupe Manenguba division, Konye (5°00″N and 9°25″E) and Ediki (4°49″N and 9°25″E) in the Meme division and Attuleh (5°27″N and 9°55″E) in the Lebialem divisions of southwest region of Cameroon (Figure 1).

The study area falls within the Cameroon-Nigeria cross-border forests which are well-known for their high level of species diversity and endemism. The area falls within the Cameroon volcanic belt that spans an altitudinal range from sea level to 4095 m. It includes Mount Cameroon, the highest peak in West Africa and part of a mountain chain that extends northwest-southeast into the Gulf of Guinea (Forboseh *et al.* 2007*)*. Temperatures are relatively constant with monthly mean minima and maxima, respectively of 22–24°C and 24–32°C (Fraser *et al*. 1998). Annual rainfall varies between 2000–3500 mm. These elevational and climatic factors result in a variety of vegetation types (Oates *et al*. 2004). Low altitude areas comprise a coastal area of mangroves and inland dense humid evergreen Guinean-Congolian forest of the Atlantic Biafran type, dominated by plant families like *Caesalpinaceae, Euphorbiaceae, Olacaceae* and *Sterculiaceae* (Letouzey 1968). At higher altitudes there are submontane and montane forest types which are dominated by species like *Adenocarpus mannii Hook.f, Agauria salicifolia Hook.f, Gambeya Africana Pierre, Schefflera barteri Harms* and *Carapa grandifolia Sprague* (Cable and Cheek 1998, Focho *et al.* 2009).

FIGURE 1 *Map of Cameroon, showing the study area*



Source: Wilcox and Diangha (2007).

Data collection

Data were collected using both quantitative and qualitative social science methods described by Acharya (2005). In order to identify potential insect collectors, a free listing exercise was administered to 10 people in each of the villages (ages between 25 to 50 years old), following the approach of Weller and Romney (1988). They were interviewed with an open-ended question that required them to list potential households where insect collection and trade is practiced. A total of 96 households were identified in the 6 villages and in each of the households, men, women and children of age above 18 years were interviewed using questionnaires and open discussion. Questions like what species of beetles are harvested for trade, where are the beetles harvested, who harvests the beetles, how are harvested beetles preserved, where are the beetles sold, how much are the beetles sold and how much does the insect trade contribute to households annual income were asked to obtain socioeconomic information on the beetle trade. Some beetle exporters in Cameroon were equally identified and interviewed. Themes emerging from the interviewee responses were coded. For each question, we kept a separate running list of codes, creating new codes 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 using Microsoft Excel 7.0. Samples of commercial forest insects were collected from the traders (participative approach) and identified using taxonomic manuals (Allard 1985, 1986 and 1991, Rigout 1989, Rigout and Allard 1992).

RESULTS

Commercial beetle species in Southwest Cameroon

We found that 19 beetle species (excluding coloured forms of some species) are currently being commercialized in Southwest Cameroon. However, different species are harvested in different localities, depending on the occurrence of species and their market values (Table 1).

Most species with limited distribution are only found in few villages, providing a restricted opportunity for their harvest. In villages where species diversity is high, insect collectors mostly target species which are sold at high market prices. Species currently having very high demand include the white forms of *Goliathus goliatus (e.g Goliathus goliathus quadrimaculatus), Fornasinius aureosparsus, Chelorrhina (Mecynorrhina) kraatzi* and *Stephanocrates preussi* (Figures 2, 3, 4 and 5).

Harvesting and preservation techniques

Current harvesting methods are less sustainable and may lead to trees death and forest destruction. It involves all group of people (children, women and men), depending on the locality

TABLE 1 *Species of commercial beetles in Southwest Cameroon*

SPECIES (Authors)	VILLAGES					
	NYASOSO	MBULLE	EBONEMIN	KONYE	EDIKI	ATTULEH
Goliathus goliatus Linné *				X	X	
Goliathus goliatus apicalis Kraatz *				X	X	
Goliathus goliatus conspersus Kraatz *				X	X	
Goliathus goliatus albatus Kraatz *				X	X	
Goliathus goliatus undulus Sjostedt *				X	X	
Goliathus goliatus quadrimaculatus Kraatz *				X	X	
Fornasinius aureosparsus Van de Poll	X	X			X	
Mecynorhinella torquata immaculicollis Drury	X	X				
Chelorrhina (Mecynorrhina) kraatzi Moser			X			X
Chelorrhina (Mecynorrhina) polyphemus confluens Kraatz	X	X	X			
Chelorrhina (Mecynorrhina) savagei Harris	X	X	X			
*Stephanocrates preussi Kolbe (green)**						X
*Stephanocrates preussi Kolbe (brown)**						X
*Stephanocrates preussi Kolbe (blue)**						X
Gnorimimelus batesi Rutherford			X			
Megalorrhina harrisi eximia Aurivilius	X	X	X			X
Eudicella morgani camerounensis White	X	X				
Eudicella gralli Buquet						X
Eudicella schultzeorum Kolbe						X
Dicronorhina micans Drury	X	X				
Mesotopus regius (tarandus) Swederus	X	X			X	
Homoderus mellyi Parry	X	X				
Homoderus gladiator Jakowleff			X			X
Prosopocoilus swanzianus Parry	X	X				
Prosopocoilus faber Thomson	X	X				
Prosopocoilus antilopus Swederus	X	X				
Prosopocoilus senegalensis Klug	X	X			X	

(*) *Coloured forms of the same species, (x) Presence of species*

and the demand in place. Harvesting begins with the location of the adult insects host plant species in the forests and farmlands. Some of the plant species that commonly attract beetles are *Vernonia amygdalina Delile, Vernonia conferta Benth, Carapa grandifolia Sprague and Nobotonia mannii Benth* (Figure 6).

The bark of located stems is removed at the base level and allowed for some few weeks to provoke the production of fermented phloem which attracts insects (Figure 7). In sunny weather, harvesters carefully observe each of the prepared stems to collect insect specimen by hand-picking and/or the use of sweeping nets. For very large species like the *Goliathus*, located specimens are best harvested at night (with the use of fire or light) or very early in the morning before sunrise by shaking the tree for the beetle to fall (Figure 8). Harvested beetle specimens are preserved by injecting them with alcohol at 50° concentration, after which they are exposed to sunlight for about 30 minutes. Well-dried specimens of valuable species are then wrapped in toilet tissue and stored in well-dried closed containers, while specimens of highly abundant less valuable species are simply stock in a well closed container (Figure 9).

Live specimens are preserved in perforated plastic cups in which pieces of sugar cane are weekly introduced as food (Figure 10 and 11). These life beetles are exported in closed perforated small plastic cups in small carton boxes. In order to export dead beetles, the specimens are sealed with nylon paper on a piece of rectangular cut carton. The sealed packages are then arranged in a small carton box and shipped with a false label.

FIGURE 2 *Goliathus goliathus quadrimaculatus*

FIGURE 3 *Chelorrhina kraatzi*

FIGURE 4 *Fornasinius aureosparsus*

FIGURE 5 *Stephanocrates preussi*

FIGURE 6 *A farmer indicating his beetle tree*

FIGURE 7 *Goliathus goliathus quadrimaculatus attracted by a phleom producing stem*

FIGURE 8 *A local collector with a hand-picked Goliathus goliathus quadrimaculatus*

FIGURE 9 *Beetle collector wrapping his stock of beetles for storage*

FIGURE 10 *Life specimens of small Cetoniine beetle species*

FIGURE 11 *Life specimen of Chelorrhina kraatzi*

Market value of commercial beetles

Market prices for commercial beetles vary depending on species, locality, quality and size of the insect. Endemic species are generally more expensive than widely spread species. Male specimens with large horns are more expensive than female specimens which generally lack horns. Good quality specimens (clean specimens with no scratch or fracture on any part of the body) are more expensive than faded specimens. For the same species, large size specimens are sold at better prices than smaller sized specimens. However, the sizes of female specimens are usually not taken into consideration. In the course of this study, the price ranges for paired good quality dead specimens of commercial beetle species were recorded (Table 2).

The white forms of *Goliathus goliatus, Fornasinus aureosparsus* and the blue *Stephenocrates preussi* are amongst the most expensive (45000–75000FCFA, 40000–70000FCFA and 25000–40000FCFA, 1$=480FCFA) for a paired good quality individuals respectively. Though the diversity of insects is probably high in the forests of this region, only species belonging to 2 families (*Cetoniidae* and *Lucanidae*) are currently being exploited for trade. Live specimens are sold at prices higher than mentioned above. However, exports of live insect specimens risk reducing the market value of the species, since this gives opportunity for foreign beetle traders to rear and reproduce these beetles for trading in their own countries. According to the respondents, *Mesotopus regius* is an example of a beetle whose value has dropped due to exportation of life individuals. From all indication, live specimens were locally sold at prices above 70,000 FCFA (146$) each in the years 2005–2007, but the market value and demand has today dropped considerably, due to the successful rearing of this species in Europe and Asia.

Marketing chain

The marketing chain of these resources within Cameroon needs to be studied further in detail, since our study is preliminary and does not cover the entire territory or provide

TABLE 2 *Market prices of high-quality male specimens of commercial beetle species*

SPECIES	FAMILY	BEETLE SIZE (mm)	AVERAGE PRICE IN FCFA (1$=480FCFA)
*Goliathus goliatus Linné **	*Scarabaidae*	95–110	3000–7000
*Goliathus goliatus apicalis Kraatz **	*Scarabaidae*	95–110	5000–10000
*Goliathus goliatus conspersus Kraatz **	*Scarabaidae*	95–110	15000–35000
*Goliathus goliatus albatus Kraatz **	*Scarabaidae*	95–100	35000–65000
*Goliathus goliatus undulus Sjostedt **	*Scarabaidae*	95–100	40000–70000
*Goliathus goliatus quadrimaculatus Kraatz **	*Scarabaidae*	95–100	45000–75000
Fornasinius aureosparsus Van de Poll	*Scarabaidae*	65–75	40000–70000
Mecynorhinella torquata immaculicollis Drury	*Scarabaidae*	80–85	3000–7000
Chelorrhina (Mecynorrhina) kraatzi Moser	*Scarabaidae*	70–75	6000–10000
Chelorrhina (Mecynorrhina) polyphemus confluens Kraatz	*Scarabaidae*	70–75	1000–2500
Chelorrhina (Mecynorrhina) savagei Harris	*Scarabaidae*	70–75	500–2000
*Stephanocrates preussi Kolbe (green)**	*Scarabaidae*	40–45	8000–15000
*Stephanocrates preussi Kolbe (brown)**	*Scarabaidae*	40–45	15000–30000
*Stephanocrates preussi Kolbe (blue)**	*Scarabaidae*	40–45	25000–40000
Gnorimimelus batesi Rutherford	*Scarabaidae*	30–35	1000–2000
Megalorrhina harrisi eximia Aurivilius	*Scarabaidae*	35–40	300–700
Eudicella morgani camerounensis White	*Scarabaidae*	35–40	300–800
Eudicella gralli Buquet	*Scarabaidae*	35–40	300–600
Eudicella schultzeorum Kolbe	*Scarabaidae*	35–40	300–600
Dicronorhina micans Drury	*Scarabaidae*	40–45	400–900
Mesotopus regius (tarandus) Swederus	*Lucanidae*	80–85	8000–15000
Homoderus mellyi Parry	*Lucanidae*	45–50	500–1000
Homoderus gladiator Jakowleff	*Lucanidae*	45–50	1000–2000
Prosopocoilus swanzianus Parry	*Lucanidae*	35–40	1500–3000
Prosopocoilus faber Thomson	*Lucanidae*	35–40	800–2000
Prosopocoilus antilopus Swederus	*Lucanidae*	35–45	200–500
Prosopocoilus senegalensis Klug	*Lucanidae*	35–45	200–500

complete details due to the difficulties encountered in obtaining information on this informal sector. However, data collected reveals that the commercialization is done through series of middlemen (intermediaries) who buy specimens from forest dependent people and resell them to exporters based in major towns like Buea, Douala, Yaoundé and Bamenda. Beetle exporters sell the collected specimens to beetle traders in Europe, America and Asia. In some cases, foreign collectors travel to Cameroon and buy reasonable stocks of beetles without obtaining legal permits or pay taxes on the resources they exploit. A total of 8 beetle exporters were identified in the area studied. Business negotiations are done through the net and the parcel shipped via express mail services once a deal is agreed. In case the foreign buyer has to transport the beetles himself, he simply puts them in his travelling box which he embarks into the plain without any strict verification. The beetles are either transported alive or dead, depending on the nature of the demand and at times in very unsustainable quantities, since there are no specific legislation that regulates the collection and trading of insects in Cameroon. The market chain of beetles in Cameroon is summarised in figure 12 below:

Contribution of the beetle trade to livelihoods in Southwest Cameroon

The exploitation and trade of beetles is an important income generating activity in each of the villages studied. The percentage of households that are practicing insects gathering and trade in each of the villages is given in table 3.

FIGURE 12 *The beetle trade chain*

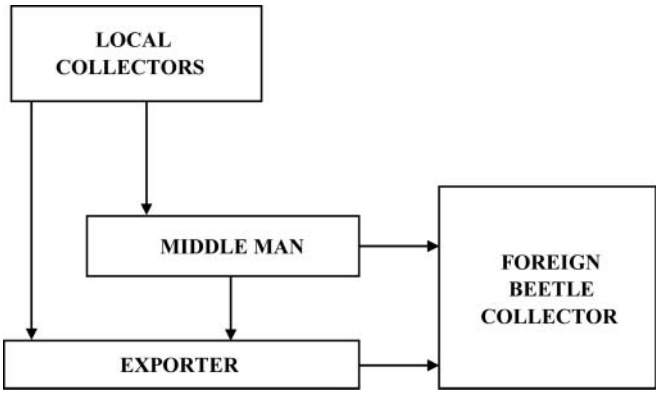


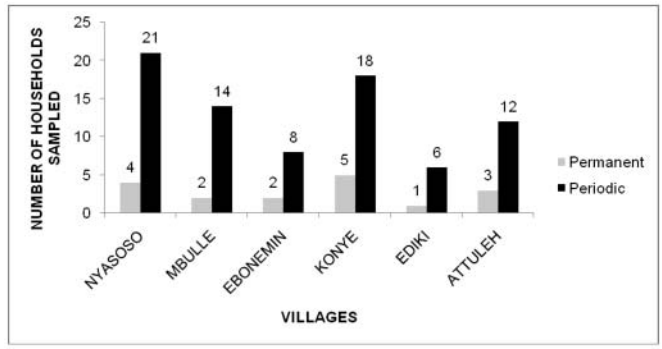
TABLE 3 *Percentage of households practicing insect trade in each of the villages studied*

Village	Number of households practicing insect trade	Total number of households	Percentage of households practicing insect trade (%)
Nyasoso	25	113	22.1
Mbulle	16	87	18.4
Ebonemin	10	19	52.6
Konye	23	108	21.3
Ediki	7	43	16.3
Attuleh	15	24	62.5

About 24.4% of households practice both agriculture and beetle collection, while 75.6 % depend uniquely on agriculture for livelihood. However, household dependence on this activity for livelihood varies from one village to the other, depending on the availability of commercial insect species and agroforestry preferences. In each of the villages, most households depend on agriculture as their main activity for livelihood; others practice agriculture and beetle trade throughout the year, while others only periodically exploit beetles when they are abundant. An indication of the number of households that permanently or occasionally complement their household income with money obtained from the gathering and trade of beetles in each of the villages was established (Figure 13).

In general, 17.7% of households that practice the gathering and trade of beetles in the six villages depend on agriculture and beetles exploitation for livelihood while 82.3% periodically exploit beetles, in times of high species occurrence and demand. About 5.2% of the respondents generate incomes between 700 000 FCFA (1459$) and 800 000 FCFA (1667$), representing more than 70% of their annual household income. Close to 9.4% of the respondents generate incomes between 400 000 FCFA (834$) to 600 000 FCFA (1250$), representing 35 to 60% of their annual household income. About 3.1% of households generate incomes

FIGURE 13 *Dependence of households on beetle trade for annual income*



between 200 000 FCFA (417$) and 300 000 FCFA (625$), representing about 30% of their annual revenue. On the contrary, 52.2% of households earn less than 100 000 FCFA (209$) from insect gathering and trade, representing less than 10% of their household's annual incomes. The trend of complementary annual income generated by households from insect trade is summarized below (Figure 14).

Whatever the households generate annually from beetle exploitation for their livelihoods, the contribution of these resources to local wellbeing in Southwest Cameroon cannot be ignored. Such income supports the fulfilment of basic households needs for feeding, education and healthcare, and also facilitates the acquisition of some farming inputs.

Seasonality of commercial beetle in Southwest Cameroon

The gathering and marketing of beetles is done throughout the year. However, different species are harvested at different periods of the year (Table 4).

In most of the villages, collectors have the possibility of harvesting different species of beetles over the year. The harvest of specimens from natural forests strongly depends on seasonal variation. The months of March and October are generally the start of the harvest season for most species and exploitation can last for at least four months. These periods are generally the beginning of the rainy and dry season periods respectively and characterized by abrupt changes in

FIGURE 14 *Household annual income generated from insect trade (in FCFA, 1$=480FCFA)*

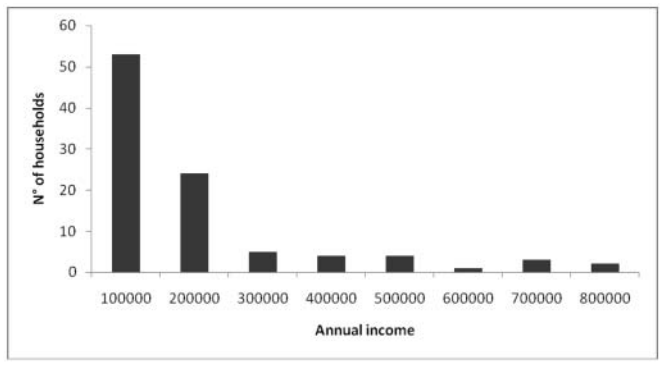


TABLE 4 *Seasonal availability of commercial beetles in Southwest Cameroon*

	MONTHS											
	Dry season		Rainy season								Dry season	
SPECIES	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Goliathus goliatus Linné *	■	■								■	■	■
Goliathus goliatus apicalis Kraatz *	■	■								■	■	■
Goliathus goliatus conspersus Kraatz *	■	■								■	■	■
Goliathus goliatus albatus Kraatz *	■	■								■	■	■
Goliathus goliatus undulus Sjostedt *	■	■								■	■	■
Goliathus goliatus quadrimaculatus Kraatz *	■	■								■	■	■
Fornasinius aureosparsus Van de Poll			■	■	■	■	■	■	■			
Mecynorhinella torquata immaculicollis Drury			■	■	■	■				■	■	■
Chelorrhina (Mecynorrhina) kraatzi Moser	■	■										■
Chelorrhina polyphemus confluens Kraatz			■	■	■							
Chelorrhina (Mecynorrhina) savagei Harris	■	■									■	■
*Stephanocrates preussi Kolbe (green)**			■	■	■							
*Stephanocrates preussi Kolbe (brown)**			■	■	■							
*Stephanocrates preussi Kolbe (blue)**			■	■	■							
Gnorimimelus batesi Rutherford			■	■	■	■	■	■	■	■		
Megalorrhina harrisi eximia Aurivilius			■	■	■	■	■					
Eudicella morgani camerounensis White			■	■	■	■						
Eudicella gralli Buquet	■	■									■	■
Eudicella schultzeorum Kolbe	■	■									■	■
Dicronorhina micans Drury			■	■	■							
Mesotopus regius (tarandus) Swederus			■	■	■	■	■	■	■	■		
Homoderus mellyi Parry											■	■
Homoderus gladiator Jakowleff	■	■	■	■								
Prosopocoilus swanzianus Parry					■	■						
Prosopocoilus faber Thomson					■	■						
Prosopocoilus antilopus Swederus			■	■	■							
Prosopocoilus senegalensis Klug			■	■	■	■						

environmental biotic and abiotic conditions that favour the development of larvae to adult insects. The abundance of each species increases to a peak, after which they decrease suddenly when conditions and food availability become less favourable.

DISCUSSION

The number of beetle species that are currently being exploited is relatively insignificant, compared to the total species richness in the area (Muafor et *al* 2011). Despite the fact that there is a demand for all types of beautiful beetles, only species with large sizes are currently being collected for trade. Many small species, some of which could equally be very expensive are neglected during the gathering process, probably due to the lack of appropriate gathering and preservation techniques. Some species which are equally beautiful but which are yet to be valorised by the buyers are not being exploited. According to Novotny *et al.* (2006), insects are highly diversified and constitute more than half of the global biodiversity of tropical forests, but the actual number of species is unknown. More quantitative studies within and between sites, as well as across taxa are needed to estimate the real potential of forests in insects (May 1992). Therefore, many species of beetles and other groups of forest insects are yet to be identified and valorised to improve rural livelihoods. However, there have been recurrent attempts at exploiting other insect groups like butterflies and moths (*Lepidoptera*) in the Southwest region of Cameroon, but these attempts have never been successful

due to lack of appropriate collection and preservation techniques. For the few species currently being exploited, harvesting is a function of the species biogeographic pattern, economic value and knowledge on how to collect and preserve specimens. Endemic species with known rarity and limited distribution range attract more customers than widely spread species. The white forms of *Goliathus* for example reach high prices because they are localised only in the humid submontane forests of the Bakossi-Korup landscapes (Muafor *et al*. 2011). These are the largest and the most expensive beetles in the region and probably in Africa. They are so expensive that during harvest season, collectors forgo many other existing species in search of the white forms of *Goliathus*. The humid submontanous forests in Nyasoso and Mbulle are not favourable to the *Goliathus* species, but harbour other expensive species like *Fornasinius aureosparsus* and *Mecynorhinella torquata immaculicollis*. The forests of Ebonemin and Attuleh, which are of the submontane Savannah-forest transition types, harbour species like *Chelorrhina kraatzi* and *Stephanocrates preussi*.

In the Southwest region of Cameroon, households alternate between agriculture and beetle collection for family subsistence. In villages like Konye, Mbulle, Ediki, and Nyasoso where cocoa is the main cash crop, farmers who practice this activity periodically gather and sell beetles as their main income generating activity between the months of November and May when there is high occurrence of most beetle species and little or no cocoa production.

Impact of insect trade on biodiversity conservation

Insects are present in every segment of forest land, no matter how small the land may be. This characteristic of insects is vital for the survival of species even in highly fragmented ecosystems. However, indigenous species are likely to disappear if relict forest patches are completely wiped out (Muafor et *al*, 2011). The impact of insect trade on biodiversity conservation could be negative or positive. This activity may affect both the health of the forest as well as the composition of insect populations if not properly managed. Current harvesting techniques are quite rudimentary and unsustainable. It involves the removal of trees barks and the use of fire in the forest. This does not only risk the sporadic death of amputated trees, but also possibilities of fire devastation in the forest and thus, destruction of the forest and biodiversity at large. The beetle trade leads to the reduction in the possibility for some species to reconstitute their populations, due to the removal of sexually matured adult individuals. Unsustainable exploitation prevents forest insects to normally reproduce off springs and replenish their populations. As consequence, the population of some species keeps reducing, risking extinction in the near future.

This is the case of some highly commercialised Cetoniine beetle species in the Southwest region of Cameroon (include the white forms of *Goliathus goliatus, Fornasinius aureosparsus, Chelorrhina kraatzi* and *Stephanocrates preussi)*. The current populations status of these highly commercialised beetles, are presumed vulnerable, regarding their endemism and/or rarity to the Cameroon forest ecosystems, overexploitation for commercial purpose, restricted or highly localized distribution range, climatic changes, lack of appropriate knowledge of their ecology and increasing habitat loss or fragmentation from forest degradation and deforestation. Current state of knowledge on the distribution range of these species is insufficient, but spot-like occurrence is known to exist along the humid forest ecosystems of the Cameroon volcanic belt. *Fornasinius aureosparsus* however, occur in restricted habitats in Cameroon, Eastern Nigeria and probably Gabon, but it is known to be very rare. All the other species are endemic to the Cameroon humid montane forest ecosystem (Allard 1985). Ecological data indicates that morphologically varied endemic communities occur on separate highlands, but studies have not been conducted to determine whether such communities are subspecies or forms. With the increasing encroachment of agro-pastoral activities and informal logging, the known habitats for these species are rapidly being fragmented, thereby reducing the possibility for their range expansion. The recent and unusual variations in the periodicity and/or intensity of the dry and rainy season in most regions of Cameroon is also a major threat to these species, since it comes alongside with abnormal temperature fluctuation and increased fragility to deseases. Insects being environmentally sensitive, they may need to adapt or migrate to more favourable habitats if microclimatic changes persist. Favourable migrations are however very difficult for these presumed vulnerable flower beetle species, due to their restricted biogeographic patterns and the high fragmentation of their habitats. These species must develop appropriate environmental adaptation to overcome both the present changing climatic situation and other threats. Otherwise, they may be endangered to the extent of becoming extinct if the biotic and abiotic pressure exceeds survival threshold of individual species.

According to respondents, the availability of those highly exploited species has considerably reduced over time, thereby limiting opportunities for future large stock harvest. Though the exploitation of beetles might impact negatively the forest and the survival of some species, it is however important to valorise and assure the sustainable management of these resources to reinforce efforts towards poverty alleviation and community based conservation in both protected and unprotected forest ecosystems. In unprotected forest areas where habitat fragmentation is predominant, sustainable insect gathering and legalised trade could be used as a major tool for the protection of relict forest patches. The habitats of some endemic and valuable species are found in forests ecosystems outside protected areas. Valorising commercial beetles and educating resident population on sustainable harvest practices and the necessity for protecting the habitat of commercial beetle species will contribute a long way in saving our remaining unprotected forest patches. In protected ecosystems all anthropic encroachment for commercial beetle collection should be strictly forbidden, regarding the status of protected areas. Nonetheless, modalities for regulated collection of commercial beetle specimens in farmlands need to be developed and used as an alternative source of income to populations around protected areas.

CONCLUSION

The insect trade is an important source of income in Southwest Cameroon, contributing therefore to poverty alleviation and livelihood improvement in the region. Apart from their socioeconomic importance, beetles and other groups of forest insects play a vital role in equilibrating forest ecosystems, through their participation in ecosystem processes like pollination of forest trees, nutrients recycling, dung decomposition and are prey to larger groups of wildlife (Kremen 1992). Although the legal tool for biodiversity conservation in Cameroon provides provisions for the sustainable management of all forms of wildlife, irrespective of their nature, beetles have however not been given any specific conservation attention. Whereas, some of the beetles exploited are endemic, rare or threatened by unsustainable exploitation and habitat destruction (Muafor *et al*. 2011). Though this sector is quite booming, no control on the exploitation and marketing of these resources is done. This has given way to high level trafficking of beetles and continuous fragmentation of their habitats. Consequently there are high risks of extinction of some endemic and/or rare species. Most conservation institutions and wildlife wardens accord little or no importance to this group of biodiversity. Despite the fact that beetles are equally threatened, none of the commercial species is found in the Convention on International Trade in Endangered Species (CITES) or the International Union for Conservation of Nature (IUCN) red list categories. However, this exclusion is probably due to lack of appropriate information on the diversity, endemism, importance and vulnerability of beetles and other groups of forest insects. However, the valorisation and the sustainable management of these resources could serve as an alternative solution to the problem of poverty, poaching and illegal timber exploitation. Nonetheless, a certain level of control and of formalization of the trading chain might be necessary to avoid the unsustainable exploitation of endangered insect species. Restricting the local people from harvesting these resources should be the last option and should only be envisaged for species proven to be endangered. However, such restrictions have proven largely inefficient with larger endangered animals and it would be surprising if they could actually have any effect on insect smuggling. While a sustainable harvesting and trade of beetles could be promoted, the trade of life specimens must be forbidden because life beetle trade is a form of genetic drainage which brings in near term a drastic devaluation of species. Once a beetle is shipped life, western beetle traders undertake rearing and domestication attempts to produce specimens which are sold as individuals exploited from the natural forests (Campbell 2002).

Though this study gives an inside to commercial insect exploitation in Cameroon, it is however, early to conclude on the true impact of beetle exploitation and trade, since additional studies need to be conducted to understand species diversity, ecology, biology and vulnerability. In order to effectively benefit from these resources while assuring their survival, beetles and other groups of forest insects should be integrated to both national and international frameworks for biodiversity conservation. Endangered and highly commercialized beetle species should be identified and included to both the IUCN red list and the CITES categories. Whether beetles are harvested in protected or unprotected ecosystems, beetle exporters should acquire an exploitation license and the trade regularized to assure the sustainable exploitation of these resources.

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