

## Contribution of forest insects to food security and forest conservation: The example of caterpillars in Central Africa

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*This paper examines the food potential of edible insects, and the implications for development policy. It is based on a study undertaken by FAO in 2003, which drew on four case studies in the Congo Basin sub-region. The paper identifies research gaps and gives policy recommendations for forest managers, conservationists, nutritionists and rural development workers to help them incorporate forest-gathered insects in food security and forest conservation strategies.*

### Policy Conclusions

- In areas such as the Congo Basin, insects contribute significantly to the food security and livelihoods of the poor, as sources of protein, carbohydrate and vitamins, and also traditional medicines.
- Being labour-intensive, insect harvesting is beneficial to the poor, especially women and children.
- Development planners and managers would gain from a greater awareness of the ways in which the value of insects in rural economies affects - and is in turn affected by - local natural resource management strategies, including farm and bush burning, pesticide use, and tree conservation decisions.
- Means need to be found to accommodate the growing demand for insects and products on the market in a context of declining habitats, as this is putting a heavy burden on the livelihoods of the poorest and most disadvantaged people.
- External interventions need to factor in their potential impacts on this aspect of the ecosystem and forest economy.
- The relationships between the bushmeat and insect commodity chains are little understood, though there may be mutual effects.

### Background

Over the past decade, recognition by forest managers of the role of Non-Wood Forest Products (NWFPs) in food security has grown considerably. However, they tend to be much less aware of the food potential of edible insects. Several investigations have shown that, in addition to their fundamental contribution for pollen dissemination, insects may contribute significantly to livelihoods in both rural and urban areas (Stack et al., 2003). FAO (1995) notes that insects are also an important NWFP that poor people gather, particularly women and children. Insects are a popular

food in many cultures all over the world, be it as an occasional delicacy or as a replacement food in times of shortages, droughts, floods or war. The potential of insects needs to be more seriously considered in food security and poverty alleviation strategies in Sub-Saharan Africa (De Follart, 1992).

Little is known about how to realise the full potential of insects as a food crop, particularly the edible insect species which are gathered in forests. To raise awareness of the potential of edible insects in food security of forest dependent people, FAO's NWFP Programme initiated a review in 2003 to:

- document their significance to people's livelihoods;
- assess linkages between insect gathering and the forest ecosystem, wildlife conservation, and bushmeat consumption patterns.

Priority was given to the Congo basin in view of the fact that the region has huge forest resources, is still rich in wildlife, and has high consumption levels of both bushmeat and many edible insect species.

Case studies were commissioned from national experts in Cameroon, Central African Republic (CAR), the Republic of the Congo (Brazzaville), and the Democratic Republic of Congo (DRC)<sup>1</sup> to document the significance of edible forest insects in their respective countries. The focus of these studies was mainly on caterpillars as they are very common insects in the forests, can be easily gathered, and are an abundant and popular food source in Central Africa. Also, most caterpillars feed on tree leaves (including the leaves of important timber species such as sapelli, *Entandrophragma cylindricum*). Their impact on tree health and on the forest ecosystem in general is also significant enough to yield a wide range of forest management options to address both local food needs and forest ecosystem health and productivity.

This paper analyses the outcome of these four case studies together with other evidence from the literature on the region. The paper provides insights on research gaps and gives policy recommendations for forest managers, conservationists,

nutritionists, and rural development workers to help them incorporate forest gathered insects in food security and forest conservation strategies for the region.

## The importance of edible insects for livelihoods in Central Africa

### **Nutritional values of caterpillars**

Malaisse (1997) gives a good overview of the nutritional values of various caterpillar species and confirms scientifically what local people knew empirically. The average percentage of proteins and fat as well as the average energy value of 24 investigated fresh caterpillar species is  $63.5 \pm 9.0$  % for proteins and  $15.7 \pm 6.3$  % for fat. This results in an energy value of  $457 \pm 32$  kcal per 100 g (numbers based on dry matter). Compared to meat or fish, caterpillars have higher protein and fat contents and provide more energy per unit.

Depending on the species, caterpillars are rich in different minerals (e.g. K, Ca, Mg, Zn, P, Fe) and/or vitamins (e.g. thiamine/B1, riboflavin/B2, pyridoxine/B6, pantothenic acid, niacin). Research shows that 100 g of cooked insects provide more than 100 % of the daily requirements of the respective contained vitamins/minerals (De Foliart, 1992). Malaisse (1997) reveals that consumption of 50 g dried caterpillars meets the daily human requirements of riboflavin and pantothenic acid as well as 30 % of the requirement of niacin.

Due to its high nutritional value, flour made from larvae is traditionally used to prepare a pulp given to children to counter malnutrition. Species being particularly rich in calcium (e.g. *Tangoropsis flavinata*), protein (e.g. *Imbrasia epimethea*, *Imbrasia dione*, *Antheua insignata*), or iron (e.g. *Cinabra hyperbius*) are given to anaemic people, or to pregnant and breastfeeding women. Several species may also play an important role in traditional medicine. On the negative side, some insects secrete toxic chemicals from food plants or produce toxins themselves (Duffey, 1980).

### **Income from gathering and trade in caterpillars**

In Central Africa, insects are widely available in village markets. Some of the favourite species also reach urban markets and restaurants (De Foliart, 1992; Tabuna, 2000). Harvesting and trade in caterpillars is a seasonal activity because the lifecycle of the insects is governed by the start of the rainy season. Only full-grown caterpillars are collected for the market. The commercialisation of live or dried larvae may be undertaken either directly by the gatherer or more frequently through wholesalers and retailers. In the former case, the product is sold on the local market. More commonly, one or more intermediaries act between producer (gatherer) and consumer and this may significantly mark up prices. Customarily, merchants go to rural areas to purchase larvae for resale in cities. Some wholesalers own storage depots in town to provide more regular supplies and get higher prices in times of shortage.

Market sellers are mostly women and children; only in a few regions are men involved, and then mainly in wholesale trade. It should be emphasised that for the majority of merchants, dealing in larvae is not their main activity but supplements their sales of other foodstuffs like fish, nuts, manioc, vegetables or fruits.

Merchants may occasionally organise themselves into formal associations for logistical reasons (for example, transporting insects to markets). In Zimbabwe, there is already a well established formal marketing system for the commercialisation of *Imbrasia belina* (Zitzmann, 1999). There is also a significant transborder trade in edible insects within the Central African region, as well as with the Sudan and Nigeria, and (on a smaller scale) with France and Belgium. Export figures are rarely available. According to an

enquiry made by Tabuna (2000), France and Belgium annually import about 5 tonnes and 3 tonnes respectively of dried *Imbrasia* sp. from DRC (valued at some US\$ 41 500 in the case of Belgium, at an average price of US\$ 13.8 per kg).

Price is dependent on the species and product quality. In the case of fresh caterpillars the price may vary even within a single day because of desiccation. Further factors influencing price are:

- the culinary traditions and species preferences of local communities,
- the period (e.g. increased prices at the beginning and the end of the season),
- the distance between producer and consumer (e.g. transportation or storage),
- the number of intermediaries,
- the total supply of larva on the market,
- the location of the market (e.g. different quarters in one town).

N'Gasse (2003) analysed the revenues of a wholesaler who purchases and sells on average some 24 kg caterpillars per day during the season (three months a year). The wholesaler purchases caterpillars at a price per kg of 1000 FCFA (US\$ 1.70) and sells them on at an average price of 1333 FCFA. N'Gasse estimated the wholesaler's profits at some US\$ 600 over the season.

Research from Botswana indicates that income from selling *Imbrasia belina* represents 13 % of the total household cash income in one year (Zitzmann, 1999)<sup>2</sup>. The labour input for that activity required only 5.7 % of that for all income generating activities. The sale of *Imbrasia belina* is the third biggest source of income after the sale of poles and livestock, and is thus an important part of household livelihoods.

To make an assessment of the contribution of insects to total household income, more in-depth comparative studies are needed. These would need to take account of other insects (such as termites) and income from other activities. In addition, research on how benefits from marketing insects are spread among producers, wholesalers, and retailers is needed. It is assumed that the existing market chain is particularly advantageous to wholesalers.

The market for caterpillars is lucrative and growing. More and more people are getting involved, and demand is increasing, even from outside the Congo Basin. Collectors of edible caterpillars may now have to go about 10 km or more into the forest to find suitable collection areas, which may inhibit disadvantaged people (for example the handicapped or home-bound women) from involvement in the trade.

## Impacts on insect populations, on forest conservation and bushmeat consumption patterns

### **Defoliation impact of caterpillars on host trees**

Foresters tend to consider caterpillars as pests. Several caterpillar species are known to defoliate trees as they develop at the beginning of the rainy season and are nourished on fresh leaves. However, the trees usually respond by producing a second crop of leaves (Reeler et al., 1991). N'Gasse (2003) observed that insect attacks in the dense moist forest zone usually generate only limited long-term damage to host plants, and that such outbreaks have not been observed to happen frequently or over a large area. The application of chemicals in these forests to control caterpillar outbreaks is therefore rare or absent, giving forest-gathered caterpillars a comparative market advantage compared to caterpillars gathered from the farm. Forest managers should therefore take care to consult with the local people if they plan to use herbicides or pesticides in their forest concessions.

Caterpillars do have a negative impact when feeding on farm crops. In the sub-region of the Congo Basin, pest control of caterpillars is usually done by applying huge amounts of chemicals, which kill the insects but also makes them unsuitable for human consumption. The question is often raised whether increased harvest of insects as food might serve as a form of biological pest control. This could obviate the need for pesticides. It might also create new economic opportunities for local people. However, only those species feeding on forest plants (such as *Imbrasia oyemensis* and *I. belina*) should be considered, as caterpillar species which feed heavily on agriculture crops would be too problematic for the farmers.

### **Harvesting impacts on the trees**

Harvesting caterpillars is generally done in a non-destructive way by picking them by hand from the ground or tree trunk, or by climbing the tree and shaking branches. However, cutting down host trees for gathering larvae is widespread. In Zambia, clearings of up to two hectares may be made in years when caterpillars are abundant (Lees, 1962). In this way, harvesting caterpillars can contribute to forest degradation and deforestation.

### **Impacts of logging, bushfires and deforestation on caterpillar populations**

The harvesting of sapelli trees is an interesting case where the survival of an important edible insect species may be put at risk by elimination of its host tree through selective logging. In the Central African Republic, the present forest concession rules require loggers to leave at least one seed tree of sapelli for every 10 hectares of logged-over forests (perhaps only a tenth of the pre-cutting frequency). The logic for this is purely silvicultural (to allow natural regeneration of the species), and gives no consideration to the fact that local people regard the caterpillar species (*Imbrasia oyemensis*) feeding on sapelli leaves as a delicacy. Leaving only one sapelli tree per 10 hectares may result in a significant diminution of the caterpillar supply as well as a considerable reduction in the regeneration of young sapelli trees, as harvesting caterpillars is easier done by cutting them down.

Deforestation and forest degradation endanger the existence of insect populations. Bushfires and the use of pesticides can disturb both habitats and insect populations. There are numerous reasons for burning forests in the region but the most frequent are shifting cultivation and expansion of permanent agricultural land. The extensive use of fire for hunting game, particularly bush rats, has a significant negative impact on insect habitats and may result in reduced survival possibilities for highly favoured edible caterpillars. It may also increase populations of other species, such as non-edible bark beetles. As insects are part of the food chain of several birds and other small animals which are hunted for bushmeat, the reduced availability of insects also affects stocks of their predators. The resulting loss of biodiversity directly affects food supplies and livelihoods for local people as well as the fructification potential of plant species by reducing their pollination.

A very interesting issue is the positive feedback of caterpillar harvesting on the frequency of bushfires, which was noted in Zambia. Holden (1991) noticed that there were very few late fires<sup>3</sup> in those areas where people were harvesting caterpillars, as the villagers sought to protect the insects. Thus, he proposed research on caterpillars not only because of their importance as food but also their favourable impact on forest/woodland management. Likewise, Leleup and Daems (1969) investigated bush-burning dates in relation to the seasonal occurrence of the different life stages (e.g. eggs, pupae) of three edible caterpillar species in DRC, and provided several recommendations on the optimal times for burning of forests.

Indirectly, deforestation may alter local micro-climates in the short run, and contribute to climate changes in the long run, both of

which could disrupt the insect lifecycles. For instance, Holden (1991) mentions drought as an incipient problem, causing negative impacts such as the disappearance of host plants and corresponding edible insect species and/or combined invasion and proliferation of other (non-edible) species.

### **Impact on bushmeat consumption**

It is not easy to draw any firm conclusions as to whether caterpillars can and do substitute for bushmeat consumption. Regional diets include a wide range of food preparations and insects are used as a standard ingredient. They are consumed by all levels of society. Caterpillars are a traditional food and consumed according to their seasonal availability and market price. Prices of caterpillars fluctuate significantly on local markets, though they are not necessarily cheaper than meat or fish. In principle, caterpillars cannot be considered a substitute for farmed meat, the supplies of which are not seasonally influenced. The situation with bushmeat is less clear. Bushmeat comes from a wide range of animals. Availability and price of bushmeat fluctuate widely according to season and market site, as well as type, cut, and state of preservation. However, when supplies of bushmeat and fish decline in the rainy season, then it does seem that people rely more on caterpillars and other available insects.

### **Policy Relevance**

Edible insects have a high nutritional value and are a main source of protein in the local diets of Central Africa. In addition, their trade, although seasonal, does provide additional income for rural as well as urban people. It particularly benefits women. There is evidence that the demand for caterpillars is growing, including for exports, and that more people are becoming involved in the trade.

Caterpillars gathered from the forests have a comparative advantage over those edible species gathered on farms as they are free from pesticides and do not feed on or compete with farm crops. While in general, gathering practices of caterpillars in the dense moist forests have had little impact on the ecosystem, there are cases where it contributes to forest degradation. This includes high value timber species like sapelli.

The impact of forest logging and bushfires on insect populations is significant. Selective logging eliminates host trees, while fire not only kills insect populations instantly but leaves surviving insects/caterpillars with fewer food options after the fire. This influences the whole food chain from insect-eating animals to their predators, and can reduce the bushmeat supply. The full impact of reduced caterpillar populations on the broader forest ecosystem is still poorly understood.

**Box One** offers some recommendations for research on insect species of development interest.

### **Conclusion**

A wide range of different insect species are part of the diets of many cultures. Forest gathered caterpillars are of particular importance for the poor in Central Africa, and have a comparative advantage as they are pesticide-free and not feeding on agriculture crops. There is a wide range of mutually-influencing factors concerning caterpillar harvesting and its impacts on the forests on the one hand, and forest harvesting impacts on the caterpillar populations on the other. These are still poorly understood. It may well be that the management and captive rearing of those insects offer possibilities for food security, forest conservation and for reducing hunting pressure on bushmeat species, which are the present focus of donor interest.

A strong demand for caterpillars, combined with increasing difficulties in harvesting areas in the forest of the most preferred species, is putting a heavy burden on the livelihoods of the poorest

### Box One: Some recommendations for the research and development community

1. More attention should be paid to the biological potential of edible forest insects, including conservation, forest management, agriculture, nutrition, and processing aspects. For example:

a. A lot of species are not yet scientifically identified and knowledge of life cycles, host plants, and abundance in different habitats, is fragmented. A detailed inventory of the natural resource base, and linkages between larvae and host plants, should therefore be one of the prioritised fields of research. Local people should be involved so that they can contribute with their traditional knowledge.

b. Research on processing and storage of caterpillars is much needed. Techniques that add value might open also new opportunities for export marketing.

2. Edible insects and their trade make a significant contribution to the livelihoods of the poorest and most disadvantaged groups of society in the region. However, more people are entering the market both at the local level and by creating exports markets, possibly with negative effects on the livelihoods of the poor. Research and development actions in this area may include:

a. A comprehensive socio-economic analysis at the household level to assess the contribution of insects to food security, including subsistence as well as income generation. The analysis should distinguish the different types of households involved in insect commercialisation: producers, wholesalers, and retailers.

b. To improve households' revenues in marketing insects, market chains, and the benefit sharing need to be better understood from a pro-poor perspective. There is an important gender aspect in that women mainly manage caterpillar processing and commercialisation; producer-trade associations among women should be supported to improve their market share and profits.

3. Once more detailed and reliable information on the natural resource base, the markets, and stakeholders is available, emphasis should be given to investigate how best the production of selected insects can be enhanced and incorporated in natural resource management and forest conservation plans, for example:

a. An interesting field of research is the captive rearing of forest-based insect species and host plants, and which have to be considered in integrated land use management as it may support efforts for forest conservation and even reforestation. It may well be that insects offer much greater possibilities for captive rearing than the bushmeat species, which are the present focus of donor interest. The aim should be to identify suitable agro-forestry management systems, appropriate selection of insect species and host plants, methods to reproduce vegetal material, and conditions enabling increased yields of production (but with low risks for farmed crops). The development of such forest management systems would also require that consideration be given to questions of tenure and access, with their corresponding institutional frameworks and regulations regarding conflict management between different user groups, caterpillar gatherers, and timber producers.

and most disadvantaged people in the region. This may be a good moment to stop considering forest caterpillars as a forest pest and to develop and implement forest management, captive rearing of insects, and agroforestry practices that recognises, in a balanced way, their importance as a food crop for local people.

### Endnotes

<sup>1</sup> Some of the material used in this paper was collected prior to 1996 before the Democratic Republic was formed. However for the sake of consistency, Democratic Republic of Congo (DRC) will be used throughout this paper.

<sup>2</sup> Two periods of harvest within one year: December / January and March / April.

<sup>3</sup> 'Late' in this context means in the weeks close to the beginning of the rainy season.

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