



Harvesting modalities and periods of edible caterpillars in the Republic of the Congo

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ARTICLE INFO

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Received : 02 October 2021

Accepted : 05 November 2021

Published: 08 February 2022



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ABSTRACT

This study is part of the development of local products in order to fight against food insecurity. Its objective is to inventory the different techniques for harvesting edible caterpillars in Congo, to determine the different harvesting periods and the types of people involved in this harvest. Field missions taking into account the calendar of probable cycles of Lepidoptera in the different departments were carried out in the Congolese forest and savannah ecosystems. This study showed that the most common method of harvesting caterpillars is collecting, followed by shaking the branches of host plants by climbers. This activity is not gender specific, and is practiced by both young and old. The timing of caterpillar harvesting varies from one ecosystem to another and even between hemispheres. Lopping, felling of host plants, post-season harvesting of chrysalises buried in the soil, and bush fires are all factors that contribute to the reduction of edible caterpillars, and even to the disappearance of some species. Increasing their production requires agroforestry programs such as conservation and reforestation of caterpillar-feeding forest species, as well as caterpillar rearing.

Keywords: Ecosystem, biodiversity, edible caterpillars, host plants, Congo-Brazzaville.

Modalités et périodes de récolte des chenilles comestibles en République du Congo

Cette étude s'inscrit dans le cadre de la valorisation des produits locaux afin de lutter contre l'insécurité alimentaire. Son objectif est d'inventorier les différentes techniques de récolte des chenilles comestibles au Congo, de déterminer les différentes périodes de récolte et les types de personnes impliquées dans cette récolte. Des missions de terrain prenant en compte le calendrier des cycles probables des lépidoptères dans les différents départements ont été réalisées dans les écosystèmes forestiers et de savane congolais. Cette étude a montré que la méthode la plus courante de récolte des chenilles est le ramassage, suivi du secouage des branches des plantes hôtes par les grimpeurs. Cette activité n'est pas spécifique au genre, et est pratiquée aussi bien par les jeunes que par les vieux. Le moment de la récolte des chenilles varie d'un écosystème à l'autre et même entre les hémisphères. L'élagage, l'abattage des plantes hôtes, la récolte des chrysalides enfouies dans le sol après la saison, les feux de brousse sont autant de facteurs qui contribuent à la diminution des chenilles comestibles, voire à la disparition de certaines espèces. L'augmentation de leur production nécessite des programmes d'agroforesterie tels que la conservation et le reboisement des espèces forestières dont les chenilles se nourrissent, ainsi que l'élevage des chenilles.

Mots-clés : Écosystème, biodiversité, chenilles comestibles, plantes hôtes, changement climatique, Congo-Brazzaville.

INTRODUCTION

The Republic of Congo, with its vegetation cover consisting of 65% forest and 35% savannah, has an

important reserve of non-timber forest products (Loumeto, 2010). It is usually presented as a country with two major biomes, equatorial rainforests and

savannahs. In fact, the dense equatorial forests include several distinct units. There are three main massifs, namely (a) the Mayombe Massif (dense rainforests, 15,000 km²), (b) the Chaillu Massif (dense rainforests dominated by *Aucoumea klaineana* Pierre, 35,000 km²) and (c) the North-Congo Massif (dense rainforests, sometimes flooded, dominated by Meliaceae, about 150,000 km²). In addition, there are mesophilic forests on sandy soils (Batéké Plateau and Cataract Plateau) and forest fragments. Some small units can still be distinguished, such as the coastal mangroves with *Rhizophora racemosa* G. Mey. (30,000 ha). The savannahs, which include herbaceous, shrub and tree species, cover approximately 35% of the territory, or 105,000 km². They are divided into the coastal savannahs of Kouilou, the Niari valley, the Cataract plateau and the Batéké plateau. Lastly, forest plantations cover 5% of the territory. The main species are various *Eucalyptus* (*E. torelliana* F.Muell., *E. grandis* W.Hill ex Maiden and *E. citriodora* Hook.), two *Pinaceae* (*Pinus caraibaea* Morelet and *P. oocarpa* Schiede ex Schlechtendahl) and two *Acacia* (*Racosperma auriculariforme* (Benth.) Pedley and *Acacia mangium* Willd.) (Mabossy-Mobouna et al., 2016).

Despite these natural assets, most of the Congolese population does not have access to sufficient food; the right to food is not yet guaranteed. The food and nutrition situation in the country therefore remains worrying, with 26% of children under 5 years of age suffering from chronic malnutrition, while 39% of households are unable to cover their food needs and do not have access to the minimum caloric intake of 2,400 Kcal per day (FAO, 2013a). In addition, the Congolese population is continually growing, along with an ever-increasing demand for food, and it is clear that agriculture is unable to ensure food security for this population. There is therefore a need to resort to other alternative solutions likely to fill this food gap. The alternative resource must allow for a diet that is sustainable, culturally and economically accessible and has good nutritional value (Mabossy-Mobouna, 2017). Given this socio-economic situation and its impact on the nutritional status of the Congolese population, it seems appropriate to promote local foods that are already consumed and that have an undeniable nutritional value, by highlighting them. Among these foods, the consumption of insects is one of the possibilities that would help solve the problem of malnutrition in the world (FAO, 2004; FAO, 2013b). Among the insects consumed, caterpillars are becoming increasingly important in improving the food situation in Central Africa (Mabossy-Mobouna et al., 2013). However, very few studies regarding the harvesting of edible

caterpillars in the different departments of the Republic of Congo have been conducted. It is this gap that this article proposes to fill.

MATERIALS AND METHODS

Materials

Omegon blackstar binoculars were used to observe the caterpillars on the leaves of the host plants from a distance. A Samsung digital camera was used to photograph the caterpillars, their host plants and the harvesting techniques of the caterpillars.

A vestige brand thermo-hygrometer was used to determine the daily thermal and hygrometric characteristics of the collection ecosystem.

Samples of caterpillars were collected in the different forest massifs and in the different savannah ecosystems for their identification.

Leaves of host plants were collected for identification.

Type of study

Our study consisted of an inventory of factors related to the harvesting of edible caterpillars in the Republic of Congo.

Type of variables

The variables describing caterpillar harvesting were the following:

- The harvesting ecosystem;
- Host plants;
- Harvest periods and times;
- The human type involved in harvesting;
- Harvesting methods;
- Causes of edible caterpillar depletion.

Study area

This study took place in the main forest massifs (Mayombe, Chaillu and the North Congo Massif) and the various savanna plant formations of Congo. Field missions were conducted in the departments of Pool, Likouala, Kouilou, Niari, Lékoumou, Cuvette-Ouest and Sangha in the period from January 2015 to October 2019 in order to inventory the different methods of harvesting edible caterpillars and to determine the periods of availability of these caterpillars in the different ecosystems. The study was also conducted in some forest galleries in the Pool Department (Kinkala, Louingui, Mbanza-Ndounga, Boko and Loumo).

The different missions were programmed taking into account the calendar of probable *Lepidoptera* cycles for the different departments of

the country. Finally, accessibility was also an important criterion for the choice of sites to be surveyed.

Study population

The study population was indigenous and Bantu harvesters in the departments of Brazzaville, Sangha, Likouala, Cuvette, Cuvette Ouest, Lékoumou, Plateaux, Pool, Niari, Kouilou and Pointe-Noire. They were selected by lot. The collectors were made up of children and adults.

Duration of the study

The study was structured over four years, starting on January 9, 2015, in localities in the departments of Brazzaville, Sangha, Likouala, Cuvette, Cuvette Ouest, Lékoumou, Plateaux, Pool, Niari, Kouilou, and Pointe-Noire that were selected at random. In addition, complementary field missions were conducted in 2020 and 2021 in these departments.

Data processing and statistical analysis

Data processing was carried out with SPSS version 20 and Excel 2013. Data entry and production of raw tables were done with SPSS and Excel software. Quantitative variables are expressed as mean (\bar{x}) \pm standard deviation (s), while indicating extreme values (minimum and maximum). Categorical variables are expressed as numbers and percentages. The test of χ^2 was used for the comparison of variables by Student's law with (k-1) degree of freedom, with a significance level of 5%. The ANOVA test was used for the comparison of calculated means.

RESULTS

Harvesting methods

Caterpillars are harvested from 5 am to 12 pm and from 3 pm to 6 pm. Three main factors would favor the fall of caterpillars and would have implications concerning the various time periods and thus their collection periods. These three factors were: (a) the increase in the temperature of the forest environment, (b) caterpillars slipping on their branches following rainfall and (c) the wilting of the leaves that support them. The increase in the temperature of the forest environment leads the caterpillars to reach cooler areas, namely the tops of forest trees. This displacement would lead to a reduction in the adhesion of the legs to the fine branches and leaves, resulting in their fall. This factor would be responsible for a massive fall of

caterpillars around 12 o'clock. In addition, the enlargement of the caterpillars would favor the fall of leaves, especially old leaves (case of caterpillars of the genus *Imbrasia*). In conclusion, this set of conditions favors a significant fall of these caterpillars.

The most widespread mode of harvesting is the collection (Fig. 1). The collectors leave the village very early in the morning around 4 am to enter the forest, equipped with pots, buckets and basins. Some return to the village at 1:00 p.m.; others wait until the second harvest period in the afternoon and do not return until 6:00 p.m. *Imbrasia* caterpillars are harvested more from 5:00 am to 3:00 pm. During the surveys, the harvesting method of cutting down host plants was not observed. Caterpillars that fall from the host plant, migrate to the ground and can be collected within 200 meters of the host plant. The fact that harvesting times may vary has also been observed elsewhere in Africa, notably in Katanga (Malaisse et al., 1974).

The second method of harvesting caterpillars is by climbing on host plants. It is often used by indigenous people (40% vs 5%). The number of caterpillars harvested varies with time and space. It is most important in the morning and gradually decreases with time to become almost negligible in the afternoon. The quantity of caterpillars collected on the ground (Photo 2, 3) per tree is lower than that collected by climbers on the same tree. Climbers collected almost all the caterpillars found in the foliage (Photo 1, 4), even those that had not yet reached the last caterpillar stage. The number of caterpillars in a tree is proportional to its crown radius and/or leaf abundance.

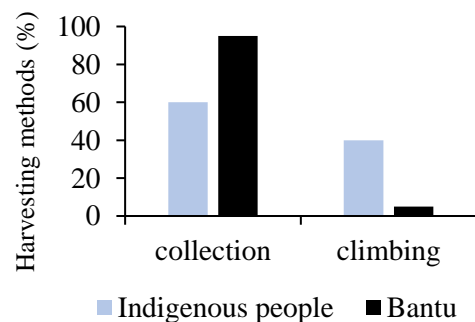


Fig. 1. Edible caterpillars' harvesting methods

Precise counts of *Imbrasia truncata* caterpillars allowed us to determine the average daily quantity. The average daily count was $3,832 \pm 2,594$ caterpillars collected from the foliage and $1,515 \pm 1,134$ caterpillars collected from the ground per person. The difference between the two caterpillar harvesting modalities is highly significant ($p < 0.001$).



Photo 1. Indigenous climbers on *Albizia ferruginea* in Loumou (Pool department), © Germain Mabossy-Mobouna, 27/07/2019.



Photo 2. Caterpillar collection by Mbendjele indigenous people in Pokola (Sangha Department). © Germain Mabossy-Mobouna, 12/08/2017.



Photo 3. Collection of *Imbrasia truncata* caterpillars by a Bantu woman in Wongo Ouest (Likouala Department). © Germain Mabossy-Mobouna, 04/08/2016.

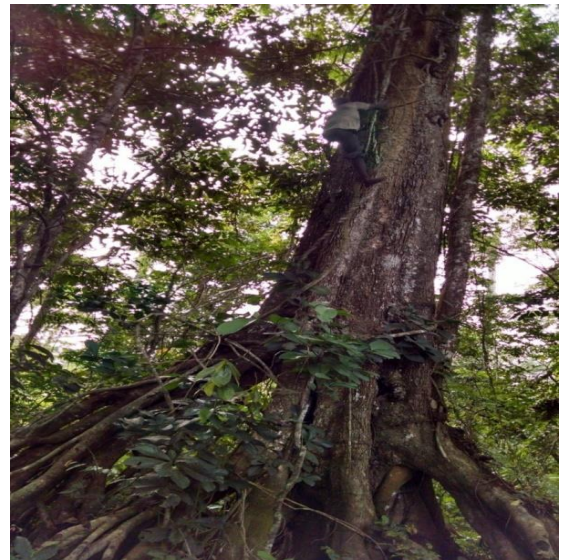
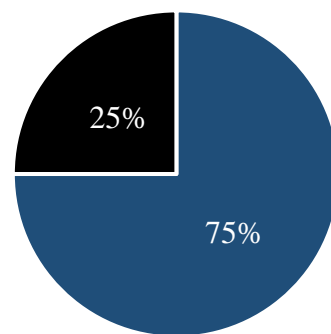


Photo 4. Native climber on *Uapaca guineensis* in Wongo Ouest (Likouala department). © Germain Mabossy-Mobouna, 04/08/2016.

Human type devoted to harvesting

Caterpillar collecting is not a human type specific activity (Fig. 2). It is undertaken by women, men and children. It is done by both indigenous people (Photo 6) and Bantu people (Photo 7, 8). However, in the departments where the two populations cohabit, the indigenous people are more involved (75%) than the Bantu (25%). Some Bantu recruit indigenous women and men to camp in the forests during the caterpillar harvesting period in order to have them harvest and smoke the caterpillars for a small fee or in exchange for clothing and cooking salt (Photo 5).



■ Indigenous people ■ Bantu

Fig. 2. Human type devoted to edible caterpillars harvesting



Photo 5. A young Bantu visiting the camp of indigenous Baaka harvesters in Ipendja (Likouala Department) © Germain Mabossy-Mobouna, 12/08/2017.



Photo 6. Two young indigenous girls collecting *Gonimbrasia melanops* caterpillars in Ipendja (Likouala Department) © Germain Mabossy-Mobouna, 12/08/2017.



Photo 7. Young Bantu people emerging from collecting *Gonimbrasia melanops* caterpillars in Wongo Ouest (Likouala Department). © Germain Mabossy-Mobouna, 04/08/2016.



Photo 8. Bantu woman leaving the harvest of "Emuala" caterpillars in Etoumbi (West Cuvette Department). Germain Mabossy-Mobouna, 17/10/2015.

Locating caterpillars on host plants

The caterpillars are spotted on the host plants, either by the characteristic noise when they eat the leaves, or by the presence of their droppings at the foot of the tree, or by the crackling sound of their droppings, or by the presence of a few caterpillars on the ground.

Harvesting period

Imbrasia sp. caterpillars are harvested in the departments of Lékoumou, Sangha and Likouala from July to September. *Imbrasia truncata* caterpillars are most commonly harvested in August and September in Pokola and Impfondo. However, in the same department, they do not appear at the same time from one locality to another. They appear first in Bétou, then in Enyellé, Impfondo and finally in Epéna in the Likouala Department. It's the same for Ouesso and Pokola in the Department of Sangha. The wave of appearance thus progresses from the northern hemisphere towards the equator and the harvesting period is about two months. During the harvest period, called "Mokongo", collectors and especially indigenous people stop other activities such as fishing and agriculture.

In the departments of Brazzaville, Pool and Plateau, caterpillars are often harvested from October to January. However, some outbreaks can be observed in May-June or in July. This was the case at the end of May 2016, when a pullulation of *Achaea catocaloides* caterpillars (*Erebidae*) consuming the leaves of *Racosperma auriculariforme* was observed in Brazzaville, in the Patte d'Oie forest, located in the heart of the city. The finding that the caterpillar was edible, led to its immediate and total harvest by Brazzavillians in

less than a week. This caterpillar is called Mabilu in Lari, Babila or Babili in Téké southern, Ayihi in Koyo, in Téké northern and in Mberé. Four years later (June 2020), a second and more significant outbreak was observed in the same area.

In the Cuvette-Ouest department, caterpillars are harvested from January to March. However, harvesting of some species can begin in December or even October.

Storage and preservation of harvested caterpillars

Caterpillars are collected alive and placed in containers during harvesting. Once the harvesters return to the village or camp, the caterpillars are lightly boiled in large pots and then spread out on racks (Photo 9) where they are smoked for two to three days.



Photo 9. Claie of the smoking of *Imbrasia epimethea* caterpillars in Wongo-Ouest village (Likouala Department). © Germain Mabossy-Mobouna, 04/08/2016.

The smoked caterpillars are stored in bags called "green bands" and then transported to the sale sites. In cities such as Impfondo and Ouesso, fresh caterpillars are lightly boiled in salt water and shipped the next day to Brazzaville by plane.

Causes of edible caterpillar scarcity

In forested areas, the depletion of edible caterpillars is often due to the expansion of agricultural areas into areas previously occupied by forests and logging by cutting down caterpillar host plants. In addition, slash-and-burn cultivation with its fierce fire incinerates both host plants and pupae undergoing metamorphosis in the soil, under the litter, and even on the undergrowth cut throughout the cultivated area. In savanna areas, host plants are either felled for fuelwood or for charcoal making.

This is what has caused the scarcity of caterpillars in some departments such as the Pool Department. In this department most of the edible caterpillar species have disappeared because the caterpillar-loving population even consumes the chrysalises, which most often interrupts the development cycle of the lepidopterans, leading to their disappearance.

DISCUSSION

The results of our study showed that caterpillars are collected either in the forest or in the savanna. There are species that are only found in the forest (most of the species of the genus *Imbrasia*) and species that are found in the savannah (the genus *Antheua*). Their availability is seasonal and the period of availability varies according to the departments. It is on average two months in each ecosystem. This is in agreement with the observations made by Pagezy (1988). This period corresponds to the rainy season. These results are in agreement with those of Moussa (2002), who pointed out the same periods of availability. However, some caterpillars may be present at the beginning of the dry season. In the northern part of Congo, the period of caterpillar availability is the same as in the Equator and North Ubangi provinces (Yabuda et al., 2019). In the southern part, the harvest periods coincide with those of Central Kongo Province (Latham, 2008). Studies in other regions indicate that edible caterpillar movements along the trunks vary with time. This is notably the case for *Elaphrodes lactea* in the open forest of Katanga (Malaisse et al., 1974).

This study showed that caterpillar collecting is not an activity specific to one type of human. It is undertaken by women, men and children, which is consistent with Looli et al.'s (2021) finding that caterpillar harvesting is a gender non-specific activity in the Kisangani region of DR Congo. This result also agrees with Badanaro et al. (2014) who showed that in Togo, children, men, and women are involved in *Cirina forda* caterpillar collection. However, in the Central African Republic (CAR), the majority of harvesters are men (Mbétid-Bessane, 2005). It is done by both indigenous people and Bantu. However, the indigenous people are more involved (75%) than the Bantu. This observation was also made by Bocquet et al. (2020), who emphasized in their study of the few caterpillars consumed by the Mongo in Equateur Province in DR Congo that it is mainly people from the Twa group who harvest the caterpillars from the trunks of trees. Indeed, indigenous people are able to locate caterpillar species in their habitat and have a good knowledge of their host plants.

The exploitation of caterpillars depends on their availability in the surrounding ecosystems.

Unfortunately, the forest species that host edible caterpillars are also the species most destroyed for charcoal production by farmers, field work and by logging companies for making quality boards. This result confirms the observations made by Muvundja et al. (2013) and Ombeni (2015) who pointed out that these exploitations generally present a negative impact on the functioning of forest ecosystems, but also on the promotion of food security of indigenous peoples based mainly on the exploitation of non-timber forest products (NTFPs), the most important of which are edible caterpillars. This partly explains the shortage of *Imbrasia* caterpillars reported by harvesters in Pokola.

Our study showed that the most common method of harvesting caterpillars is by picking. This result is contrary to those obtained by Balinga et al. (2004) who showed that some harvesters in Cameroon, Congo and CAR cut host branches to collect *Imbrasia* caterpillars. It is also contrary to that of Looli et al. (2021) who found several modes of caterpillar harvesting in Kisangani.

Caterpillars are harvested in different departments, either by picking up caterpillars from the ground or by shaking caterpillars from the branches of host plants. These techniques alone are not destructive of biodiversity. However, lopping, felling of host plants, post-season harvesting of chrysalises buried in the soil and bush fires are all factors that contribute to the reduction of edible caterpillars and even the disappearance of certain species.

Increasing the production of caterpillar species requires agroforestry programs such as the conservation and reforestation of caterpillar-feeding forest species and caterpillar-rearing. Thus, the possibility of large-scale production of these caterpillars must be encouraged in order to make them available and accessible.

CONCLUSION

The results obtained in this study fill in a gap in knowledge on a topic that has proven to be essential for local populations in the Republic of Congo. Similar studies are available for many parts of Africa. The present study has highlighted the different caterpillar harvesting techniques in the Republic of Congo. The harvesting by some populations of almost all caterpillars encountered and the post-season harvesting of chrysalids do not contribute to the sustainable management of edible caterpillars. Similarly, the felling of host plants by logging companies, field work and bush fires contribute effectively to the scarcity or even disappearance of certain species of edible caterpillars. To this end, the increase in caterpillar production and their sustainable management

requires agroforestry programmes such as the conservation and reforestation of caterpillar-feeding forest species, the breeding of caterpillars and the prohibition of bad human practices that may contribute to their disappearance.

Conflicts of Interest

The authors declare no conflict of interest.

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