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RESEARCH

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Edible caterpillars and their host plants: ethnobotanical insights in Kwilu, Democratic Republic of Congo

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Abstract

Background In Kwilu Province, Democratic Republic of Congo, almost 99% of the population eats a variety of edible caterpillars. Many plant species used by humans are also eaten by these caterpillars. Intensive human use of these plants could lead to their gradual extinction. This would directly affect the caterpillars that feed on them and reduce their protein supply to local populations. Assessing these pressures requires a basic understanding of the species involved.

Methods Semi-structured surveys were conducted with 180 randomly selected informants in the two most populated areas of Kwilu (Masi-Manimba and Idiofa). Questions focused on the 'most consumed' edible caterpillars (i.e. those that are best known and most eaten), their host plants, and how the local population uses them. Caterpillars and branches of host plants were collected during the survey visits. The importance of each cited caterpillar species, their host plant, and the host plant's use category by the local population was assessed.

Results Seventeen species of 'most consumed' edible caterpillars were recorded, with the Saturniidae being predominant. They feed on the leaves of fifty-one plant species, mostly Fabaceae. There are seven main use categories of caterpillar host plants. Among these, wood charcoal, construction, and slash-and-burn agriculture are estimated to be the primary factors causing the destruction of caterpillar's host plants. *Petersianthus macrocarpus* (P. Beauv.) Liben and *Ricinodendron heudelotii* (Baill.) Pierre ex Heckel are preferred by the 'most consumed' caterpillars. Both plant species, along with *Erythrophleum africanum* (Benth.), hold great cultural importance in Kwilu and are under significant pressure.

Conclusions The promotion of edible caterpillars through the establishment of plantations for the semi-rearing would contribute to the conservation of these species and make them more available to the local population. Caterpillar preference testing, diet modification and interaction studies between these species would enable better management.

Keywords Ethnoscience, Ecology, Saturniidae, Campeophagy, Usages

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Background

The Democratic Republic of Congo (DRC) is recognized as one of the world's mega-diverse countries due to its exceptional biological diversity, high endemism, and diverse natural habitats influenced by climatic variability [1, 2]. Although it possesses the vast natural resources that could drive socio-economic development, it remains one of the poorest countries in the world [7]. With an underdeveloped industrial sector, the country faces persistent poverty and high unemployment rates [8]. More than 70% of rural Congolese experience food insecurity, relying heavily on forest resources for their livelihoods [7, 9]. Among these resources, caterpillars serve as a crucial protein source, accounting for approximately 40% of the country's total animal protein intake. Their consumption, known as campeophagy, is widespread, affecting nearly 85% of the Congolese population, especially in Kwilu Province, one of the poorest regions [3, 10, 11]. With a very high poverty rate (77.2% in 2012), the province's economy is based on trade and slash-and-burn agriculture [25]. As a result, the total forest area of the province is currently very small. It is estimated to have been 35,655 Km^2 initially, 18,823.8 Km^2 in 2000 and 13,967.7 Km^2 in 2018 [26]. It has a variety of ecological characteristics due to its geographical location and its diverse ecosystems. Phytogeographically, it belongs to the Guineo-Congo region, which is characterized by gallery forests along rivers and wooded savannas [23, 79]. It stands out as a reservoir of caterpillars, hosting one of the highest diversities of caterpillar species [3, 4]. Research has emphasized the need to promote these insects as a sustainable food source through mass production via semi-domestication [5, 6].

Despite the ecological and economic importance of caterpillars, no in-depth study has been conducted on their relationship with host plants and, by extension, on the interaction between these plants and human communities in the DRC. Caterpillars feed on a wide range of plants, classified as monophagous (feeding on a single plant species), oligophagous (feeding on a single plant family), or polyphagous (feeding on plants from multiple families) [12, 13]. In addition to being a food source for caterpillars, these plants serve multiple functions for local communities, including food, medicine, construction materials, and fuel [14].

However, deforestation, driven by tree felling for caterpillar harvesting, logging, and slash-and-burn agriculture, has led to ecosystem degradation and a decline in certain caterpillar species [15, 16]. Sustainable large-scale caterpillar production depends on a thorough understanding of their natural habitats, particularly their host plants, which must be continuously available to ensure long-term viability. Without these plants, caterpillars stop feeding and face extinction. Additionally, with nearly 85% of households in the region relying on plants for various needs, deforestation intensifies, further threatening both host plants and the caterpillars that depend on them [9, 17, 18]. Several studies indicate that the loss of host plants results in the gradual decline of specific caterpillar species, including *Anaphe panda* (Boisduval, 1847), *Cirina forda* (Westwood, 1881), *Elaphrodes lactea* (Gaede, 1932), *Gonimbrasia anthinoides* (Rougeot, 1978), and *Platylesches moritili* (Wallengren, 1857) [19–21]. Lunga [77] reported significant declines in edible caterpillars in the former Bandundu Province (which includes Kwilu). This biodiversity loss impacts both food security and ecosystem functions, such as pollination, which is crucial for plant reproduction [21].

Understanding the ecological knowledge of local populations regarding resource use is essential for biodiversity conservation, sustainable resource management, and climate change mitigation [22]. However, Kwilu Province remains one of the least studied regions in the DRC [4], and data on the host plants of edible caterpillars and their uses are lacking. The study focuses on Kwilu's two most populous areas, Idiofa and Masi-Manimba, which were selected for their contrasting socio-ecological contexts. Idiofa is characterized by dense forest cover and greater reliance on artisanal logging, while Masi-Manimba is characterized by a mixed savanna-forest mosaic and greater agricultural pressure [23, 26]. These differences are important for understanding how habitat type (forest vs. savanna) and local human activities shape host plant availability and caterpillar ecology. For example, forest-dwelling species such as *Piptadeniastrum africanum* (Hook. f) Brenan may face greater extraction pressure in Idiofa, whereas savanna-associated plants such as *Burkea africana* Crochet. may be more resilient in the fragmented landscapes of Masi-Manimba.

This study examines the relationships between the most commonly consumed caterpillars, their host plants, and human communities (who use these plants). Caterpillars are the food and cultural resources valued by humans, while host plants are their ecological support and a multiple-use resource for local communities [3, 9, 28]. The main questions the study aims to answer are: (1) Which caterpillar species are most consumed by the local population and what are their host plants? (2) What are the habitat types and morphological traits of host plants for edible caterpillars? (3) Which host plants support more than two caterpillar species and what is their cultural importance as hosts? (4) What are the dominant use categories of edible caterpillar host plants, and how do these uses correspond to the most culturally important host species (5) How do different use categories of caterpillar host plants correlate with their cultural importance, and which uses contribute most to their overexploitation? The main objective of this study is to assess pressures on the most commonly consumed caterpillar food plants by cataloging these plants and their uses in Kwilu Province. Specifically, this study seeks to compile a list of caterpillar-associated food plants and evaluate their significance to local communities. The expected outcomes will help prioritize plant species for cultivation, facilitating the development of sustainable caterpillar farming. This research aligns with the Sustainable Development Goals (SDGs) adopted by the United Nations.

Methods

Study area

The study area includes Idiofa and Masi-Manimba, the two most populous areas located almost in the centre of Kwilu Province. The former (Idiofa), which is more forested and relatively isolated, is located between 595 and 675 km by road from the capital, Kinshasa, while Masi-Manimba, which is more open and dominated by savannah, is located on the national road (RN1), about 372 km from Kinshasa [23, 79]. The province of Kwilu (surface area: 79,071 Km^2) is one of the new provinces of the DRC, resulting from the dissolution of the former province of Bandundu in 2015 [79]. It is bordered to the north by the province of Mai-Ndombe, to the south by the province of Kwango, to the east by the province of Kasaï Central and to the west by the province of Kwango and the city of Kinshasa. It covers an area of 79.1 Km^2 and comprises five territories, the most populated of which, Idiofa and Masi-Manimba (Fig. 1), are in the centre of the province. The population is estimated at over 8 million. The density is around 100 inhabitants/Km^2 [23]. It has a humid tropical climate of type AW (a savanna climate with a dry winter or a winter-dry season) in accordance with the Köppen climate classification, characterized by the existence of two contrasted wet seasons and relatively cool nights [24]. The average annual temperature is 25 °C, average rainfall between 800 and 1500 mm, and relative humidity remains high throughout the year.

Ethnobotanical surveys

The data collection was authorized by several competent authorities. The investigators obtained official approval

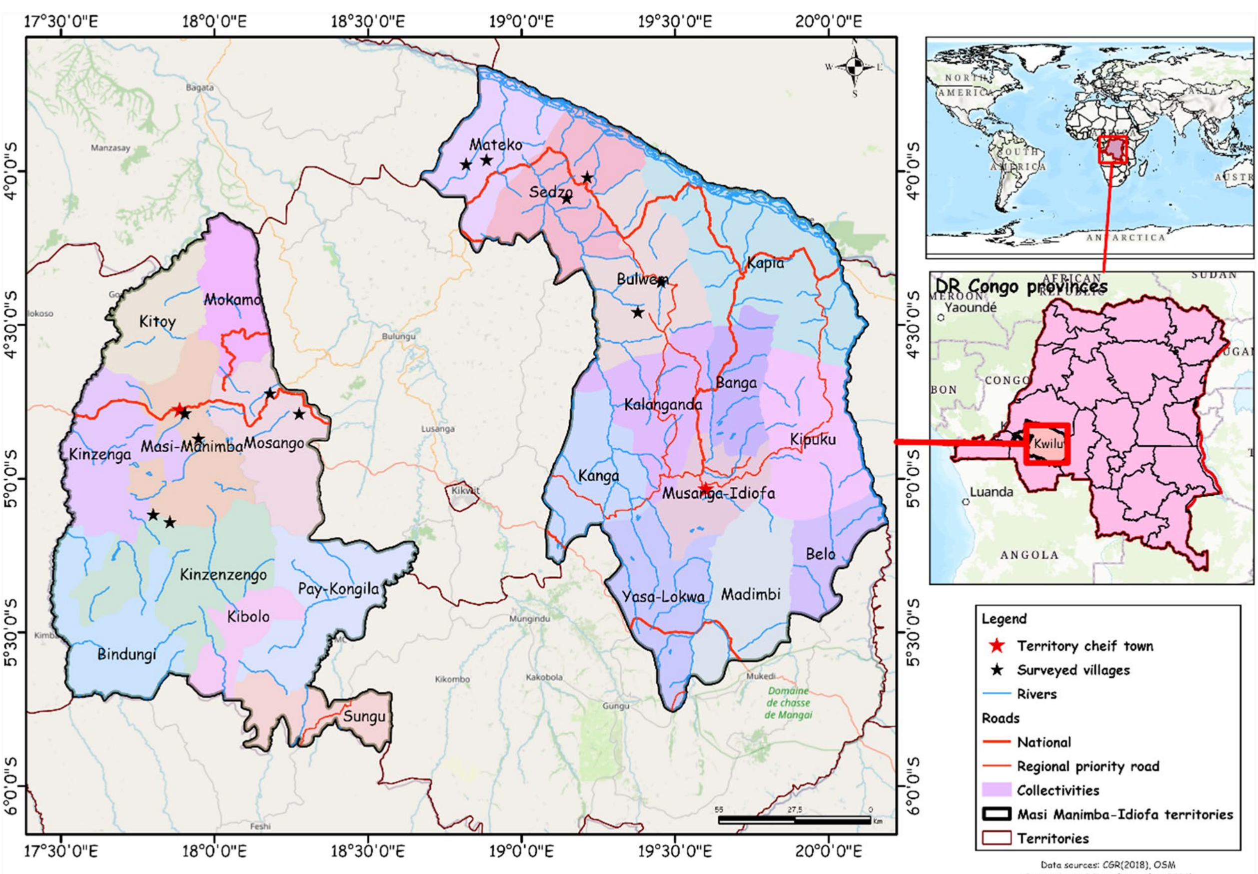

Fig. 1 Map of the study area. The study was conducted in the Masi-Manimba and Idiofa territories. Surveyed villages are indicated. The colours on the map represent the collectivities. The map was created using ArcMap 10.8.1

from the Department of Functional and Evolutionary Entomology of Liege University, the Institut Supérieur Pédagogique de Bandundu, and the Administrator of the Masi-Manimba and Idiofa Territories. A permit was also obtained from the Provincial Coordination of the Environment and Sustainable Development in Kwilu Province, as well as verbal consent from each participant. Semi-structured interviews were conducted with 180 randomly selected informants. The information was collected between 2020 and 2022 in 12 villages in six sectors belonging to two of the most populated zones in central Kwilu Province (Bulwem, Mateko and Sedzo in the Idiofa zone and Kinzenzengo, Masi-Manimba and Mosango in the Masi-Manimba zone). In each village, 15 informants were randomly selected (i.e. 30 per sector and 90 per area). The villages were selected based on their abundance and diversity of caterpillars (recognized by the authorities as caterpillar reserves). Interviews were conducted at the informants' homes and during the survey visits. After explaining the objectives of the study, a questionnaire written in French was presented to the respondents (S4). A free enumeration method was used and the respondents were asked to list the best known and most commonly consumed caterpillars, their host plants and uses categories in the area. The survey was conducted in the local language (Kikongo). Species with a frequency of >75% of all respondents were selected for the study. The protocol also included the host plants of these caterpillars and traditional knowledge about the different uses of the plants. To assess the cultural importance of these host plants, seven main categories of use have been identified according to emic categories, including timber for small-scale logging (of international importance for its quality), local building materials, craft and technological uses, cultural uses and medicinal uses. Finally, the 'other' category covers usages that are not common (or rarely mentioned), including food, hygiene, cooking (and fishing and hunting techniques). Of the informants, 115 were male (63.9%) and 65 were female (36.1%), 79 were elderly (> 69 years), i.e. 43.9%, 74 were adults (i.e. 46–69 years), i.e. 41.12%, and 27 (15%) were relatively young (30–45 years).

Sampling and identification of caterpillars and their host plants

Caterpillars and branches of host plants were collected during the survey visits. The caterpillars were preserved in ethanol (70%) for identification using the determination key established by Mabossy-Mobouna et al. [27] and the work of Latham et al. [28]. Caterpillars consumed in the region were previously inventoried by Madamo et al. [3]. The plant material was collected and kept at the Herbarium of the University of Kinshasa (UNIKIN). Each species has a reference number given by the collector (Table S1). The plant material was identified with the help of the national herbarium of the DRC, at the "Systémique, Biodiversité et Conservation de la Nature" laboratory of the Department of the Environment (University of Kinshasa), the Flora of the Belgian Congo and Rwanda-Urundi, the Flora of Central Africa, Cameroon and Gabon and the Flora of East Africa. Botanical families and scientific names were determined for each host plant according to APG IV.

Caterpillars and host plants importance assessment

The local importance of each cited caterpillar species, host plant and use category was calculated using the relative citation frequency (CF). The ethnobotanical index used was cultural importance (CI) [29]. The relative frequency of citation was calculated using the formula: $CF = (n/N) \times 100$, where n is the number of informants who cited the species and N is the total number of informants. The cultural importance index was calculated using the formula: $CI = NUi/N$, where NUi is the total number of recorded uses for each species and N is the total number of informants involved in the study. The higher the CI value, the more important the species. Edible caterpillars are considered 'most consumed' (i.e. recognized by most of the local population) if the relative frequency of citation is greater than 75%.

Statistical analysis

All statistical tests and graphs were generated in R 4.4.1 [30]. Frequencies were calculated for habitat types, morphological traits, and caterpillar host plant use categories and presented in sector plots. Chord diagram representing the interactions between edible caterpillars and their associated host plants and the uses of the main host plants of edible caterpillars was generated using the 'circlize' package [32]. To evaluate how host plant use categories correlate with their cultural importance (CI), a Principal Component Analysis (PCA) was performed using the package 'FactoMineR' [31]. Trees with a CI >3 were included in this analysis. Before performing the PCA, the data were standardized to ensure that all variables were on a comparable scale. A covariance matrix was computed to understand the relationships between the different host plants. Eigenvalues and their corresponding eigenvectors were calculated from the covariance matrix. Principal components were selected based on the amount of variance explained, typically choosing those that collectively account for a significant portion of the total variance.

Results

Diversity of 'most consumed' edible caterpillars and their host plants

Of all the caterpillars consumed in Kwilu Province, seventeen were cited by informants with a frequency of more than 75% (Table 1). Of these, 64.7% had a frequency greater than 90%, with the best known and most consumed species in both areas being *C. forda*, *Cymothoe caenis* (Drury, 1773), *Imbrasia epimethea* (Drury, 1773) and *Imbrasia obscura* (Butler, 1878). Saturniidae (47%) and Notodontidae (35%) are well represented, while the other families are represented by a single species (Erebidae, Hesperiidae and Nymphalidae). The genus *Imbrasia* is the most represented in the list. The 'most consumed' caterpillars of Kwilu are illustrated in Fig. 2. These caterpillars feed on the leaves of fifty-one plant species (Table S1). They are divided into 16 families, with the Fabaceae family dominating (23 species), followed by the Apocynaceae, Phyllanthaceae, Rubiaceae and Poaceae families, each of which is represented by three species, while the others are poorly represented (1 or 2 species).

Of these plant species, nine (17.7%) host more than two species of 'most consumed' caterpillars simultaneously, mainly Saturniidae, which have almost all the same hosts. *Petersianthus macrocarpus* (P. Beauv.) Liben (PNHMA) is recorded as feeding on five species of most consumed caterpillars, *Millettia eetveldeana* (Micheli) Hauman (MLTED) and *Ricinodendron heudelotii* (Baill.) Pierre ex Heckel (RIDHE) each host four species of these caterpillars. These plants, with the highest CI (Table S1), serve as hosts for more than three caterpillar species in both areas, with mean CI values of 4.3 ± 0.0, 3.8 ± 0.1, and 3.3 ± 0.1, respectively. Additionally, the cultural importance of certain host plants varies between areas. For example, *Amphimas pterocarpoides* Harms and savannah species hold greater significance in Masi-Manimba. Conversely, other species are more culturally important in Idiofa, such as *P. africanum* (CI = 2.4 in Idiofa vs. 1.4 in Masi-Manimba) and *U. guineensis* (CI = 2.6 in Idiofa vs. 1.2 in Masi-Manimba).

Most reported plant species come from forest (74%), 16% come from savanna, 8% come from both savanna and forest and 2% are cultivated (Fig. 3). Morphologically, these species are dominated by trees (66%), followed by lianas (12%), shrubs (10%), grass (8%) and bushes (4%).

Feeding mode of edible caterpillars in Kwilu

More than half (58.8%) of edible caterpillars in Kwilu have a specialist feeding mode (Table S1), feeding on plant species from a single botanical family, while 41.2% are generalists, feeding on leaves from trees from more than two families. Among the specialists, 50% are strict specialists (or monophagous, using a single host species), such as *Imbrasia ertli* (Rebel, 1904) and *Pseudantheraea discrepans* (Butler, 1878) (Fig. 4), but also *A. panda*, *C. caenis* and *E. lactea*. On the other hand, 50% are less specialized. They are described as oligophagous because they use more than one host species (2 to 6) from the same family. Examples are the caterpillars of *Alenophalera brunneomixta* (Mabille, 1898), *C. forda*, *Coeliades libeon* (Druce, 1875) and two species of *Epidonta*. The 'most consumed' edible caterpillars of Kwilu with higher overall levels of polyphagy are mainly Saturniidae (Table S1), including *Bunaea alcinoe* (Stoll, 1780) (14 host species from 9 families and 7 orders), *Gonimbrasia petiveri* (Guérin-Méneville, 1845) (10 species from 8 families and 6 orders), *I. epimethea* (8 species from 7 families and 5 orders), *I. obscura* (13 hosts from 6 families and 6 orders), *Imbrasia truncata* (Aurivillius, 1909) (5 hosts from 5 families and 4 orders), *Achaea catocaloides* (Guenée, 1852) (15 hosts from 4 families and 4 orders) and *Haplozana nigrolineata* (Aurivillius, 1901) (5 species from 3 families and 3 orders).

Host trees use categories

The population recognizes seven main categories of use for the host trees of Kwilu caterpillars (Fig. 5). These include medicinal purposes and local building needs (20%), wood charcoal (19%), craft and technological applications (e.g. furniture, dugout canoes) (15%), and food production (15%). Additionally, 12% of host trees are used for multiple purposes, such as food, cooking, packaging, bioindicators, shelter, shade, hunting, fishing, and hygiene (31 species), while another 12% are used for artisanal forestry (22 species). Cultural or ritual uses account for 2% (5 species). Most of these trees serve multiple functions (Table S2), and all usage categories are present in both zones. The most widespread uses in the province are related to medicine, building, and wood charcoal, which are also the most in-demand categories for caterpillar host species.

For fuel, informants acknowledge that all species can be used, except those prohibited due to traditional beliefs, such as *Mitragyna stipulosa* (DC.) Kuntze. Regarding other uses, informants report that *Albizia adianthifolia* (Schumach.) W. Wight and *Milicia excelsa* (Gallois) CCBerg signal the start of the rainy season by shedding all their leaves. The seeds of *R.*

Table 1 Diversity and frequency of occurrence of the 'most consumed' caterpillars and their host plants

Caterpillar families	Caterpillar species	CF Masi-Manimba (%)	CF Idiofa (%)	Fabaceae	Apocynaceae	Phyllanthaceae	Rubiaceae	Poaceae	Euphorbiaceae	Combretaceae
Erebidae	*Achaea catocaloides* (Guenée, 1852)	97.8	95.6	+						
Hesperidae	*Coeliades libeon* (Druce, 1875)	100	55.6					+		
Notodontidae	*Alenophalera brunneomixta* (Mabille, 1898)	95.6	92.2	+						
	Anaphe panda (Boisduval, 1847)	92.2	92.2							
	Elaphrodes lactea (Gaede, 1932)	85.6	86.7	+						
	Epidonta sp.1	94.4	94.4	+						
	Epidonta sp.2	94.4	92.2	+						
	Haplozana nigrolineata (Aurivillius, 1901)	95.6	57.8	+		+		+		
Nymphalidae	*Cymothoe caenis* (Drury, 1773)	100	100							
Saturnidae	*Bunaea alcinoe* (Stoll, 1780)	92.2	87.8	+	+		+		+	+
	Cirina forda (Westwood, 1849)	100	100	+						
	Gonimbrasia petiveri (Guérin-Méneville, 1845)	82.2	83.3		+	+	+		+	+
	Imbrasia epimethea (Drury, 1773)	100	100	+	+	+	+		+	
	Imbrasia ertli (Rebel, 1904)	100	52.2	+						
	Imbrasia trucanta (Aurivillius, 1909)	94.4	100	+		+	+		+	
	Imbrasia obscura (Butler, 1878)	100	100	+	+				+	+
	Pseundantheraea discrepans (Butler, 1878)	82.2	100			+				

Table 1 (continued)

Caterpillar families	Caterpillar species	Lamiaceae	Meliaceae	Moraceae	Clusiaceae	Lecythidaceae	Malvaceae	Marantaceae	Myristicaceae	Achariaceae
Erebidae	*Achaea catocaloides* (Guenée, 1852)		+			+		+		
Hesperidae	*Coeliades libeon* (Druce, 1875)									
Notodontidae	*Alenophalera brunneomixta* (Mabille, 1898)									
	Anaphe panda (Boisduval, 1847)						+			
	Elaphrodes lactea (Gaede, 1932)									
	Epidonta sp.1									
	Epidonta sp.2									
	Haplozana nigrolineata (Aurivillius, 1901)									
Nymphalidae	*Cymothoe caenis* (Drury, 1773)									+
Saturnidae	*Bunaea alcinoe* (Stoll, 1780)	+		+	+	+				
	Cirina forda (Westwood, 1849)									
	Gonimbrasia petiveri (Guérin-Méneville, 1845)	+				+			+	
	Imbrasia epimethea (Drury, 1773)					+			+	
	Imbrasia ertli (Rebel, 1904)									
	Imbrasia trucanta (Aurivillius, 1909)									
	Imbrasia obscura (Butler, 1878)		+	+						
	Pseundantheraea discrepans (Butler, 1878)									

CF: Citation frequency; + indicates that the caterpillar species feeds within the plant families

Fig. 2 Illustration of the 'most consumed' caterpillars of Kwilu. **a** *Anaphe panda* (Boisduval, 1847) **b** *Imbrasia ertli* (Rebel, 1904); **c** *Coeliades libeon* (Druce, 1875); **d:** *Imbrasia epimethea* (Drury, 1773) **e** *Pseudantheraea discrepans* (Butler, 1878); **f** *Epidonta* sp.; **g** *Cirina forda* (Westwood, 1881); **h** *Achaea catocaloides* (Guenée, 1852); **i** *Imbrasia obscura* (Butler, 1878); **j** *Imbrasia truncata* (Aurivillius, 1909); **k** *Haplozana nigrolineata* (Aurivillius, 1901); **l** *Gonimbrasia petiveri* (Guérin-Méneville, 1845); **m** *Cymothoe caenis* (Drury, 1773); **n** *Bunaea alcinoe* (Stoll, 1780); **o** *Elaphrodes lactea* (Gaede, 1932); **p** *Alenophalera brunneomixta* (Mabille, 1898)

heudelotii are consumed, while those of *Eriosema psoraleoides* (Lam.) G. Don are used as a fishing poison. The sap of *Funtumia africana* (Benth.) Stapf and *Holarrhena floribunda* (G. Don) Dur. & Schinz (used as glue) helps catch birds. Additionally, the leaves of *Millettia macroura* Harms are rubbed to produce soap for washing dishes, bark dust from *Hymenocardia acida* Tul. is used for smoking a type of fish known as 'eel,' and the leaves of *Haumania liebrechtsiana* (De Wild. & T. Durand) J. Léonard serve for packaging and cooking. While medicinal plant use has a relatively minor impact, excessive harvesting contributes to ecosystem disruption. The plants and their associated diseases are listed in Table S3.

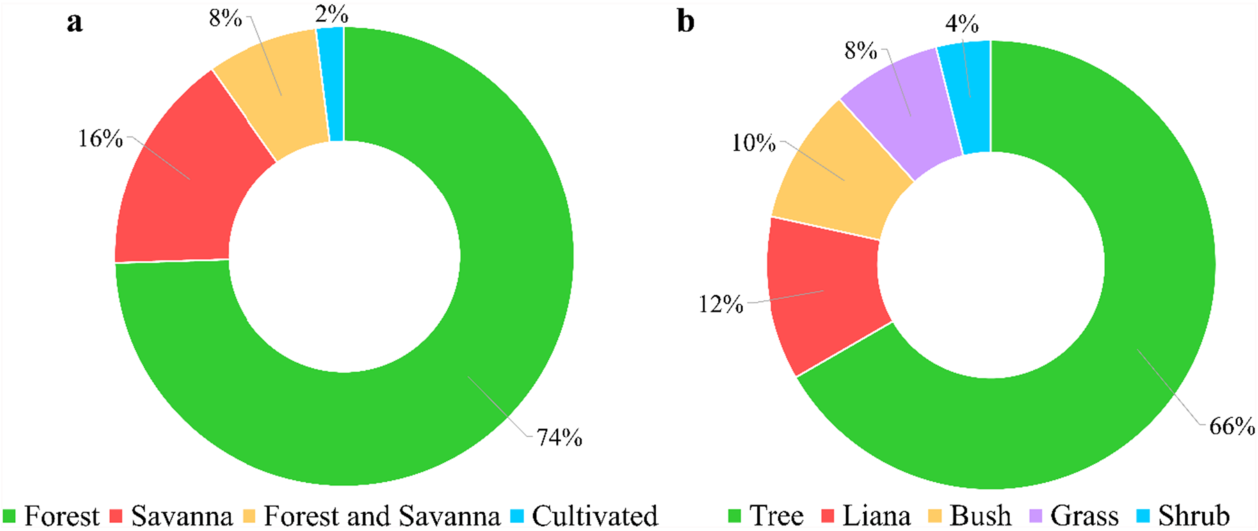

Fig. 3 Caterpillar habitats **a** and morphological types of caterpillar host plants **b**. The proportions represent the significance of each ecosystem for edible caterpillars and the distribution of host plant types in the Idiofa and Masi-Manimba territories

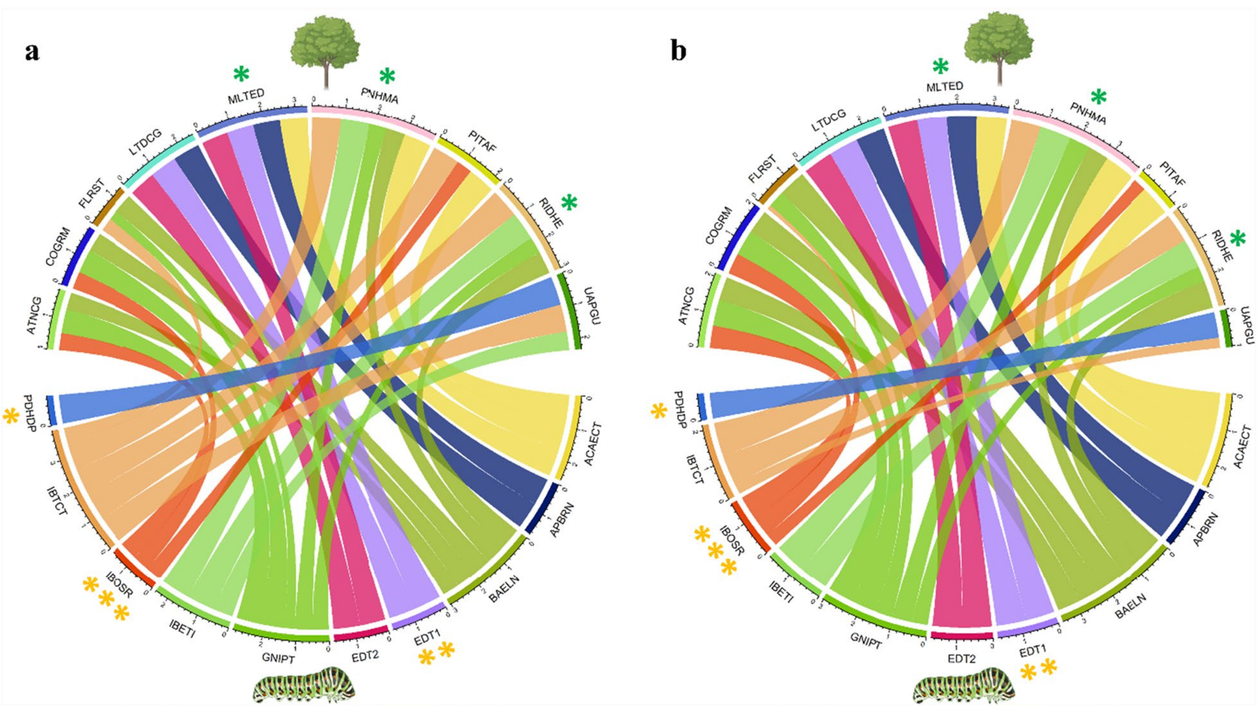

Fig. 4 Correspondence between the main edible caterpillars and their associated host plants based on citation frequency. The networks illustrate the feeding pressure of caterpillars on nine highly valued host plants. **a** Idiofa; **b** Masi-Manimba. In each network, the upper section represents the host plants, marked with green stars to indicate the most preferred plants (those hosting 4–5 caterpillar species). The lower section corresponds to the caterpillar species, with yellow stars denoting their feeding behaviour: one star for monophagous caterpillars, two stars for oligophagous caterpillars, and three stars for polyphagous caterpillars. The width of each band represents the degree of feeding pressure on a host plant, while the colour reflects the number of caterpillar species feeding on its leaves. ATNCG: *Alstonia congensis;* COGRM: *Combretum racemosum*; FLRST: *Hallea stipulosa*; *LTDCG*: Leptoderris congolensis*; MLTED*: Millettia eetveldeana*; PNHMA: *P. macrocarpus*; PITAF: *Piptadeniastrum africanum*; RIDHE: *R. heudelotii*; UAPGU: *Uapaca guineensis.* ACAECT: *Achaea catocaloides*; *APBRN: *Alenophalera brunneomixta*; *BAELN: *Bunaea alcinoe*; *EDT1: *Epidonta sp.1*; *EDT2: *Epidonta sp.2*; *GNIPT: *Gonimbrasia petiveri*; *IBETI: *Imbrasia epimethea*; *IBOSR: *Imbrasia obscura*; *IBTCT: *Imbrasia truncata*; *PDHDP: *Pseudantheraea discrepans.* The species codes have been taken from the EPPO (https://www.eppo.int/RESOURCES/eppo_databases/eppo_codes). *The code was assigned arbitrarily

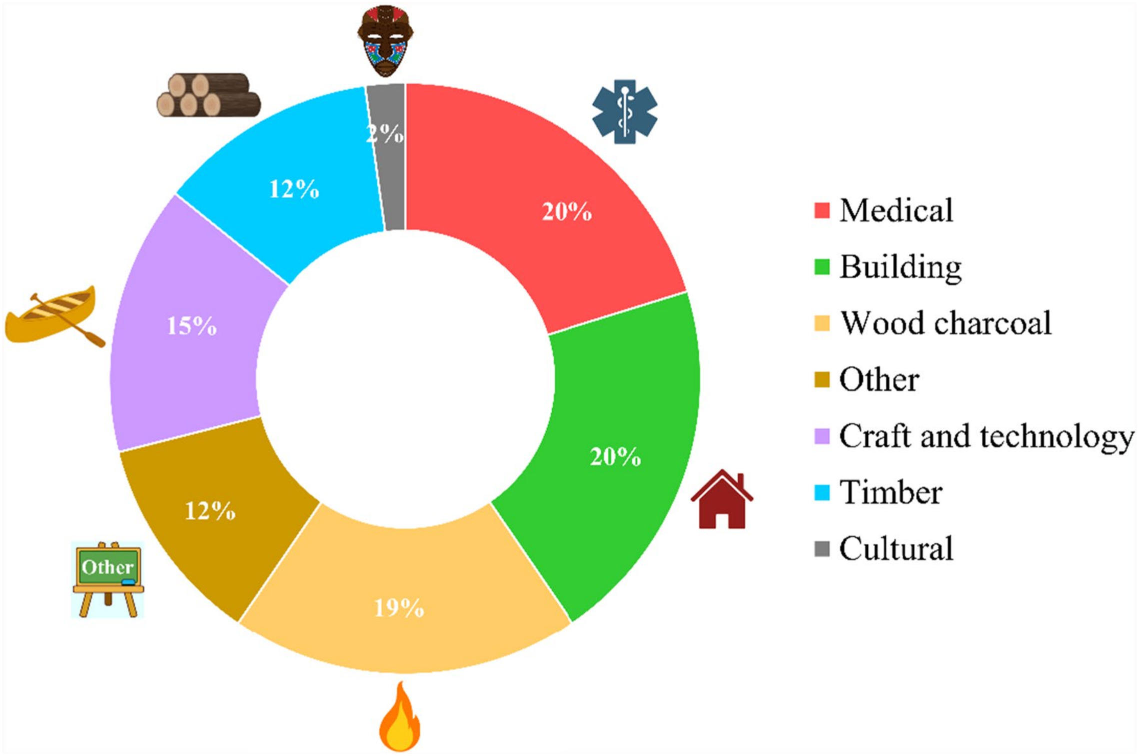

Fig. 5 Proportions of caterpillar host plant use categories, with different uses represented by specific icons. The frequency of host plant utilization by the local population is also indicated

Considering the different uses of the plants, the results indicate that he most prioritized plant species are those serving as key caterpillar hosts and those most frequently used by the population for various purposes (Fig. 6). *R. heudelotii* is the only tree species used for all purposes (medicine, culture, handicraft and technology, construction, wood charcoal, timber and other miscellaneous uses) in Masi-Manimba and Idiofa. All host plant species of the edible caterpillars are used as medicinal plants. The species *Alstonia congensis* Angl. and *Combretum racemosum* P. Beauv. are only used for medicinal purposes at both sites.

Regarding other uses (i.e. other), the informants claim that the species *A. adianthifolia* and *M. excelsa* mark the beginning of the rainy season for the population by losing all their leaves. While the seeds of *R. heudelotii* are eaten, those of *E. psoraleoides* are used as poison in fishing, and the sap of *F. africana* and *H. floribunda* (glue) is used to catch birds. In addition, rubbing the leaves of *M. macroura* produces soap foam for washing dishes, the dust from the bark of *H. acida* is used to dry (smoke) a type of fish known as 'eel', and the leaves of *H. liebrechtsiana* are used for packaging and cooking.

In the medical domain (Table S3), 76 diseases are mentioned by the population, of which 23 dominate with very high quotations, especially in the Masi-Manimba territory. The most frequently mentioned were haemorrhoids, rheumatism, stomach aches, malaria, snake bites, general asthenia and headaches. Of all the host plant species cited as remedies, 37.8% have a very high average medicinal importance (in terms of number of diseases) for the population (CI > 3), being able to treat between five and twenty diseases.

Principal component analysis of anthropogenic pressures on host plants

Principal component analysis establishes the relationship between caterpillar host plants and their categories of use, indicating the species most used by the population (Fig. 7). In the graph of variables, the first dimension captures 39% of the total variance and is highly correlated with the uses of wood charcoal, building, timber, craft and technology, and medical purposes. This dimension provides information on the uses that contribute most to the destruction of caterpillar host plants in the region, primarily wood charcoal and building. The host species with the highest CI (CI > 0.95 (1.0)) in these two categories uses include *Erythrophleum africanum*, *Entandrophragma angolense* C. DC., *Entandrophragma cylindricum* Sprague, *P. macrocarpus*, *R. heudelotii*, *P.*

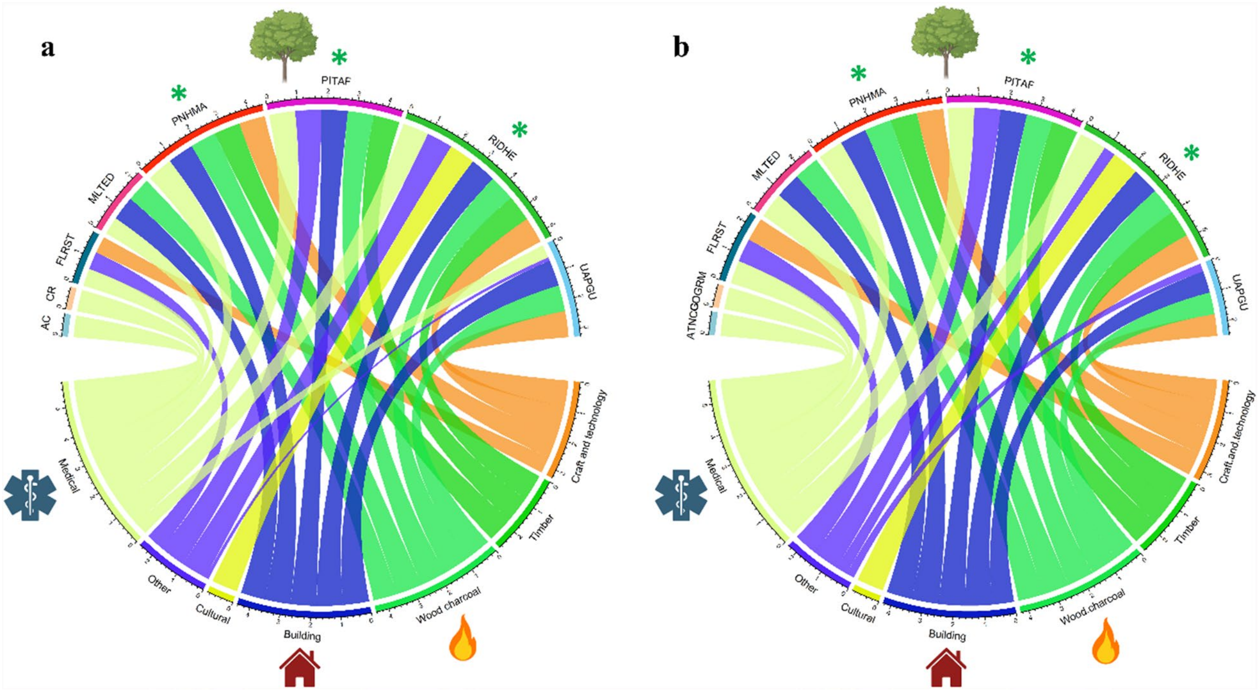

Fig. 6 Correspondence between the modes of use of the main host plants of edible caterpillars. The networks represent the anthropic pressure on the caterpillars' preferred hosts in the two areas: **a** Idiofa; **b** Masi-Manimba. The upper part of each network represents the host plants, with green stars indicating the level of pressure on the three plant species most preferred by the caterpillars (5–7 uses). The lower part of the network corresponds to the use categories, with icons representing the uses most exploited by the local population, particularly traditional medicine, charcoal production, and local construction. The width of the band for each host plant is proportional to the degree of pressure, while the colour reflects the number of uses for each plant. AC(ATNCG): *Alstonia congensis*; CR(COGRM): *Combretum racemosum*; FLRST: *Hallea stipulosa*; *LTDCG: *Leptoderris congolensis*; MLTED: *Millettia eetveldeana*; PNHMA: *Petersianthus macrocarpus*; PITAF: *Piptadeniastrum africanum*; RIDHE: *R. heudelotii*; UAPGU: *Uapaca guineensis*. The species codes have been taken from the EPPO (https://www.eppo.int/RESOURCES/eppo_databases/eppo_codes). *The code was assigned arbitrarily

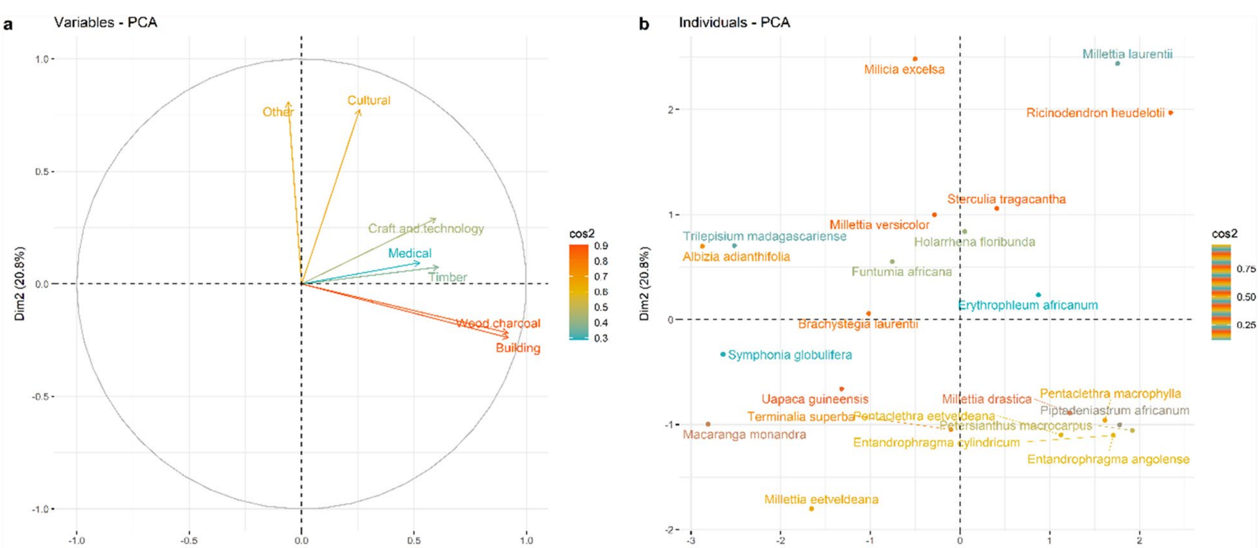

Fig. 7 Principal component analysis of host species by use categories. The variable graph **a** illustrates the most common uses, while the individual graph **b** highlights the tree species most frequently utilized. This analysis considers only tree species with a CI > 3

africanum, *Pentaclethra macrophylla* Benth., *Millettia Laurentii* De Wild, *P. eetveldeana* and *Millettia drastica* Welw. ex Baker. These species are also widely used as timber, with higher CI than others. Although their use is of moderate intensity, the vast majority of these species are also utilized for medical, craft, and technological purposes. The second dimension accounts for almost 21% of the total variance and is correlated with cultural and other uses that are less exploited by the population. Few host species fall into these categories. The species used for cultural purposes include *R. heudelotii*, *M. laurentii*, *Millettia versicolor* Welw. ex Baker and *M. excelsa*. The most important species used for 'other' purposes are *E. africanum* and *M. laurentii*.

The individual PCA graph highlights the host plant species most frequently utilized and classifies them into four groups according to their CI. The first group includes species with the highest cultural importance (total CI >5.5), which are used in all target categories. These are *M. laurentii*, *R. heudelotii*, and *M. excelsa*. They are, therefore, the most widely used and priority species. The second group includes species (CI >3.95 (4)) that are strongly correlated with craft and technology, timber, wood charcoal, building, and medical uses; they are also priority species. The third group includes species that are extensively used for wood charcoal and partly for traditional medicine and timber. The last group consists of species with low cultural importance, which have no significant cultural value and are characterized by a negative coordinate on the axis.

Discussion

The food and commercial value of the identified caterpillars, such as *C. forda*, *I. epimethea* and *I. truncata*, has already been pointed out by several authors [4, 11, 28]. They are consumed throughout the country and across sub-Saharan Africa [4, 33–38]. However, for some of them, this importance varies according to the typical environment, as is the case of *I. truncata* and *P. discrepans*, which are present in Idiofa, in the forest massif and well known by the population, while *H. nigrolineata* and *C. libeon* are present in Masi-Manimba, in the savannah [3, 23]. The dominance of the Saturniidae and Notodontidae families is consistent with the findings of many authors [4, 15, 36, 39, 76]. In terms of host plants, the list (i.e. the number of plants) varied between study zones. For example, 55 host plants for 47 caterpillar species were identified in Kongo Central, DRC, while a list of 90 host plants for 29 caterpillar species was compiled for the Republic of Congo [10, 39]. This variation confirms the influence of ecological and edapho-climatic factors, among others, on the caterpillar diet, given the diversity of the study environments. It also explains the dominance of generalist caterpillars over specialist caterpillars in these study areas [39]. Despite the differences between study areas, the data show a strong similarity in the plant species identified as caterpillar hosts. For example, *P. macrocarpus* is reported as a host for *I. epimethea* in the Republic of Congo, while *E. africanum* and *B. africana* serve as hosts for *C. forda* in Angola [36, 39].

The importance of Fabaceae in the diet of edible caterpillars has been widely reported by several authors, including Bomolo et al. [40]; Lautenschläger et al. [36]; Looli et al. [15]; Okangola et al. [14].; Nsevolo et al. [4]. As suggested by Stone [41], this preference may be explained by the fact that Fabaceae, belonging to one of the oldest plant orders (Fabales), were probably well established before the evolution of Saturniidae and thus available as a food source. Another possible explanation is their abundance in the flora of the Kasai phytogeographic sector (part of the Guineo-Congolese region), to which the study area belongs [42]. Furthermore, the ability of nine plant species to host more than two caterpillar species is probably related to their leaf composition. Numerous studies have demonstrated a close relationship between insect diet and the chemical composition of the nutrient substrate [43, 44], particularly with regard to phenolic compounds found in lepidopterans [45–47]. The selection of plant species by caterpillars is therefore a result of behavioural and metabolic adaptations [48, 49]. For example, *C. forda* contains polyphenols, saponins, alkaloids, flavonoids, tannins, and cyanogenic glycosides [50, 51], while *B. alcinoe* contains alkaloids, flavonoids, cardiac glycosides, sterols, tannins, and terpenes [52]. Furthermore, the preference of Saturniidae for *P. macrocarpus* and *R. heudelotii* as common hosts is likely due to their high content of phenolic compounds, especially tannins and resin, as reported by Janzen [53] and confirmed by several authors [54, 55].

The dominance of specialist caterpillars that are more closely associated with their host plants has already been observed by numerous authors in tropical regions known for their high biodiversity [71, 72]. The polyphagy of some of the most commonly consumed caterpillars has been noted by several authors, including Bomolo et al. [40]; Lautenschläger et al. [36]; Looli et al. [15]; Mabossy-Mobouna et al. [39]; Okangola et al. [14]. Among the Saturniidae family (e.g. *B. alcinoe*, *G. petiveri*, *I. epimethea*), polyphagy is at its peak, with these species feeding on plants from at least seven families and more than two orders. This has already been reported by numerous authors for certain moth species [73–75].

Our research has identified a non-exhaustive range of uses of caterpillar host plants for different purposes. Use for wood charcoal and building materials, together with shifting cultivation on burned land, are considered by many authors to be those that destroy forests [80, 81] and consequently host plants through their felling.. The importance of plants used for wood charcoal production in western DRC can be explained by their domestic use by almost the entire population, as only 1.1% have access to industrial or electrical energy [56]. Furthermore, due to the proximity of the region to Kinshasa, the supply of charcoal and woodfuel exceeds 5 million tonnes of wood per year, which requires the annual exploitation of approximately 60,000 hectares of natural forests in the peri-urban area. This serves as an indicator of the province's high poverty rate, one of the highest in the country [56], and also reflects the country's status as a developing country [57, 58]. In this context, nearly 50% of host plants are intensively exploited, including both specialist caterpillar hosts and common hosts for multiple species. For example, *E. africanum*, the main host of *C. forda* (a caterpillar of primary food and economic importance), and *I. ertli*, are specialist species, while *P. macrocarpus* and *R. heudelotii* serve as hosts for many Saturniidae.

The findings on the use of wood as a local building material are in line with those of various authors who confirm that in the DRC, construction practices are adapted to the lifestyle of the population. These authors also highlight that almost all rural houses continue to be built using local materials and traditional construction techniques mastered by the local population [59]. Some, such as Roux [60], estimate the shortage of quality housing in the DRC at 12 million units. The lifespan of these structures depends on the choice of wood species, with criteria including hardness and resistance to boring insects [61]. This applies to species such as *E. africanum*, *M. drastica*, *M. laurentii*, *M. versicolor*, and *M. excelsa* [17, 62]. On the other hand, certain Poaceae species are commonly used for roofing, as highlighted by Koni and Bostoen [17]. These findings are consistent with Gutierrez et al. [59], who reported that more than 80% of rural Congolese households have thatched or straw roofs. Almost 50% of the host plants, typically the same species as above, are intensively exploited.

The choice of wood species for craft and technological purposes is influenced by the social value and significance of the object being made. For example, mortars require hard, durable wood due to their use in pounding grain, while dugout canoes require robust materials, unlike stools, which can be made from a simple piece of wood [17, 58]. *R. heudelotii* is of exceptional value because it is used to make canoes, tom-toms, mortars, paddles, artistic objects, and chairs. Historically, its trunk was even used to carve coffins by the Ding people of the Sedzo sector in Idiofa territory, a practice that continues today in the Kisangani region [17, 63]. Its use in sculpture is also highly valued in countries such as Benin [64]. Other species are used in the construction of bridges (e.g. *Brachystegia Laurentii* (De Wild.) Louis ex J. Léonard, *P. macrocarpus*), as well as in the manufacture of pestles, hoes, doors, furniture, and other objects [17]. It should be noted that while these uses are widespread in different environments, some are restricted to specific regions. For example, *A. congensis* is used to create masks, while *Caloncoba welwitschii* (Oliv.) Gilg is employed to make stepladders in Kisangani province [65]. These uses affect about 43% of host plants, including those mentioned above. *M. excelsa* together with *R. heudelotii* and *M. versicolor* are also used to make cultural objects such as masks, statues, and drums (*tam-tams*) [17, 64]. In addition, Koni and Bostoen [17] confirm the various "other" uses identified in this study for the species mentioned.

Medicinal plants are widely used in the study area. Our observations are consistent with the findings of Ndoye and Awono [18], who reported that nearly 85% of households in Greater Bandundu rely on traditional medicine for primary health care due to poverty. This has also been highlighted by the World Health Organization (WHO) as a common trend among African populations [66]. Few researchers have specifically investigated the therapeutic properties of caterpillar host plants [14]. However, many have focused on medicinal plants in general [66, 67, 78]. Some, such as Ouachinou et al. [68], even highlight similarities in the use of medicinal plants in different study regions. For example, *R. heudelotii*, which has an average cultural importance index (CI) of 16.1, is recognized by Akpovo and Fandohan [64], Onefeli et al. [69] for its exceptional medicinal properties. The essential medicinal value of this species has been further confirmed in other studies [14, 63]. Furthermore, the preference for other host species, such as *P. macrocarpus*, *O. welwitschii*, and *A. adianthifolia*, in the treatment of various diseases has already been mentioned by other researchers [70].

Multivariate analysis reveals a critical ecological dilemma in Kwilu Province, where socio-economic dependencies intersect with biodiversity conservation. The strong association of culturally important species with charcoal production and building materials reflects a broader pattern observed in tropical ecosystems, where multipurpose plant species face disproportionate exploitation pressures [82, 83]. This is of particular concern for keystone species such as *R. heudelotii* and *P. macrocarpus*, whose ecological role as hosts of numerous caterpillars enhances their conservation importance. The observed dichotomy between utilitarian and cultural uses presents complex management challenges. While utilitarian uses drive large-scale habitat modification, cultural uses, although less extensive, may provide conservation leverage through traditional protection mechanisms [84]. This is consistent with emerging frameworks that advocate for biocultural approaches to insect conservation [85], mainly where edible insects significantly contribute to food security. The ecological specialization of many Lepidoptera on these hosts [86] creates cascades of vulnerability, where depletion of host plants could disproportionately affect caterpillar populations. This is particularly relevant for monophagous species, whose fate is directly linked to the availability of specific host plants. The spatial variation in use patterns between areas underscores the need for landscape-scale conservation strategies. The differential cultural importance of species such as *P. africanum* across regions highlights how local socio-ecological contexts shape resource use patterns [87]. Such variation requires flexible, community-tailored conservation approaches rather than one-size-fits-all solutions. These findings add to growing evidence that edible insect conservation must be integrated with sustainable forest management [88]. The identification of high-risk host species provides a scientific basis for prioritizing reforestation efforts and developing alternative livelihood strategies to reduce pressure on critical caterpillar hosts. Future research should quantify the population-level effects of host plant harvesting on caterpillar abundance to refine these conservation strategies.

Conclusions

The results of this study revealed a wide variety of host plants for the most commonly consumed caterpillars in the region. Many caterpillars, especially those of the Saturniidae family, share the same food sources, with some plant species being used as food for more than one caterpillar species. In addition, these plant species have multiple uses. Monophagous caterpillars could be at risk if their host plants are overexploited for other purposes, especially slow growing species such as *E. africanum*. The most consumed Saturniidae species could also face significant threats if their common host plants, *P. macrocarpus* and *R. heudelotii*, continue to be extensively used for other purposes. Fabaceae and other plants rich in phenolic compounds play a crucial role in the diet of caterpillars at Kwilu, thus supporting the development of Saturniidae species. Despite the community's extensive ecological knowledge and awareness of the threats to edible caterpillars, no conservation strategies have been implemented to protect these host species through reforestation. Yet this is a critical issue. Reforesting ecosystems where these species once occurred, and creating new ecosystems with host plants that support highly productive caterpillars, could make a significant contribution to biodiversity conservation, while providing a sustainable food source for local people.

Abbreviations

CI	Cultural importance
SDGs	Sustainable development goals
CF	Citation frequency
APG	Angiosperm phylogeny group
PCA	Principal component analysis
EPPO	European and Mediterranean Plant Protection Organisation

Supplementary Information

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Additional file 1

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Author contributions

FMM, RCM and FF planned and designed the study. FMM collected the data. FM and PL identified the caterpillars and CL and MF identified the plants. MCC and AG analysed the data. FMM wrote the first manuscript, and then improved by RCM, FF, MCC, AG, PL, FM, MF, CL and DM. All authors read and approved the final manuscript.

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Availability of data and materials

All data generated or analysed during this study are included in this published article and its supplementary information files.

Declarations

Ethics approval and consent to participate

This study was conducted with the approval of a number of appropriate bodies. The research reported here obtained official authorization from the Functional and Evolutionary Entomology Department of the University of Liège, the Institut Supérieur Pédagogique de Bandundu (MINESU/ISP-BDD/D.G/01/RSPS/03/2019) and the administrator of the Masi-Manimba and Idiofa territories. Above all, the research received permission from the Provincial Coordination of the Environment and Sustainable Development of Kwilu Province (276/C.P-EDD/BGF/0.04./BDD/2019). Prior to data collection, free, prior, and informed consent (FPIC) was obtained from all participating community members in accordance with ethical guidelines and regulations for research involving indigenous and local knowledge of the Institut Supérieur Pédagogique (ISP/Bandundu-DR Congo). Verbal consent was obtained from all informants after explaining the purpose of the study and its potential benefits.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Brouwer M (2017) Les forêts d'Afrique centrale pour toujours, Meindert Brouwer Partner, Pays-Bas
2. Pélissier C, de Marcken P, Cherel E, Mapilanga J (2018) Le réseau des aires protégées de la République démocratique du Congo : Évaluation pour sa consolidation et son extension. IUCN et WWF. pp 132
3. Madamo MF, Malaisse F, Latham P, Francis F, Caparros MR. Caterpillars consumed in Masi-Manimba territory (Kwilu), Democratic Republic of the Congo. J Insects Food Feed. 2023;9(1):3–13. https://doi.org/10.3920/JIFF2022.0032.
4. Nsevolo MP, Kiatoko N, Kambashi MB, Francis F, Caparros MR. Reviewing entomophagy in the Democratic Republic of Congo: species and host plant diversity, seasonality, patterns of consumption and challenges of the edible insect sector. J J Insects Food Feed. 2023;9(2):225–44. https://doi.org/10.3920/JIFF2022.0024.
5. Konda Ku Mbuta A, Ambühl D (2022) Cheniculture et reforestation. Domestication des chenilles comestibles africaines. Résultats et perspectives. Projet pionnier de domestication des chenilles de Saturniens, village de Kilueka, République Démocratique du Congo, Edition Syfood. Switzerland: Armée du Salut, pp 300
6. Muyay T (1981) Les insectes comme aliments de l'homme. Centre d'Etudes Ethnologiques de Bandundu (CEEBA), Bandundu (Zaïre) pp 177
7. Debroux L, Hart T, Kaimowitz D, Karsenty A, Topa G (2007) La forêt en RDC post-conflit : analyse d'un agenda prioritaire. CIFOR-Banque Mondiale-CIRAD, Bogor. pp 107
8. Kuma JK (2020) Pauvreté et chômage en République Démocratique du Congo : état des lieux, analyses et perspectives. HAL Open science pp 24
9. Mbemba FLT (2013) Aliments et denrées alimentaires traditionnels du Bandundu en R.D. Congo: répertoire et composition en nutriments, French edition. Editions L'Harmattan, Paris, France. pp 332
10. Latham P. Edible caterpillars and their food plants in Bas-Congo province, Democratic Republic of Congo. 3rd ed. UK: The Salvation Army International; 2015. p. 47.
11. Nsevolo P, Taofic A, Caparros Megido R, Sablon L, Haubruge E, Francis F. La biodiversité entomologique comme source d'aliments à Kinshasa (République Démocratique du Congo). Ann Soc entomol Fr. 2016;52(2):57–64. https://doi.org/10.1080/00379271.2016.1186467.
12. Hartley SE, Jones TH. Plant diversity and insect herbivores: effects of environmental change in contrasting model systems. Oikos. 2003;101:6–17. https://doi.org/10.1034/j.1600-0706.2003.12566.x.
13. Schoonhoven LM, Jermy T, Loon JJA. Insect-plant biology: from physiology to evolution. London, UK: Chapman & Hall; 1998. p. 409.
14. Okangola E, Solomo E, Lituka Y, Tchatchambe WB, Mate M, Upoki A, et al. Etude ethnobotanique et floristique de quelques plantes hôtes des chenilles comestibles à usage médicinal dans le secteur de Bakumu-Mangongo (Territoire d'Ubundu, Province de la Tshopo, RD Congo). Int J Innov Sci Res. 2016;26(1):146–60.
15. Looli BL, Dowiya B, Bosela O, Salumu P, Monzenga JC, Posho B, et al. Techniques de récolte et exploitation durable des chenilles comestibles dans la région de Yangambi, R.D. Congo. Geo Eco Trop. 2021;45(1):113–29.
16. Tamesse JL, Kekeunou S, Tchouamoa Djuideu CL, Meupia MJ. Villagers' knowledge of some edible insects in southern Cameroon: crickets, termites, honeybees and cockchafers. J Insects Food Feed. 2018;4(4):203–9. https://doi.org/10.3920/JIFF2017.0077.
17. Koni MJ, Bostoen K. Noms et usages des plantes utiles chez les Nsong (RD Congo, Bandundu, bantu B85F). Göteborg Africana Informal Series. 2008;6:71p.
18. Ndoye O, Awono A (2005) The markets of non-timber forest products in the provinces of Equateur and Bandundu, Democratic Republic of Congo. Center for International Forestry Research (CIFOR), Central Africa regional office, Yaounde, Cameroon. pp 57. https://doi.org/10.13140/2.1.1028.7685
19. Ashton MS, Hall JS. The ecology, silviculture and use of tropical wet forests with special emphasis on timber rich types. In: Gunter S, Weber M, Stimm B, Mosandl R, editors. Silviculture in the Tropics. New York: Springer Verlag; 2011. p. 145–92. https://doi.org/10.1007/978-3-642-19986-812.
20. Büchi L, Vuilleumier S. Coexistence of specialist and generalist species is shaped by dispersal and environmental factors. Am Nat. 2014;183(5):612–24. https://doi.org/10.1086/675756.
21. Vantomme P, Göhler D, N'Deckere-Ziangba F. (2004) Contribution of forest insects to food security and forest conservation: the example of caterpillars in central Africa. Odi Wildlife Policy Briefing. pp 3
22. Guillouët M. Mieux reconnaître les savoirs écologiques traditionnels : Enjeux de définition, de transmission et de protection. Décryptage de la fabrique écologique. 2022;41:1–14.
23. CAID (2016) (Cellule d'Analyses des Indicateurs de Développement). Fiche du territoire de Masi-Manimba. Kinshasa, RD Congo
24. Fehr S (1990) Climatologie de Kikwit, une ville de la région de Bandundu Central au Zaïre, pp 68
25. World Bank (2016) République démocratique du Congo RDC – Évaluation de la pauvreté. Rapport n°: ACS19045. GPV01 Afrique. pp 160
26. FAO (2021) (Food and Agriculture Organization). Programme de finalisation et de mise en œuvre du système national de surveillance des forêts de la RDC
27. Mabossy-Mobouna G, Lenga A, Latham P, Kinkela T, Konda Ku Mbuta A, Bouyer T, et al. Clef de détermination des chenilles de dernier stade consommées au Congo-Brazzaville. Geo Eco Trop. 2016;40(2):75–103.
28. Latham P, Malaisse F, Konda Ku Mbuta A, Razafimanantsoa TM, Mabossy-Mobouna G, Madamo Malasi F, Bouyer T, et al. Caterpillars and chrysalises eaten in Africa. Paul Latham: Scotland; 2024. p. 301.
29. Houéhanou D, Assogbadjo A, Chadare F, Zanvo S, Sinsin B. Approches méthodologiques synthétisées des études d'ethnobotanique quantitative en milieu tropical. Ann Sci Agron. 2016;20:187–205.
30. R Core Team. (2024) R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/
31. Lê S, Josse J, Husson F. FactoMineR: an *R* package for multivariate analysis. J Stat Soft. 2008;25:18. https://doi.org/10.18637/jss.v025.i01.
32. Gu Z, Gu L, Eils R, Schlesner M, Brors B. circlize implements and enhances circular visualization in R. Bioinformatics. 2014;30:2811–2. https://doi.org/10.1093/bioinformatics/btu393.
33. Kelemu S, Niassy S, Torto B, Fiaboe K, Affognon H, Tonnang H, et al. African edible insects for food and feed: Inventory, diversity, commonalities and contribution to food security. J Insects Food Feed. 2015;1(2):103–19. https://doi.org/10.3920/JIFF2014.0016.
34. Kusia ES, Borgemeister C, Khamis FM, Copeland RS, Tanga CM, Ombura FL, et al. Diversity, host plants and potential distribution of edible saturniid caterpillars in Kenya. Insects. 2021;12(7):600. https://doi.org/10.3390/insects12070600.
35. Latham P, Malaisse F, Konda Ku Mbuta A, Oberprieler R. (2021a) Some caterpillars and pupae eaten in Africa. Draft Edition, Scotland. pp 282
36. Lautenschläger T, Neinhuis C, Monizi M, Mandombe JL, Förster A, Henle T, et al. Edible insects of Northern Angola. Afr Invertebr. 2017;58(2):55–82. https://doi.org/10.3897/AfrInvertebr.58.21083.
37. Mabossy-Mobouna G, Malaisse F, Richel A, Maesen P, Latham P, Roulon-Doko P, et al. *Imbrasia obscura*, an edible caterpillar of tropical Africa: chemical composition and nutritional value. Tropicultura. 2018;36(4):798–811. https://doi.org/10.25518/2295-8010.522.
38. Malaisse F, Latham P. Human consumption of Lepidoptera in Africa: an updated chronological list of references (370 quoted!) with their ethnozoological analysis. Geo Eco Trop. 2014;38(2):339–72.

39. Mabossy-Mobouna G, Ombeni JB, Bouyer T, Latham P, Bisaux F, Bocquet E, et al. Diversity of edible caterpillars and their host plants in the Republic of the Congo. Afr J Trop Entomol Res. 2022;1(1):3–27.
40. Bomolo O, Niassy S, Chocha A, Longanza B, Bugeme DM, Ekesi S, et al. Ecological diversity of edible insects and their potential contribution to household food security in Haut-Katanga Province, Democratic Republic of Congo. Afr J Ecol. 2017;55(4):640–53. https://doi.org/10.1111/aje.12400.
41. Stone SE (1991) Food plants of World Saturniidae. Memoirs of the Lepidopterists' Society 4. pp 186
42. Ayingweu AC. Analyse phytogéographique de la flore forestière du secteur du Kasaï au Congo-Kinshasa. Syst Geogr Plants. 2001;71(2):859–72. https://doi.org/10.2307/3668724.
43. Giampieri F, Alvarez-Suarez JM, Machì M, Cianciosi D, Navarro-Hortal MD, Battino M. Edible insects: a novel nutritious, functional, and safe food alternative. Food Front. 2022;3(3):358–65. https://doi.org/10.1002/fft2.167.
44. Van Huis A, Van Itterbeeck J, Klunder H, Mertens E, Halloran A, Muir G, et al. Insectes comestibles: perspectives pour la sécurité alimentaire et l'alimentation animale. FAO, Rome: Italy; 2014. p. 207.
45. Nino MC, Reddivari L, Osorio C, Kaplan I, Liceaga AM. Insects as a source of phenolic compounds and potential health benefits. J Insects Food Feed. 2021;7:1077–87. https://doi.org/10.3920/jiff2020.0113.
46. Odebiyi JA, Omoloye AA, Bada SO, Awodoyin RO, Oni PI. Response of larvae of *Cirina forda* Westwood (Lepidoptera: Saturniidae) to spatio-temporal variation in the nutritional content of foliage of *Vitellaria paradoxa* Gaertn f (Sapotaceae). Ghana J Agric Sci. 2009;42(1–2):105–13. https://doi.org/10.4314/gjas.v42i1-2.60649.
47. Simmonds SJ. Flavonoid–insect interactions: recent advances in our knowledge. Phytochemistry. 2003;64(1):21–30. https://doi.org/10.1016/S0031-9422(03)00293-0.
48. Stahl E, Hilfiker O, Reymond P. Plant–arthropod interactions: who is the winner? Plant J. 2018;93(4):703–28. https://doi.org/10.1111/tpj.13773.
49. Hussain M, Debnath B, Qasim M, Bamisile BS, Islam W, Hameed MS, et al. Role of saponins in plant defense against specialist herbivores. Molecules. 2019;24(11):2067. https://doi.org/10.3390/molecules24112067.
50. Omotoso OT, Adesola AA. Comparative studies of the nutritional composition of some insect orders. Int J Entomol Nematol Res. 2018;2(1):1–9.
51. Oriolowo OB, Abubakar DS, Bidda RD, Masaudu S. Nutritional comparison of the pallid emperor moth, *Cirina forda* and the Atlantic mackerel, *Scombrus scomber*. Acta Entomol Zool. 2021;2(1):24–31. https://doi.org/10.33545/27080013.2021.v2.i1a.26.
52. Mathew TJ, Ndamitso MM, Shaba EY, Mustapha S, Muhammed SS, Salihu AS. Physicochemical and phytochemical composition of locust bean tree emperor moth larvae (*Bunaea alcinoe*) from Gurara local government area, Niger state, Nigeria. Int J Eng Sci Invention. 2014;3(1):14–8.
53. Janzen DH. Patterns of herbivory in a tropical deciduous forest. Biotropica. 1981;13(4):271–82. https://doi.org/10.2307/2387805.
54. Uzoekwe NM, Hamilton-Amachree A. Phytochemicals and nutritional characteristics of ethanol extract of the leaf and bark of Njangsa (*Ricinodendron Heudelotii)* plant. J Appl Sci Environ Manage. 2016;20(3):522–7. https://doi.org/10.4314/jasem.v20i3.5.
55. Yakubu OF, Adebayo AH, Famakinwa TO, Adegbite OS, Ishola TA, Imonikhe LO, et al. Antimicrobial and toxicological studies of *Ricinodendron heudelotii* (Baill). Asian J Pharm Clin Res. 2018;11(1):299–305. https://doi.org/10.22159/ajpcr.2018.v11i1.21251.
56. Ministère du Plan (2014) Rapport, résultats de l'enquête sur l'emploi, le secteur informel et sur la consommation des ménages/2012, République Démocratique du Congo
57. Pearce DW. The economic value of forest ecosystems. Ecosyst Health. 2001;7(4):284–96. https://doi.org/10.1046/j.1526-0992.2001.01037.x.
58. Traoré L, Ouedraogo I, Ouedraogo A, Thiombiano A. Perceptions, usages et vulnérabilité des ressources végétales ligneuses dans le Sud-Ouest du Burkina Faso. Int J Biol Chem Sci. 2011;5(1):258–78. https://doi.org/10.4314/ijbcs.v5i1.68103.
59. Gutierrez ES, Sahdia K, Crété E (2019) Fiche de réponse abris détaillée République Démocratique du Congo (Sud-Est) : cultures constructives locales pour des habitats durables et résilients. CRAterre, pp 60
60. Roux J (2015) République Démocratique du Congo. Secteurs prometteurs. Approche du marché. Recommandations
61. Lykke AM, Kristensen MK, Ganaba S. Valuation of local use and dynamics of 56 woody species in the Sahel. Biodivers Conserv. 2004;13:1961–90. https://doi.org/10.1023/B:BIOC.0000035876.39587.1a.
62. Arbonnier M (2009) Arbres, arbustes et lianes des zones sèches d'Afrique de l'Ouest. 3e édition. Editions Quae, Paris, Muséum national d'histoire naturelle (MNHN), Versailles, France. pp 576
63. Azenge C, Meniko JPP. Espèces et usages d'arbres hors forêt sur les terres agricoles dans la région de Kisangani en République Démocratique du Congo. Revue Marocaine Sci Agron Vét. 2020;8(2):163–9.
64. Akpovo AH, Fandohan AB. Usages, distribution des connaissances traditionnelles et valeur économique de *Ricinodendron heudelotii* au Bénin. Revue Marocaine Sci Agron Vét. 2021;9(2):274–85.
65. Bengwela MT. Essences forestières utilisées dans la fabrication des œuvres d'art dans la ville de Kisangani, RD Congo. J Agric Res. 2019;5(7):1–17. https://doi.org/10.53555/ar.v5i7.3044.
66. Ngbolua KN, Inkoto CL, Mongo NL, Ashande CM, Masens YB, Mpiana PT. Etude ethnobotanique et floristique de quelques plantes médicinales commercialisées à Kinshasa, République Démocratique du Congo [Ethnobotanical and floristic study of some medicinal plants marketed in Kinshasa, Democratic Republic of Congo]. Revue Marocaine Sci Agron Vét. 2019;7(1):118–28.
67. Masunda AT, Inkoto CL, Bongo GN, Wa Oloko JD, Ngbolua KTN, Tshibangu DS, et al. Ethnobotanical and ecological studies of plants used in the treatment of diabetes in Kwango, Kongo central and Kinshasa in the Democratic Republic of the Congo. Int J Diabetes Endocrinol. 2019;4(1):18–25. https://doi.org/10.11648/j.ijde.20190401.14.
68. Ouachinou JMAS, Adomou AC, Dassou GH, Yedomonhan H, Tossou GM, Akoegninou A. Connaissances et pratiques ethnobotaniques en médecines traditionnelles vétérinaire et humaine au Bénin : similarité ou dissemblance ? J Appl Biosci. 2017;113:11174–83. https://doi.org/10.4314/jab.v113i1.6.
69. Onefeli AO, Akinyele AO, Fatoba HT. Agroforestry potential of *Ricinodendron heudelotii* (Baill.) Pierre ex Pax in Nigeria. Žemės ūkio mokslai. 2019;26(2):94–102. https://doi.org/10.6001/zemesukiomokslai.v26i2.4063.
70. Kabena ON, Nyakembe NE, Amogu JJD, Asamboa LS, Lengbiye EM, Mboloko JE, et al. Spermicidal and antibacterial effects of Oncoba welwitschii Oliv. (Salicaceae). Eur J Med Plants. 2020;21(17):59–67. https://doi.org/10.9734/ejmp/2020/v31i1730336.
71. Dyer LA, Singer MS, Lill JT, Stireman JO, Gentry GL, Marquis RJ, et al. Host specificity of Lepidoptera in tropical and temperate forests. Nature. 2007;448:696–700. https://doi.org/10.1038/nature05884.
72. Forister ML, Novotny V, Panorska AK, Baje L, Basset Y, Butterill PT, et al. The global distribution of diet breadth in insect herbivores. Proc Natl Acad Sci USA. 2015;112(2):442–7. https://doi.org/10.1073/pnas.1423042112.
73. Janzen DH. Two ways to be a tropical big moth: santa Rosa saturniids and sphingids. Oxford Surv Evol Biol. 1984;1:85–140.
74. Nylin S, Slove L, Janz N. Host plant utilization, host range oscillations and diversification in Nymphalid butterflies: a phylogenetic investigation. Evolution. 2014;68(1):105–24. https://doi.org/10.1111/evo.12227.
75. Wang H, Holloway J, Janz N, Braga MP, Wahlberg N, Wang M, et al. Polyphagy and diversification in tussock moths: support for the oscillation hypothesis from extreme generalists. Ecol Evol. 2017;7(19):7975–86. https://doi.org/10.1002/ece3.3350.
76. Yabuda HK, Mbembo BM, Bongo GN, Gbendo TG, Tshil FM, Kogba LS, et al. Contribution to the ecological study of edible caterpillars in Gbado-Lite city and its surroundings, Nord-Ubangi Democratic Republic of Congo. Plants Environ. 2019;1(2):109–14.
77. Lunga ZR. Impacts environnementaux des modes de cueillette de chenilles Cirina forda (Westwood) sur l'espèce *Erythrophleum africanum* dans la chefferie Pelende-nord en RD. Congo Congo Sci. 2017;5(1):1–9.
78. Latham P, Konda Ku Mbuta A, Alliez JL. Plantes utiles du Kongo Central Province, République Démocratique du Congo. University Library J. C. Senckenberg; 2021. p. 921. https://doi.org/10.21248/gups.61777.
79. CAID (2021) (Cellule d'Analyses des Indicateurs de Développement). Données par territoire, province du Kwilu. Kinshasa, RD Congo
80. Ngoy C, Mukungu J (2011) Etude qualitative des moteurs de la déforestation et de la dégradation forestière dans le territoire de Bolobo, province du Bandundu. Projrt R-PAN WWF. pp 66

81. Tchatchou B, Sonwa DJ, Ifo S, Tiani AM (2015) Déforestation et dégradation des forêts dans le Bassin du Congo: État des lieux, causes actuelles et perspectives. Papier occasionnel 120. Bogor, Indonesie: CIFOR
82. Ahrends A, Burgess ND, Milledge SAH, Bulling MT, Fisher B, Smart JCR, et al. Predictable waves of sequential forest degradation and biodiversity loss spreading from an African city. Proc Natl Acad Sci USA. 2010;107:14556–61. https://doi.org/10.1073/pnas.0914471107.
83. Siry JP, Cubbage FW, Ahmed MR. Sustainable forest management: global trends and opportunities. For Policy Econ. 2005;7:551–61. https://doi.org/10.1016/j.forpol.2003.09.003.
84. Gavin MC, McCarter J, Mead A, Berkes F, Stepp JR, Peterson D, et al. Defining biocultural approaches to conservation. Trends Ecol Evol. 2015;30:140–5. https://doi.org/10.1016/j.tree.2014.12.005.
85. Shipley JR, Gossner MM, Rigling A, Krumm F. Conserving forest insect biodiversity requires the protection of key habitat features. Trends Ecol Evol. 2023;38:788–91. https://doi.org/10.1016/j.tree.2023.05.015.
86. Janzen DH, Hallwachs W. To us insectometers, it is clear that insect decline in our Costa Rican tropics is real, so let's be kind to the survivors. Proc Natl Acad Sci USA. 2021;118: e2002546117. https://doi.org/10.1073/pnas.2002546117.
87. Dawson NM, Coolsaet B, Sterling EJ, Loveridge R, Gross-Camp ND, Wongbusarakum S, et al. The role of indigenous peoples and local communities in effective and equitable conservation. Ecol Soc. 2021;26(3):19. https://doi.org/10.5751/ES-12625-260319.
88. Van Itterbeeck J, Sivongxay N, Praxaysombath B, Van Huis A. Indigenous knowledge of the edible weaver ant *Oecophylla smaragdina* Fabricius Hymenoptera: formicidae from the Vientiane Plain, Lao PDR. Ethnobiol Lett. 2014;5:4–12. https://doi.org/10.14237/ebl.5.2014.125.

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