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# Edible Amphibians in Kisangani and Its Hinterland, Democratic Republic of the Congo: Diversity, Local Perceptions and Implications for Biological Conservation

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## Abstract

Human communities' perceptions toward wildlife are influenced by values, beliefs, and people's perceptions of local species. This study identified the amphibian species consumed by humans in Kisangani and its hinterland, in comparison with other non-human animal species, with particular emphasis on the factors influencing or discouraging such consumption. During eight-month period, from February to September 2021, we participated in nocturnal capture sessions with hunters, using visual survey, systematic excavation of habitats using a headlamp, and acoustic survey hearing vocalizations along the Congo

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River, streams, and around swamps. During these nocturnal capture sessions, we also conducted interviews with hunters and additional interviews were conducted the following day with other respondents (consumers or no). A total of 545 respondents were interviewed. An open-ended questionnaire was developed using specimens of the different species in hands, supported by an image-based identification test. The results revealed that, among all amphibian species occurring in the study area, seven (*Amietia nutti*, *Hoplobatrachus occipitalis*, *Amnirana albolabris* (currently accepted as *Hylarana albolabris*), *Ptychadena mascareniensis*, *P. perreti*, *Xenopus pygmaeus* and *X. ruwenzoriensis*) are consumed in the study area by local human populations, particularly by the Kumu and Topoke ethnic groups. Methods of frog preservation and preparation vary among individuals. The consumption or avoidance of amphibians is based on traditions, religious and local beliefs about the medicinal properties of amphibians, as well as the perceived deadly danger attributed to some species by different ethnic groups. The findings of this preliminary survey demonstrate the importance of amphibians in the dietary habits of human populations in Kisangani and its hinterland. This suggests that amphibian conservation plans should be adapted to the needs of local communities.

## Subject Areas

Biology & Environmental Sciences

## Keywords

Amphibians, Food/Nutrition, Local Knowledge, Conservation, Ethnic Groups, Kisangani

## 1. Introduction

Human communities' perceptions of wildlife and their support for the effectiveness of conservation efforts depend on their knowledge of and attitudes toward local species [1] [2]. These perceptions, shaped by aesthetic aspects, customs, folklore, or evolutionary divergence [1] [3], may vary according to gender, negative experiences, oral traditions, and the environments in which people live [4] [5]. For example, the fear and disgust that humans attribute to amphibians compared with other animal groups [6] [7] reduce the feasibility of implementing conservation strategies with local communities [8]. All these factors determine the degree of coexistence between human populations and biodiversity, particularly wildlife [9].

The hunting of amphibians for food affects their populations through unsustainable harvesting methods [10]-[13], generating consequences for consumers, especially rural populations whose survival directly depends on wildlife resources [14]-[20]. Numerous factors, including social determinants, influence this dependence [21] [22]. This could also be the case in the Democratic Republic of the Congo (DRC), particularly in the Kisangani region, where forests are threatened

by hunting [19] [20] [23] [24], a situation exacerbated by population growth.

Ethnozoology is a discipline that studies and interprets the roles animals play in the cultures of different societies [9] [25] [26]. Local communities have always shown an interest in the study of other animal species [27]. Ethnozoological research therefore provides a broader perspective on biological phenomena and helps to understand how sociocultural aspects influence human interactions with wildlife [28]-[30]. Some of these studies have examined human attitudes toward amphibians in the America [2] [27] [31]. Others have investigated the nutritional value of amphibians by identifying species consumed as bushmeat in Europe [11] [13], Asia [12], and Africa [32]-[34]. In the DRC, and particularly in the Kisangani region, such studies remain fragmentary. Therefore, the present study was undertaken, representing the first investigation on this thematic to document amphibians consumed as bushmeat in this region. It was inspired notably by previous works on bushmeat consumption in the Kisangani region and its surroundings [14] [17] [20] [23] [24].

The study aims to examine the role of amphibians in the daily lives of human populations in Kisangani and its hinterland. More specifically, it seeks to: 1) inventory the species consumed as bushmeat by different ethnic groups; and 2) identify the social determinants influencing such consumption. Thus, we assumed: 1) As observed for mammals [14] [17] [20] [23] [24], amphibians are consumed because of their significant contribution of proteins, which are essential for human well-being [11] [12] [32]. A similar situation may also occur in Kisangani and its hinterland, where the species are consumed and their local names vary among ethnic groups. 2) Given that methods of amphibian preservation and preparation, the danger attributed to certain species, and social, cultural, medicinal, or religious perceptions differ among ethnic groups [12] [21] [22] [35] and individuals [1] [2] [6] [9], it is likely that similar perceptions also characterize the communities inhabiting the study area.

## 2. Materials and Methods

### 2.1. Study Area

The study was carried out in Kisangani city (0˚30'34.3"N; 25˚11'31.2"E) and in four villages located around the Yoko Forest Reserve, on the Kisangani-Ubundu Road axis, in Tshopo Province. These villages are Kisesa (0019'25.2"N; 25015'14.2"E), Babogombe (0˚17'36.3"N; 25˚17'17.5"E), Babusoko I (0˚16'48.6"N; 25˚17'33.5"E) and Babongena (0˚15'44.1"N; 025˚18'04.5"E) (**Figure 1**). The Kisangani region benefits from an Afi type climate characterized by rainfall throughout the year, which is interrupted by two sub-dry seasons. The long rainy season runs from September to December, and the short rainy season covers the months from March to June. On the other hand, the long sub-dry season extends through January and February and the short sub-dry season covers July and August [36] [37]. Monthly temperatures range from 22.4˚C to 29.3˚C, with an annual average of 25˚C. As is the case throughout the central forest basin, annual rainfall varies be-

tween 1500 and 2000 mm, with an average of 1750 mm. Atmospheric humidity is high, with a monthly average of 85%, and relative insolation varies between 42 and 45%. The original vegetation of the Kisangani region is rainforest [38], which has been profoundly altered today by human activities, giving way to many ruderal herbaceous, weed and post-cultivation groups and numerous relics and introduced trees [39]. On the outskirts of the Kisangani city, there are secondary forest formations, rarely a few remnants of primary forest and groups on hydromorphic soils [40]. The hydrographic network is dominated by the Congo River and its two tributaries (Lindi and Tshopo), which collect water from numerous streams.

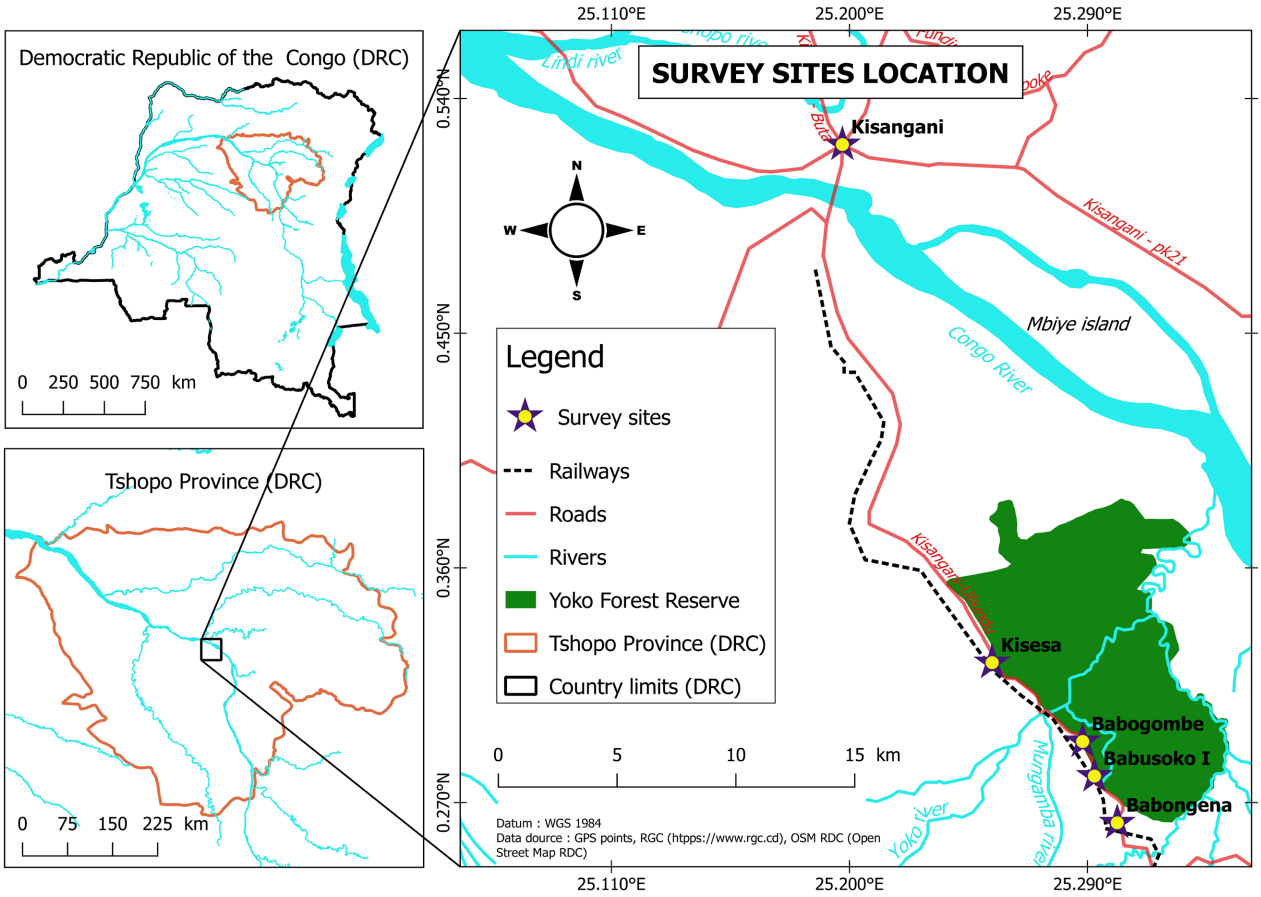



**Figure 1.** Location of the study sites. Kisangani is the capital city of Tshopo Province. The villages of Kisesa, Babogombe, Babusoko I, and Babongena are located around the Yoko Forest Reserve, along the road connecting Kisangani and Ubundu, DRC.

Kisangani's population is heterogeneous and made up of several ethnic groups, the result of events that have marked the region's history. The Kumu ethnic group, indigenous to Kisangani, live all around the city. The Wagenia, originally recognized as a vagabond people, are now considered indigenous to Kisangani due to their age. In various parts of the city, they can find the Bamanga, Popoï, Boa ethnic groups from the Buta Road ; the Turumbu, Bangubangu, Mbole, Kumu, Wagenia, Rega ethnic groups (the latter being Arabized) from Maniema by road, river and rail. The Topoke, Lokele and Basoko ethnic groups also arrived via the Congo

river and its affluent (the Tshopo). The Bali, Lendu, Budu, Bangbetu, Logo, Alur, Hema and Nande ethnic groups arrived via the Ituri road, which leads to the towns of Bunia, Beni and Butembo. The Lokele are essentially fishermen, while the Topoke are mostly farmers who have imposed "chikwange", one of the main recipes consumed in the region. The Nande are mainly traders and farmers. In addition to farming, trading and fishing, Kisangani's population also raises small livestock and poultry, artisanal mining, hunts and collects caterpillars, depending on the ethnic group. All these activities enable the population to exploit the forest in a variety of ways, resulting in the modification of natural habitats and the replacement of the original flora.

## 2.2. Methods

Over an eight-month period, from February to September 2021, we collected data on edible amphibians within the study area. During three consecutive days campaigns per month (in the first and third weeks of each month), between 6:30 p.m. and 8:30 p.m., we participated in nocturnal amphibian capture sessions supported by the three techniques, including visual survey, systematic excavation of habitats using a headlamp, and acoustic survey hearing vocalizations [41] [42] along the Congo River (within the city of Kisangani), rivers, streams, and around swamps across all study sites (Kisangani city and the four rural areas).

At each of the five study sites, three sampling stations were identified. Five teams, each consisting of four researchers, worked alongside hunters to ensure the simultaneous collection of data over an eight-month period. Each team was assigned to one of the five sites and surveyed its three designated stations for three consecutive days during each field mission. Two field missions were conducted each month, so that each station at each site was sampled twice per month throughout the eight-month data-collection period. Thus, each station was visited 16 times during the study period. Given the three stations per site, each site was therefore surveyed 48 times, corresponding to 48 effective capture nights per site. Across the five sites, the theoretical number of capture nights would consequently have been 240 ($48 \times 5$). However, because the five teams worked simultaneously, the actual duration of fieldwork remained 48 nights for the entire study area. The total sampling effort, expressed in researcher-nights, was therefore 960 researcher-nights, corresponding to 48 field nights × 5 teams × 4 researchers per team.

Captured specimens were individually marked using simple, conventional marking procedures consisting of colour marks applied to the head or dorsum, following procedures previously described in the literature [43]-[46]. Each specimen was photographed in situ and identified based on colour patterns, external morphological characteristics, and regional taxonomic descriptions available in the literature [10] [47]-[56]. Following identification, specimens were released at their respective capture sites. The marking procedure was used to distinguish captured individuals during field sampling and to minimize the risk of duplicate records; however, no subsequent recapture analysis was conducted. One specimen

per species, together with the corresponding photographs, was retained for use during interviews with respondents. During these nocturnal capture sessions, we also conducted individual interviews with hunters, following approaches previously tested by [12] and [32].

Additional individual interviews were conducted the following day between 8:00 a.m. and 10:00 a.m. with other respondents at each site to gather as much information as possible on the species consumed in the region. A total of 545 participants, all married and aged between 21 and 65 years, were interviewed, including 357 in Kisangani city (246 men and 111 women), 83 in Kisesa (52 men and 31 women), 21 in Babogombe (15 men and 6 women), 45 in Babusoko I (31 men and 14 women), and 39 in Babongena (25 men and 14 women). Among the respondents, 47 were both hunters and consumers, 32 were exclusively hunters, 285 were exclusively consumers, and 181 were non-consumers. Except for the hunters identified during the survey of sampling stations at each site, the other respondents were selected based on their availability and willingness to participate in the survey. Of the 545 respondents, 278 were Topoke, 209 Kumu, 9 Bangubangu, 24 Lokele, 15 Mbole, and 10 Turumbu. Marital status was not considered an eligibility criterion for participation in the survey, but rather as a sociodemographic characteristic collected to describe the composition of the sample.

An open-ended questionnaire was developed using specimens of the different species in hands, supported by an image-based identification test. The main questions asked were: 1) Which of these frogs are considered edible or non-edible according to your tribal customs? 2) To which tribe do you belong, and does your tribe permit or prohibit the consumption of these frogs? 3) What are the local names of each of these frogs in your dialect? 4) According to your customs, what benefits or beliefs are associated with their consumption or avoidance? 5) According to your customs and opinion, what other reasons explain why these frogs are consumed or not consumed? Additional questions related to age and marital status were also included. To facilitate communication, interviews based on the preestablished questionnaire were conducted in Kiswahili and Lingala, with the assistance of facilitators who provided translation to ensure better mutual understanding.

## 2.3. Data Analysis

Responses to the open-ended questions concerning species consumption were grouped into categories according to their content and then coded. For each category, the number of respondents (n) providing a corresponding response was counted and expressed as the corresponding proportion (%) of the total number of respondents. Thus, among the 545 respondents, all 278 Topoke respondents (51.01%) and all 209 Kumu respondents (38.35%) reported consuming all the recorded amphibian species. In contrast, 9 Bangubangu respondents (1.65%), 24 Lokele respondents (4.40%), 15 Mbole respondents (2.75%), and 10 Turumbu respondents (1.83%) reported that they do not consume any amphibian species.

## 3. Results

The survey results revealed that a total of seven amphibian species are consumed both in Kisangani and its hinterland. These species include *Amietia nutti* (Pyxicephalidae), *Hoplobatrachus occipitalis* (Dicroglossidae), *Hylarana albolabris* (Ranidae), *Ptychadena mascareniensis*, *P. perreti* (Ptychadenidae), *Xenopus pygmaeus* et *X. ruwenzoriensis* (Pipidae) (**Table 1**). Their consumption is not part of the dietary practices of all ethnic groups, as only the Topoke and Kumu ethnic groups consume amphibians within the study area. **Figure 2** illustrates the seven species consumed in the study area.

The seven consumed amphibian species recorded in the study area have different conservation statuses according to their respective species-level assessments in the IUCN Red List of Threatened Species. *Amietia nutti* is classified as Least Concern (LC) [57], as are *Hoplobatrachus occipitalis* [58], *Amnirana albolabris* (currently accepted as *Hylarana albolabris*) [59], *Ptychadena mascareniensis* [60], *Ptychadena perreti* [61], and *Xenopus pygmaeus* [62]. In contrast, *Xenopus ruwenzoriensis* is classified as Data Deficient (DD) [63].

Frogs are preserved in a variety of ways. Some consumers preserve frogs in cold water before cooking, which takes place on the same day. For others, the meat is sun- or fire-dried. This conservation method is less common in Kisangani and its hinterland; however, as most consumers prefer fresh meat. Cooking methods vary from consumers. The sauce is prepared with oil and various ingredients, to make the frog meat delicious. The sauce in a "papillotte", a steam cooking method, involves placing the meat and ingredients in *Megaphrynium macrostachyum* leaves and cooking the whole (**Figure 3**). This method, known in the region as "Liboke" in the Lingala language, is suitable for all types of food and can be carried out in an oven or with embers.

**Table 1.** Amphibian species consumed by ethnic group in Kisangani and its hinterland. The Topoke and Kumu ethnic groups are the amphibian consumers in the region. The plus sign (+) indicates that the species is consumed, whereas the minus sign (–) indicates that the species is not consumed by the ethnic group.

| Species | Local name by ethnic group | | |
|---|---|---|---|
| | Topoke | Kumu | Bangubangu* |
| *Amietia nutti* | Lingombe (+) | Kenonge (+) | Mutaba (–) |
| *Hoplobatrachus occipitalis* | Linahu (+) | Lingombe (+) | Jwaba (–) |
| *Hylarana albolabris* | Igogo, Mwengi, Bochwaafulo (+) | Tshede (+) | Kiolela (–) |
| *Ptychadena mascareniensis* | Motsholo, Mongendu (+) | Benga (+) | Luunda (–) |
| *Ptychadena perreti* | Motsholo, Mongendu (+) | Benga (+) | Luunda (–) |
| *Xenopus pygmaeus* | Mbatu (+) | Muka (+) | Litoke (–) |
| *Xenopus ruwenzoriensis* | Mbatu (+) | Muka (+) | Litoke (–) |

*The Bangubangu are not known to eat amphibians. However, given their presence in villages along the road connecting Kisangani and Ubundu, they were surveyed to provide data on the virtues of amphibians.

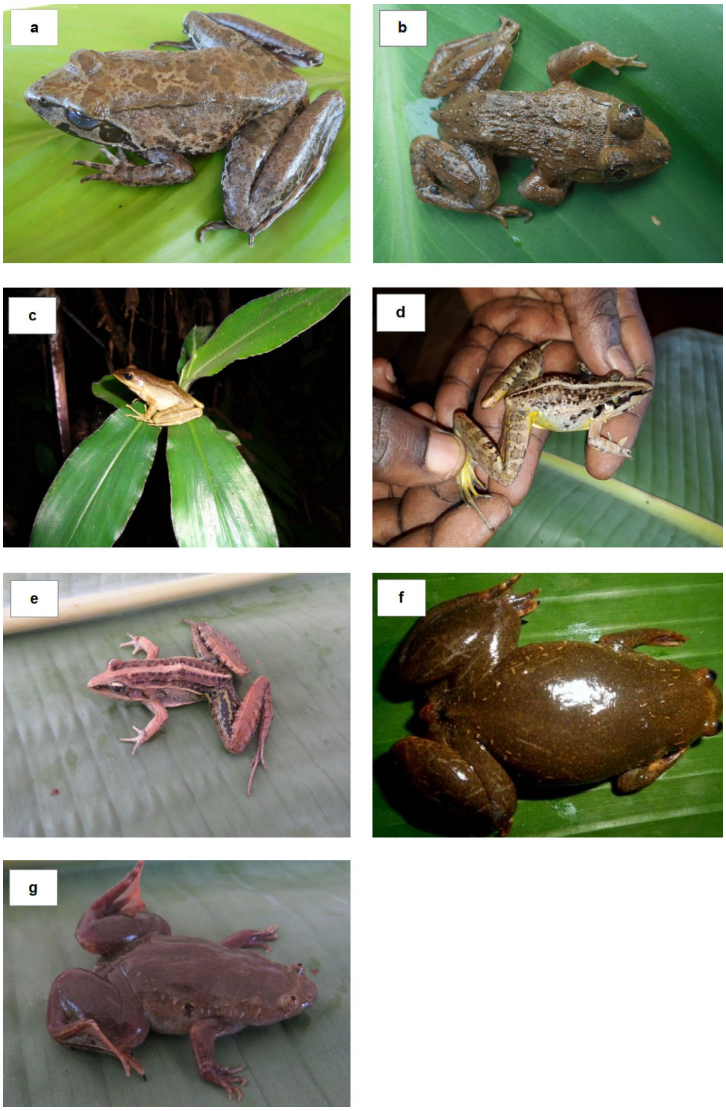



**Figure 2.** Amphibian species consumed in Kisangani and its hinterland, DRC. *Amietia nutti* (a), *Hoplobatrachus occipitalis* (b), *Hylarana albolabris* (c), *Ptychadena mascareniensis* (d), *Ptychadena perreti* (e), *Xenopus pygmaeus* (f) and *Xenopus ruwenzoriensis* (g).



**Figure 3.** The sauce in a papillotte, one of the cooking methods of frog meat by the Kumu and Topoke ethnic groups in Kisangani city and its hinterland, DRC.

The sauce in the pan and in a papillotte are the two most common cooking methods used by consumers. Some consumers prefer to grill or to fry the frog meat with choice spices to enhance its flavor. Still others broth the meat frog with ingredients of their choice (salt, chilies, ginger, tomato) which bring a good taste. In addition to the species consumed, some species are not consumed because of their appearance and certain local beliefs and accounts reported by respondents from the ethnic groups concerned.

- For the Topoke ethnic group

The species *Hylarana albolabris* is forbidden to men, as its consumption causes sores on the penis. On the other hand, consumption of these species has no negative effects on women's health, according to respondents. The species *Xenopus pygmaeus* and *X. ruwenzoriensis* are eaten only by men of all ages but are forbidden to pregnant women. As these amphibians do not have an externally visible anus, their consumption by women would result in a narrowing of the uterine cervix, making childbirth sometimes difficult. Conversely, the consumption of *Amietia nutti* and *Hoplobatrachus occipitalis* by pregnant women is encouraged; as individuals of these species are robust and large, their consumption would positively affect the mass of newborns. Not eating other species also has certain virtues. This is the case for species of the Leptopelis genus, which are forbidden to pregnant women. According to local beliefs, the behavioral habits of these species suggest that prolonged sleep could have a negative effect on newborns. Whether or not the other two species (*Ptychadena mascareniensis* and *P. perreti*) are consumed has no impact on consumers' health.

- For the Kumu ethnic group

Pregnant women are encouraged to eat *Amietia nutti*, *Xenopus pygmaeus* and *X. ruwenzoriensis* meat. As these amphibians are large and have massive bodies, their consumption can have positive effects on the size of newborn babies. The consumption of all other species meat (*Hoplobatrachus occipitalis*, *Hylarana albolabris*, *Ptychadena mascareniensis*, *P. perreti*) is unconditional. This contrasts with other species whose non-consumption is accompanied by several virtues. This is the case for species of the Leptopelis genus, whose individuals were once used in big game hunting: the ash from charred individuals was used to poison arrowheads.

- For the Bangubangu ethnic group

Respondents indicated that no species of amphibian is consumed by the Bangubangu ethnic group. All species that were once consumed by ancestors only during the rainy season are no longer eaten in the name of religion. However, some species are used in traditional medicine. For example, according to local beliefs, all species of toad (Bufonidae family) are used to treat dermatitis when the animal bites the leg of the sick person. If the toad does this, there is hope that the person will recover; if not, recovery is uncertain. The same applies to the use of a toad's heartbeat to identify a pregnant girl, since the heartbeat of the latter and that of the toad have the same frequency. The entrance of any species of toad into a house housing a pregnant woman means that the latter will give birth to a girl.

On the other hand, the bite of a healthy person by toads is bad luck; if the bitten person does not die, it means that another family member will.

## 4. Discussion

Data collection methods and techniques can differ considerably among research fields, and their effectiveness depends on the researcher's experience and the effort invested [64]. Hook fishing, machete cutting, and scooping remain the most used techniques by fishers in Kisangani because of their efficiency. Since scooping contributes to the destruction of habitats and breeding sites favorable to amphibians [65], it can be concluded that the hunting of consumed species exerts pressure on their populations [10]-[13]. Surveys and interviews conducted using questionnaires make it possible to gather a substantial amount of information from respondents [2] [6] [9] [12] [32]. Similarly, the present study relied on surveys and individual interviews based on a pre-established questionnaire to collect the necessary data on edible amphibians. This represents the first study conducted in this field in the Kisangani region.

The results of this study reveal that seven amphibian species are included in the dietary habits of human populations in Kisangani and its hinterland. These species include *Amietia nutti*, *Hoplobatrachus occipitalis*, *Hylarana albolabris*, *Ptychadena mascareniensis*, *P. perreti*, *Xenopus pygmaeus* and *X. ruwenzoriensis*. Similar findings have been reported in previous studies conducted in other regions of the world, particularly in Nigeria, where *Hoplobatrachus occipitalis* is consumed [33]. In the same country, *Rana esculenta* is consumed only in the northwestern region [34], whereas three species (*Hoplobatrachus occipitalis*, *Ptychadena pumilio* and *Xenopus muelleri*) are consumed exclusively in the southwestern part of the country [32]. Similar studies further indicate that *Pelophylax epeiroticus* is consumed in Greece [13], while 11 species (*Amolops* sp., *Euphlyctis cyanophlyctis*, *E. ghosi*, *Fejervarya teraiensis*, *Hoplobatrachus crassus*, *H. tigerinus*, *Megophrys major*, *Pterorana khare*, *Polypedates teraiensis*, *Rhacophorus bipunctatus* and *R. maximus*) are consumed in Dimapur, India [12]. This diversity of consumed amphibian species may explain their nutritional importance as significant sources of animal proteins for humans [10] [32] [34]. Regional differences in consumed species may be related to the dietary habits that characterize ethnic groups and individuals. The present study demonstrated that the surveyed populations possessed a thorough knowledge of local species. In contrast, previous studies reported that respondents experienced difficulties distinguishing amphibians and showed limited familiarity with local species [9] [66] [67].

Regarding preservation methods (keeping individuals in water, salting, and smoking) and preparation techniques (broth, grilling, cooking in papillotes, and sauce preparation), these practices vary among consumers. Similar studies have shown that such practices differ according to the culinary traditions of ethnic groups, with smoking being considered the most effective preservation method [12]. In contrast, in Kisangani and its hinterland, cooking in papillotes is particu-

larly appreciated, resulting in a high demand for *Megaphrynium macrostachyum*, one of the dominant herbaceous-layer species characterizing the remaining forests surrounding the city of Kisangani. We hypothesize that the pressure exerted on plant resources within these forest ecosystems could affect the amphibians that depend on them. Such is the case for *Hylarana albolabris*, among the species reported in the present study, as well as other non-edible species including *Leptopelis notatus*, *L. calcaratus*, *L. millsoni*, *L. christyi*, and *L. ocellatus* [68]. Frog legs constitute a traditional food source for rural populations and are considered one of the most appreciated delicacies in many developed and developing countries, where the high demand for animal protein is partly compensated for the large-scale production of frogs [11] [34].

The harvesting of amphibians by human populations in Kisangani and its hinterland is primarily carried out for subsistence purposes. Similar observations were reported by [19]. In the study area, the price of frogs sold in local neighborhoods ranges between 500 and 1500 Congolese francs, equivalent to approximately 0.217 to 0.652 USD, based on an exchange rate of 2300 CDF for 1 USD (August 2026), depending on the size of the individuals. Although mammal hunting is still permitted during certain periods of the year, ensuring the availability of bushmeat in Kisangani markets, amphibian consumption remains relatively limited. Nevertheless, it is influenced by several factors, particularly the dietary preferences of consumers. This is the case for the consumption of *Hoplobatrachus occipitalis* and *Amietia nutti*, which is motivated by their pleasant taste and fleshy hind legs. According to studies conducted in Nigeria [33] [69], similar reasons may explain the widespread trade of H. occipitalis legs worldwide. In contrast, in Madagascar, [70] demonstrated that frog trade involves multiple actors, with demand primarily originating from restaurants, while direct benefits accrue to hunters, who tend to target large-sized frogs whose prices range between 0.29 and 0.32 USD.

From the perspective of human perceptions of amphibians, the results of this survey revealed differences according to the ethnic affiliation of the respondents. Studies have shown that the consumption or avoidance of frogs is based on traditional and religious beliefs, medicinal values, or the perceived lethal dangers attributed to certain species [12] [21] [22] [34]. For instance, frog meat is believed to rapidly cure gastritis, reduce blood loss, and promote the healing of bone fractures and skin burns [12]. In contrast, many other amphibian species elicit feelings of disgust [71] [72]. This is particularly the case for toads, which represent an emblematic example of zoophobia in humans [35]. Likewise, according to certain respondents from the Islamic faith, all aquatic animals are considered edible, except carnivorous species and crocodiles. In addition, other Islamic doctrines consider frog meat to be unfit for consumption [73]. However, a related study concluded that many aquatic animals, including frogs, are edible even when found dead [34]. These factors limiting amphibian consumption may have beneficial effects on the conservation of their populations and on ecological balance within ecosystems [74].

According to the results of this survey, human populations expressed a strong perception of the medicinal, ecological, and conservation value of frogs. In contrast, the attitudes toward and knowledge of amphibian species are generally poor [6] [67] and differ from the information collected in the study area. This lack of knowledge significantly influences levels of fear and disgust, which are respectively low and high in both sexes [6]. A similar study reported that place of residence (urban or rural) and sociodemographic variables affect knowledge and perceptions of amphibians [9]. These observations contrast with those made in Kisangani and its hinterland. To adapt amphibian conservation strategies while considering the specific conditions of local communities, it is therefore important to identify the sociodemographic factors that shape human perceptions of amphibians. Some studies have concluded that conservation education activities in schools remain necessary to improve human knowledge and attitudes toward frogs [6] [67]. We believe that similar activities could also be implemented in the study area for local populations.

Positive human attitudes toward amphibians are associated with the ecosystem functions attributed to different species [4] [9] [75], as well as their uses as food sources, fishing bait, medicinal resources, pets, biological laboratory models, or educational materials [1] [9] [66] [67] [76] [77]. Examples of amphibian use in traditional medicine have been documented worldwide, particularly in Latin America and Europe [77]-[80]. In contrast, other studies have reported negative attitudes toward amphibians, influenced by various factors such as gender, level of education, negative personal experiences, or oral traditions [1] [4] [5]. Examples include beliefs that amphibians inflate until they explode, secrete poisonous milk through their skin, cause warts upon contact, or are used in witchcraft practices [7] [9]. These types of beliefs and negative popular perceptions underlie disgust, persecution, and killing, thereby reducing the feasibility of implementing conservation strategies for amphibians.

## 5. Implications for Conservation

The destruction of natural habitats is recognized as one of the major threats to the survival of amphibian populations. This is exemplified by scooping, a hunting technique that leads to the destruction of breeding sites favorable to many species. In addition, amphibians are also threatened by human persecution through the consumption of certain species. The complex relationship between humans and these animals has thus shifted toward their persecution, capture through hunting, killing, and subsequent consumption, all of which could constitute serious and real threats. Hunting and fishing also provide insight into ecosystem resilience and the relationships between hunting areas, resources, actors, and driving forces that affect ecosystem components. In this way, they contribute to the establishment of a socio-ecological system aimed at the sustainable management of biodiversity, particularly wildlife. However, amphibian exploitation within the study area appears to be both illegal and unsustainable. Therefore, the farming of con-

sumed species appears to be an important strategy to reduce or slow down their exploitation, which is currently intensified by population growth observed in the Kisangani region. This is particularly the case for frog farming (ranaculture), which should be preceded by a better understanding of the ecological preferences of the target species. Because the contribution of amphibians to dietary protein intake, the pressure exerted on their populations and population trends, as well as the legality and sustainability of individual harvesting, were not assessed, these aspects represent limitations to the scope of the conclusions of this survey and are considered conservation concerns. Similarly, the applicable legal provisions governing amphibian harvesting were not examined, and the quantities of leaves harvested from *M. macrostachyum* were not quantified. Therefore, this preliminary study highlights the need for additional data addressing these aspects to better understand the complex factors that may contribute to anthropogenic pressure on amphibian populations in the Kisangani region. These additional data, which are both necessary and urgently needed, will help inform the development of approaches that integrate sustainable hunting practices with the long-term management of ecosystems and landscapes.

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## Ethics Statement

This study was not submitted for prior review or approval by an institutional or national ethics committee. The animal component of the study involved the temporary capture of specimens, which were subsequently released. No specimen was intentionally subjected to any procedure intended to cause harm. Handling of the specimens was limited to photographing, identification, and the collection of information related to the consumption of each species. The collection of data from human participants relied on non-interventional methods and procedures. The respondents were informed in advance about the purpose of the study, and their oral consent to participate was obtained. The interviews involved no manipulation, experimental intervention, or invasive procedure involving the participants. No personally identifiable information was collected, analyzed, or presented in the study. All information obtained through the interviews was used exclusively for scientific purposes and reported in a manner that protected the confidentiality of the participants.

## Conflicts of Interest

The authors declare no conflicts of interest.

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