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Exploitation and threat traits of the *Hoplobatrachus occipitalis* community, an economically important frog in the Poro region, Northern Côte d'Ivoire

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ABSTRACT

The Poro region is home to several natural habitats for frogs, and their consumption has become widespread in this part of northern Côte d'Ivoire. Frog harvesting has become a significant source of income and food for those involved in this sector. This activity is not subject to any regulatory framework, and this could lead to the extinction of the resource if no action is taken by the relevant authorities. Our study aims to characterize the exploitation of the edible frog, *Hoplobatrachus occipitalis*, and the factors threatening it in the Poro region, to improve fisheries resource management planning. The methodology consisted of conducting surveys with stakeholders in the sector and field visits to understand the fishing environment. The results show that spears (29%) and fishing rods (71%) are the equipment used by fishermen, who are predominantly Senufo (50%). The frog is mainly consumed in soup (62%), accompanied by rice, foutou, or attiéké. The use of agrochemicals for crops and chemicals for mining, drought, and rapid urbanization are the main factors threatening the frog population in the Poro region. Furthermore, the lack of regulations governing, the sector could be the most significant threat to this population. This study establishes a database on frog harvesting for fisheries resource managers in the Poro region, providing them with reliable information for better planning of the sustainable management of this resource.

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INTRODUCTION

Frogs are recognized globally as an important resource for humans in economic, food, medicinal, and agricultural terms (Godome *et al.,* 2018). Economically, for example, they generate income (Oungbé *et al.,* 2018). Agriculturally, due to their insectivorous diet, they could be used to control insect pests (Penner *et al.,* 2010).

In Africa, frogs are used by local populations as a culinary ingredient (Efenakpo *et al.,* 2016; Kia *et al.,* 2018), in traditional medicine (Mohneke *et al.,* 2010b), and for cultural purposes (Mohneke *et al.,* 2010b; Onadeko *et al.,* 2011).

In Côte d'Ivoire, a country with a diverse climate, wetlands serve as habitats or refuges for frogs (Oungbé, 2021). These include temporary and seasonal water courses on the one hand, and surface water reservoirs on the other. In this country, the consumption of the common frog (*Hoplobatrachus occipitalis*) has increased, and today frogs are considered an important source of protein in the diets of the population (Kouamé *et al.,* 2015; Blé *et al.,* 2016).

Unfortunately, frogs are valued only in the diets of certain ethnic groups specifically located in the western region of Côte d'Ivoire. In this region, frogs are subject to significant artisanal exploitation (Oungbé, 2021).

The consumption of these fish products is considered one of the cultural traits characterizing the Guéré and Yacouba, the main ethnic groups in this region (Keita, 2023).

Despite their importance to society, frogs are subject to human behaviors that can cause their decline. These include the loss of their habitats, the reduction of their food resources (Philippe *et al.,* 2002), and their uncontrolled exploitation (Keita, 2023) by farmers. These practices are common in the Korhogo area, where no studies on frog exploitation exist, although Kien *et al.* (2024) recently reported the development of a thriving market linked to the existence of numerous restaurants specializing in frog consumption. In this region, the use of fertilizers, herbicides, and pesticides is very high for fertilizing plots and protecting vegetable crops (Koudou *et al.,* 2020). Mining, which is booming in the area, also uses chemical products.

This study was initiated to better understand frog harvesting and its environment in this area. It is part of a series of research projects aimed at gathering useful information for better management of this resource in northern Côte d'Ivoire. The overall objective of this study is to assess the harvesting of the edible frog, *Hoplobatrachus occiptalis*, in the municipality of Korhogo. The specific objectives related to this overall objective are: to describe the factors of production, to present the production and processing and to identify threats traits of *Hoplobatrachus occiptalis* in this area of Côte d'Ivoire.

MATERIALS AND METHODS

Study area

The municipality of Korhogo is located between 9°34' north latitude and 5°37' west longitude in the northern part of Côte d'Ivoire. It has a population of 440,926 and is part of the savanna region. This department of Korhogo, representing 3.9% of ivorian territory with an area of 12,500 km², is bordered to the north by Mali and Burkina Faso (Boko-Koiadia *et al.,* 2016).

The sites were selected (Fig. 1) based on the intensity of frog harvesting and the presence of frog markets. Thus, the lowland rice paddies of the Soba district of Korhogo (9°34 north-5°37 west) and the garden of Peleforo Gon Coulibaly University, the lakes of the Koko district (9°34 north-5°37 west) of Korhogo and the village of Nangakaha (9°34 north-5°31 west), the rice paddies of the village of Pignon (9°57 north-5°63 west), the rivers of the village of Lataha (9°57 north-5°59 west), and the wells of the village of Nangounkaha (9°48 north-5°57 west) were sampled. Market garden crops (mints, lettuce, and cabbage) or food crops (rice) are cultivated on these sites (Kien *et al.,* 2024).

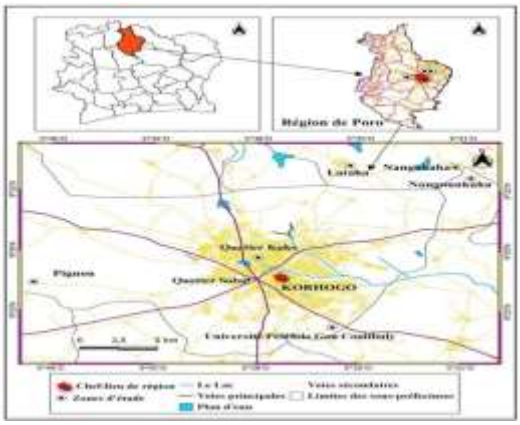

Fig. 1. Location of sampling sites in the city of Korhogo and its surroundings (Kien *et al.*, 2024)

Data collection

A preliminary survey was conducted among fishermen, vendors, and consumers in the urban and peri-urban areas of Korhogo. The results of this survey showed that only the species *Hoplobatrachus occipitalis* is traded and consumed. Data was collected monthly for 12 months, from April 2024 to March 2025. All fishermen, vendors, and consumers were included. Information was gathered through questionnaires and interviews, supplemented by direct field observations. The survey involved 37 fishermen, 18 vendors, and 110 consumers.

For the fishermen, information was recorded daily by trained interviewers stationed in each area. Each day, upon returning from fishing, the fisherman's name, the fishing area and date, the gear used, the weight of the catch, and the distribution network were recorded on forms.

Rödel's (2000) identification key was used to identify the sampled *Hoplobatrachus occipitalis* frogs. A commercial scale was used to weigh this species. Data sheets were collected monthly, and the information was used to characterize the fishers, identify fishing techniques, estimate the quantities caught, and describe the marketing channels. Interviews were conducted to understand the difficulties encountered by the stakeholders and to note their wishes and suggestions. For the vendors, information was sought regarding the quantities bought/sold, the forms sold, the sales location, the purchase/sale prices, etc. Regarding consumers, their habits and preferences in consuming frogs were examined.

Data analysis

The data from this survey were entered using Excel spreadsheet software version 2013. It was used to create tables, histograms and pie charts which allowed us to characterize the actors, the capture devices, the production and the consumption of *Hoplobatrachus occipitalis*.

RESULTS

Description of the species *Hoplobatrachus occipitalis*

The species *Hoplobatrachus occipitalis* (Fig. 2) belongs to the family Dicroglossidae. This species represents 99% of the captures recorded in the different areas. Broad and flat with complete webbing between the toes, this frog has very bulging eyes located dorsally. The skin on its back forms very short, discontinuous folds, rather irregularly arranged, resembling pustules. The overall coloration is a brownish gray, more or less dark, speckled with darker, irregular, and often indistinct spots (Fig. 2).

Fig. 2. *Hoplobatrachus occipitalis*

Factors of production and production of *Hoplobatrachus occipitalis*

Frog fishers

The survey results showed that frog fishing is practiced by both non-natives and locals (Fig. 3). Frog fishermen in the Korhogo area are predominantly Senoufo, representing 50% of the population. The other fishermen are either Baoulé (16%), Guéré (17%), or Adjoukrou (17%). These fishermen are mostly young (78%). Adults represent only 22% of this group.

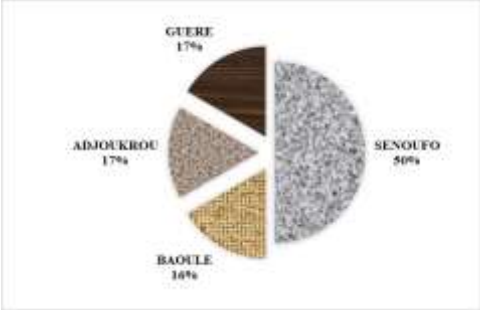

Fig. 3. Distribution of fishermen according to ethnicity

Fishing gear

Frogs are collected in the city of Korhogo using two fishing methods: spears and fishing rods. The fishing rod, consisting of a short wooden shaft with a string attached and a hook at the end, is the most used method, employed by 71% of fishers. The spear, made of a thin wooden shaft 2 to 3 meters long with three or four sharpened iron rods attached to the end, is used by only 29% of fishers. Spears are generally used at night. At night, fishers use a torch wrapped with a rubber band over their head.

Production

The total biomass of *Hoplobatrachus occipitalis* recorded across all sites is 43,213 g (Table 1). This biomass is distributed as follows: 11,984.61 g in lakes (7,139.11 g in the rainy season and 4,845.5 g in the dry season), 8,552.99 g in wells (4,426.55 g in the rainy season and 4,126.44 g in the dry season), 8,319.99 g in rivers (2,482.62 g in the rainy season and 5,837.37 g in the dry season), 12,363.99 g in rice paddies (8,948.53 g in the rainy season and 3,415.46 g in the dry season) and 5,383 g in lowlands (3,391.99 g in the rainy season and 1,991.71 g in the dry season). Generally, the rainy season (26,388.1 g) is more productive than the dry season (20,216.48 g).

Table 1. Production (g) of *Hoplobatrachus occipitalis* by site and by season

	Lakes	Wells	Rivers	Rice paddies	Lowland	Total
Rainy season	7,139.11	4,426.55	2,482.62	8,948.53	3,391.29	26,388.1
Dry season	4,845.50	4,126.44	5,837.37	3,415.46	1,991.71	20,216.48
Total	11,984.61	8,552.99	8,319.99	12,363.99	5,383	46,604.58

Fig. 4. Pile of 500 FCFA

Fig. 5. Pile of 1000 FCFA

Valorization of *Hoplobatrachus occipitalis*

Marketing channels

Two marketing channels were identified during this study of the frog sector in Korhogo. In the first, referred to as the short channel, frogs are sold directly to households by fishermen and other resellers. Once in the hands of the resellers, the frogs are sold in the markets in piles of three, either smoked or fresh. The price per pile varies from 500 (Fig. 4) to 1000 FCFA (Fig. 5) depending on the size of the frogs in the pile. Restaurant owners offer frogs grilled or in soup to consumers.

In the long channel, the marketed product passes through at least two intermediaries from the fisherman to the consumer. Thus, for example, wholesalers from Korhogo buy frogs in villages or camps. Next, they offer the fish to other intermediary fishmongers residing in Korhogo or coming from other cities. These intermediary fishmongers then resell the fish retail to consumers in their respective areas or deliver it to

retailers. These retailers also sell the product retail to consumers outside the area. It should also be noted that some of the fish is intended for personal consumption.

Consumers

Analysis of the data from this survey (Fig. 6) indicates that frog consumers in the city of Korhogo come from all regions of the country.

Fig. 6. Forms of consumption of *Hoplobatrachus occipitalis* (A: Soup, B: Fried, C: Smoked)

Nevertheless, the Senufo (25%), Gouro (13%), Abron, Guéré, and Yacouba (8% each) are the most numerous in this population. 96% of consumers prefer frog because of its taste, while only 4% cite its accessibility and lower cost.

Forms of consumption

The frog specimens harvested in Korhogo are generally consumed in soup (62%) (Fig. 7). Other forms of consumption include fried (22%) and smoked (16%).

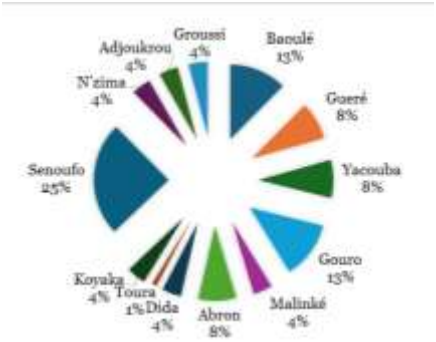

Fig. 7. Distribution of consumers by ethnicity

Threats traits of frogs

Regarding the difficulties faced by stakeholders in the frog sector in the Poro region, respondents identified factors of anthropo-climatic and ecological origin (Fig. 8). 72.24% of the fishermen and vendors interviewed believe that agrochemical pollution, including the use of fertilizers, pesticides, and herbicides in agriculture and the use of chemicals at mining sites, are the main threats to frog populations. Water scarcity during droughts, leading to the drying up of ponds and other water sources that serve as frog habitats, was mentioned in 12.23% of responses, while urbanization was cited in 9.2%. Other factors mentioned in the responses included overexploitation (4.31%) and predation (2.02%).

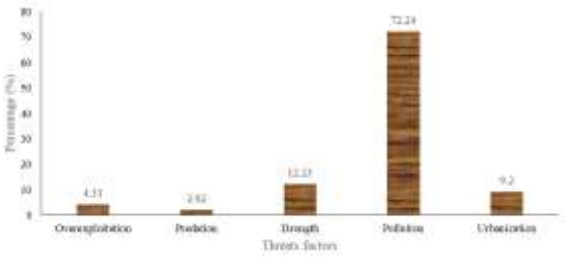

Fig. 8. Factors representing a threat to frog populations in the Poro region of northern Côte d'Ivoire

DISCUSSION

Factors of production and production of *Hoplobatrachus occipitalis*

The production and sale of frogs for food is an increasingly common activity in both urban and rural areas. This long-standing activity in the mountainous west of Côte d'Ivoire is booming in the north. Frog farming in the north is unique in that it highlights new markets associated with ethnic groups not

traditionally known to consume frogs and reveals the atlas of species inhabiting this area (Kien *et al.,* 2024). This population is comprised of 97% *Hoplobathrachus occipitalis* due to its excellent adaptation to the area's environmental conditions (Kien *et al.,* 2024). The survey conducted during this study shows that *Hoplobatrachus occipitalis* is the only species consumed in the region.

Analysis of production factors revealed that 50% of the fishermen are Senufo. The study area could explain this result, as the Senufo are the predominant ethnic group in the population of Korhogo (Koudou *et al.*, 2020). In Côte d'Ivoire, frog fishing was long associated only with the Guéré and Yacouba groups. Kéita (2023) showed that all ethnic groups have begun to incorporate the edible frog, H. occipitalis, into their diet. In Korhogo, those interviewed stated that they are interested in this activity because it is profitable and provides a protein that is increasingly preferred to fish by consumers due to its taste and lower cost. Most of these fishermen use a rod for fishing (71%). This result is linked to the fact that the vast majority of fishermen practice day fishing. Kéita (2023) reports that this gear is the appropriate one for daytime fishing, with arrows being associated with torches for nighttime fishing.

The production of *Hoplobatrachus occipitalis* varied from season to season during this study. The largest catches (22,388.1 g) were recorded during the rainy season. These results corroborate those of Ernst (2002), Kouamé (2009), and Oussou (2022), who explain that frog abundance increases from the dry season to the rainy season. High rainfall during the rainy season in Korhogo makes the resource accessible to fishing gear (Koudou *et al.,* 2020).

Indeed, during the rainy season, frogs are abundant in the water because they find favorable conditions, as their skin needs to be constantly moist for optimal cutaneous respiration (Rödel, 2000). Furthermore, the disappearance of certain habitats in the dry season, particularly lowlands and temporary ponds (Kia *et al.,* 2018; Oungbé *et al.,* 2018) which dries up with the cessation of rains, could also explain the decline in fishermen's production observed in this study during this period.

Valorization of *Hoplobatrachus occipitalis*

This study also notes that *Hoplobatrachus occipitalis* can be consumed in various forms. Consumers prefer this meat in soup (kédjénou) at 62%, rather than grilled (22%) or smoked (16%). This same trend was observed by Keita (2023). Our results also show that the Senufo are the ethnic group that consumes the most frogs (25%). This predominance is likely since they are the indigenous people of the city of Korhogo and confirms Oussou's (2022) observations that frog consumption is no longer limited to the peoples of western Côte d'Ivoire. The Baoulé are the second most popular ethnic group in Korhogo. Baoulé's prominence is likely due to their large population and their spread throughout the country, both in urban and rural areas (Alla, 1991).

Threats traits of frogs

Frogs play an important role in preventing vector-borne diseases such as malaria. By consuming insect larvae in stagnant water, frogs contribute to reducing the prevalence of these diseases. This ability of frogs to control insect pests in agriculture and public health has already been highlighted by Penner *et al.* (2010), Altherr *et al.* (2011), and Oungbe *et al.* (2018). In this regard, Mohneke *et al.* (2010a) indicated that the decline in frog populations coincided with an increase in insects in rice paddies. The solution found by farmers to eliminate these insects was the use of insecticides. In the Poro region, the use of fertilizers, insecticides, and pesticides (agrochemical pollution) in fields (rice paddies and vegetable gardens) and the use of chemicals in artisanal mining were identified by stakeholders as the factors that pose the greatest threat (72.24%) to frogs in their environment. Water scarcity (12.23%), urbanization (9.2%), overexploitation (4.31%), and predation (2.02%) were mentioned as secondary factors. The same factors are cited by other authors, but with varying degrees of importance. This is the case for Mohneke *et al.* (2010c), who identified water scarcity as the primary

threat (46%) to frogs in Burkina Faso. The legal vacuum surrounding frog harvesting in Côte d'Ivoire, mentioned by animal and fisheries resource managers in Korhogo during our interviews, is seen in Burkina Faso as one of the most damaging threats to "neglected" natural resources such as these frogs (Coulibaly and Zigui, 2021). On this subject, Altherr *et al.* (2011) state that there is no regulatory mechanism for this activity in almost all African countries. In Côte d'Ivoire, and particularly in the northern part of the country, frog harvesting is an unregulated and uncontrolled activity. This legal vacuum could be the most significant threat to the conservation and sustainable management of this resource if no action is taken.

CONCLUSION

Frog harvesting contributes to meeting the animal protein needs of the population in the Korhogo region. Unfortunately, this "neglected" resource does not benefit from adequate support for its sustainable management. This study contributes to the knowledge of the frog sector in Côte d'Ivoire. It has been revealed that today, fishing, marketing, and consumption of frogs are practiced by all ethnic groups. The dominance of one ethnic group is linked to the study area. Frogs, generally caught with sticks or arrows, are sold fresh, smoked, or in soup, with a high demand for soup. Catches are best during the rainy season.

The *Hoplobatrachus occipitalis* species is the only edible frog in the Poro region. These frogs are harvested using artisanal methods without any conservation measures. The lack of regulations governing the sector, coupled with overexploitation, the use of agrochemicals in agriculture, and the use of chemicals in mining, could lead to the decimation of the frog population. In this context, it is essential to consider domestication and breeding strategies for these species now and to encourage conservation efforts.

The results presented here, made available to fisheries managers in general, will allow for better planning of fisheries resource management and a better understanding of the behavior of *Hoplobatrachus occipitalis* (common frog) with a view to its rearing in aquaculture farms in Côte d'Ivoire in general, and in the Korhogo area in particular. A study of the diet of *Hoplobatrachus occipitalis* will complement this data with a view to raising this species in Korhogo.

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