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Status of harvesting, consumption and wild stocks of the edible frog *Hoplobatrachus occipitalis* (Günther, 1858) in the city of Daloa (Côte d'Ivoire)

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Abstract

This study was carried out to know the actual state of the wild stocks and, therefore, the consumption and the means of a collection of the most consumed edible frog on Ivory Coast. For this end, a survey was carried out through the snowball technique among all the actors involved in the consumption of this frog. The most common techniques used to harvest the frog *Hoplobatrachus occipitalis* are night hunting with an arrow (36.00%) and fishing with a hook (32.00%). Unfortunately, hunting with machetes is aggressive at 81.81% and with arrows at 60.22%. The respondents found frog meat very popular at 57.00% and like to eat it in soup at 52%. In terms of weekday consumption, 6 to 10 frogs are consumed most often at home and 20 to 30 frogs in restaurants. In lowland areas, wild stocks are 50-70% lower than in rivers. This study showed that the frog *Hoplobatrachus occipitalis* is consumed a lot in the city of Daloa, which negatively impacts these wild stocks.

Keywords: Survey, *Hoplobatrachus occipitalis*, collection, consumption, stock

Introduction

Humans have consumed frogs for centuries. Today, the international market for frogs is mainly supplied by animals collected from the wild. In Europe, frog's legs are the main product consumed and are a popular dish ^[1]. Several European countries have gradually integrated frogs into their gastronomy since the 16th century. More recently, the development of the cold chain has led to a sharp increase in its consumption, which now amounts to 8,000 to 10,000 tons of frog's legs per year in all the countries concerned ^[2]. Most of the frogs consumed are taken from natural stocks. However, these stocks have been declining sharply, particularly since 1980 ^[3]. In a number of hot countries (Madagascar, Malaysia, Thailand, China etc) frogs are commonly eaten by the local population, sometimes almost whole (after simple removal of the head and entrails). Elsewhere, particularly in sub-Saharan Africa, wild catches are quite common to supply local restaurants. Everywhere there are local species that are edible and consumed. The overexploitation that has prevailed in Europe, combined with profound changes in natural habitats with the increased use of chemical fertilisers, weed killers and insecticides has led to a gradual but continuous reduction of local species ^[4, 5]. In Côte d'Ivoire, in recent years the population has started to gradually integrate the frog *Hoplobatrachus occipitalis* into its diet. Indeed, there has been a strong increase in its consumption in many parts of the country, especially in the forest, because of its so-called pleasant taste ^[6, 7]. It is a robust, fast-growing species with adult specimens weighing up to 400g. *Hoplobatrachus occipitalis* is more widespread in Africa ^[8, 9]. This species is most often found in the savannah and forest margins ^[10, 11]. Therefore, this survey was carried out to address many of the major concerns about the status of the wild population of this frog in Côte d'Ivoire and more particularly in Daloa. The objective of this study was to make an inventory of the means of collection, consumption and wild stocks of the edible frog *Hoplobatrachus occipitalis* in the city of Daloa. This was done in order to have reliable information for the preservation of wild frogs.

Material and Methods

Study site and population

The choice of Daloa as the survey location was based on the criteria of the socio-economic importance of this locality.

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Daloa is the capital of the Haut-Sassandra region and the third-largest city in Côte d'Ivoire (figure 1) in terms of population with 266,324 inhabitants in 2014 [12]. The town is located at 141 km from Yamoussoukro, the political capital, and 383 km from Abidjan, the economic capital [13]. The city of Daloa was the study population in all its components, Ivorians and non-Ivorians divided into youth, adults, women and men. With a target population that consisted of all

inhabitants of Daloa with a link to the frog *Hoplobatrachus occipitalis*. The first group was made up of individuals involved in collecting frogs in the natural environment. These are fishermen and hunters. The second group was made up of those who do this as a trade. These are the sellers (at home, markets, restaurants) and the restaurant owners (occasional or specialised). Consumers at home and in restaurants made up the last group.

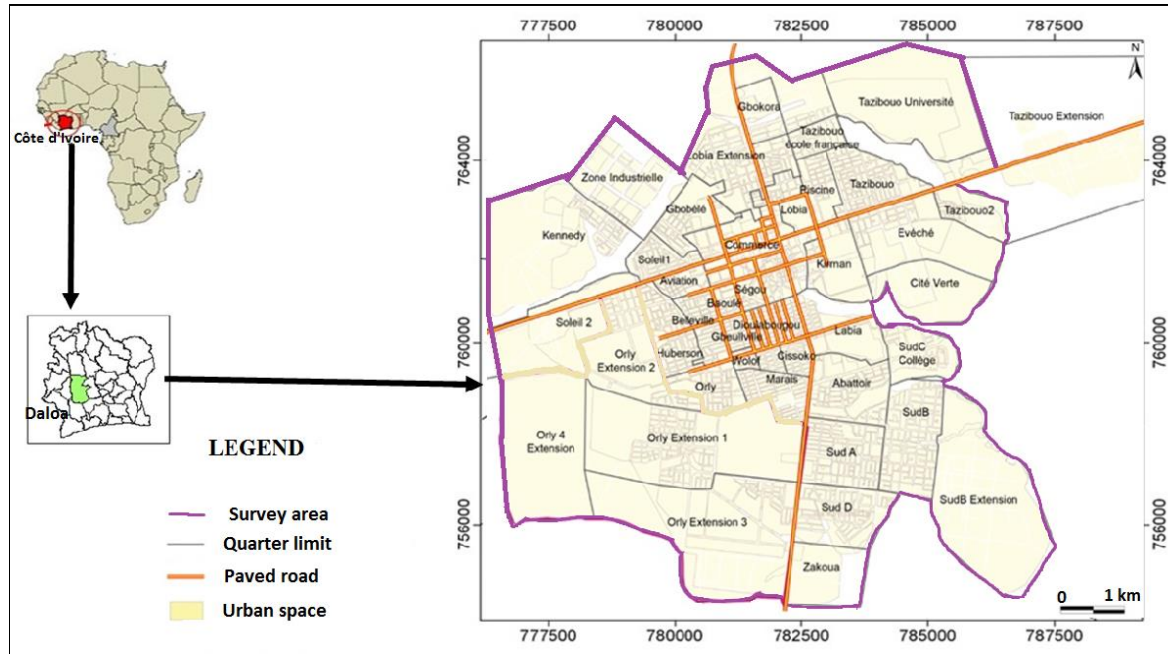


Fig 1: Map of the city of Daloa (source; BNETD/CCT, 2016)

Survey technique applied

The snowball technique was used to mobilise the study sample or observed population. Indeed, snowball sampling [14] is a form of link-tracing sampling design in which individuals in the initial sample are asked to identify acquaintances who are then asked to identify, in turn, acquaintances, and so on for a fixed number of stages or cycles. This technique gave us a study population of 203 inhabitants of Daloa. The majority of the inhabitants were involved in several activities related to frogs, so that 354 people were surveyed, including fishermen, hunters, sellers, restaurant owners and consumers.

Themes to be assessed and development of the questionnaire

The objectives of the survey were to carry out an inventory of wild stocks, to determine the state of consumption and finally to identify the forms of taking of the frog *Hoplobatrachus occipitalis*. The questionnaire was designed according to the key aspects of the three previous objectives

Data summary

After filling in 354 survey forms the information of each respondent was centralized by operational objective in tables. Thus, each theme per objective was filled in quantitatively according to the opinions of the population.

Statistical processing of survey data

The data obtained was translated into bar charts (horizontal and vertical), pie charts, curves and tables. This was done using EXCEL 2016 software.

Results

Forms of sampling

Frog sampling techniques

The most common techniques used to collect the frog *Hoplobatrachus occipitalis* (figure 2) are night hunting with an arrow (figure 3) and fishing with a hook, with 36.00% and 32.40% respectively. The intermediate techniques are fishing with a net, night hunting with a machete and capture by pond drainage with 8.40%, 8.00% and 8.00% respectively. The least used techniques are capture with traps and use of stone-throwers.

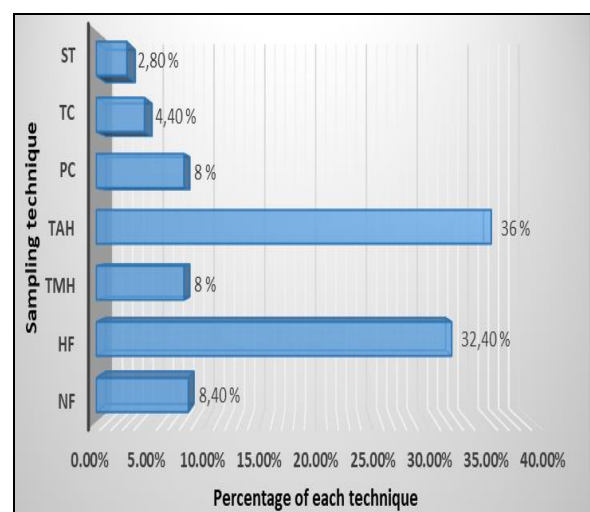


Fig 2: Percentage use of each harvesting technique

ST: stone-throwing; TC: trap capture; PC: pond capture, TAH: torch and arrow hunting, TMH: torch and machete

hunting, HF: hook fishing, NF: net fishing.



Fig 3: Frog collection instruments used by population (torch and arrow)

Impact of harvesting techniques on the frog

The most aggressive techniques that cause the most serious injuries are hunting with machetes (81.81%) and arrows (60.22%) (Table 1). Fishing with hooks and the use of stone-

throwers result in minor injuries at 76.92% and 60.00% respectively. The sampling techniques that preserve the frog’s integrity are the use of traps, pond drainage and net fishing with 70%, 63.15% and 57.89% respectively.

Table 1: Impact rates of different collection techniques for the frog *Hoplobatrachus occipitalis*

Sampling technique	Healthy	Weakly Injured	Seriously Injured
Fishing (net)	57,89%	26,31%	15,78%
Fishing (hooks)	11,53%	76,92%	11,53%
Hunting (torch and machete)	0%	18,18%	81,81%
Hunting (torch and arrow)	0%	39,77%	60,22%
Capture (pond drainage)	63,15%	31,57%	5,26%
Capture (use trap)	70%	20%	10%
Other technique (slingshot)	20%	60%	20%

Consumption

Reasons and mode of consumption

The results of the survey showed that the consumers in the study sample like to consume the frog *Hoplobatrachus occipitalis* because of its highly appreciated taste at 57%

(Figure 4). Next, the frog's legs are appreciated by 20% to a lesser extent the affordability and cultural reasons. Consumers of *Hoplobatrachus occipitalis* like to eat it in kedjenou or soup (52.00%) (Figure 6A), followed by smoked frogs (28.00%) (Figure 6B) and grilled frogs (20.00%).

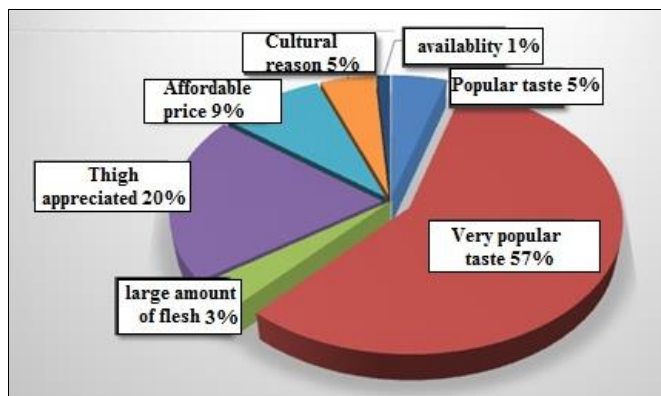


Fig 4: Percentages of different reasons for eating the frog *Hoplobatrachus occipitalis*

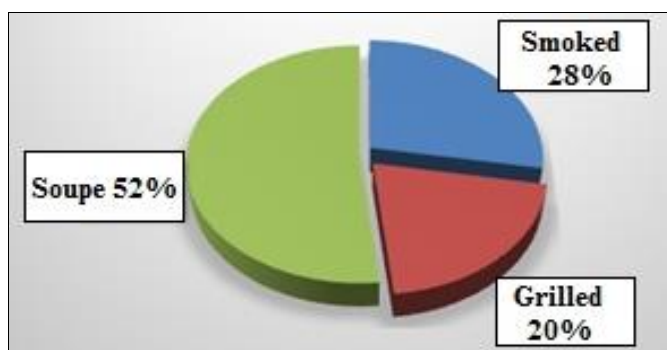


Fig 5: Percentages of different consumption patterns of the frog *Hoplobatrachus occipitalis*



Fig 6: Different ways of eating the frog *Hoplobatrachus occipitalis* A: kedjenou (pepper soup) of frog; B: smoked frog

Quantity of frog sold and consumed

The quantities sold by the restaurant owners and the sellers during the week evolve in practically the same direction (figure 7). In fact, the quantities of 101 to 150 frogs are the most sold during the week with 33.33% for restaurant owners and 30.58% for vendors. The smallest quantities sold during

the week are 10 to 30 frogs, with 10.23% for vendors and 8.33% for restaurant owners (figure 7 A). At the consumer level, the quantities of 6 to 10 frogs are the most consumed at home with 40.76% during the week, while the quantities that are most consumed in restaurants are 20 to 30 frogs during the week with 26.82% (figure 7 B).

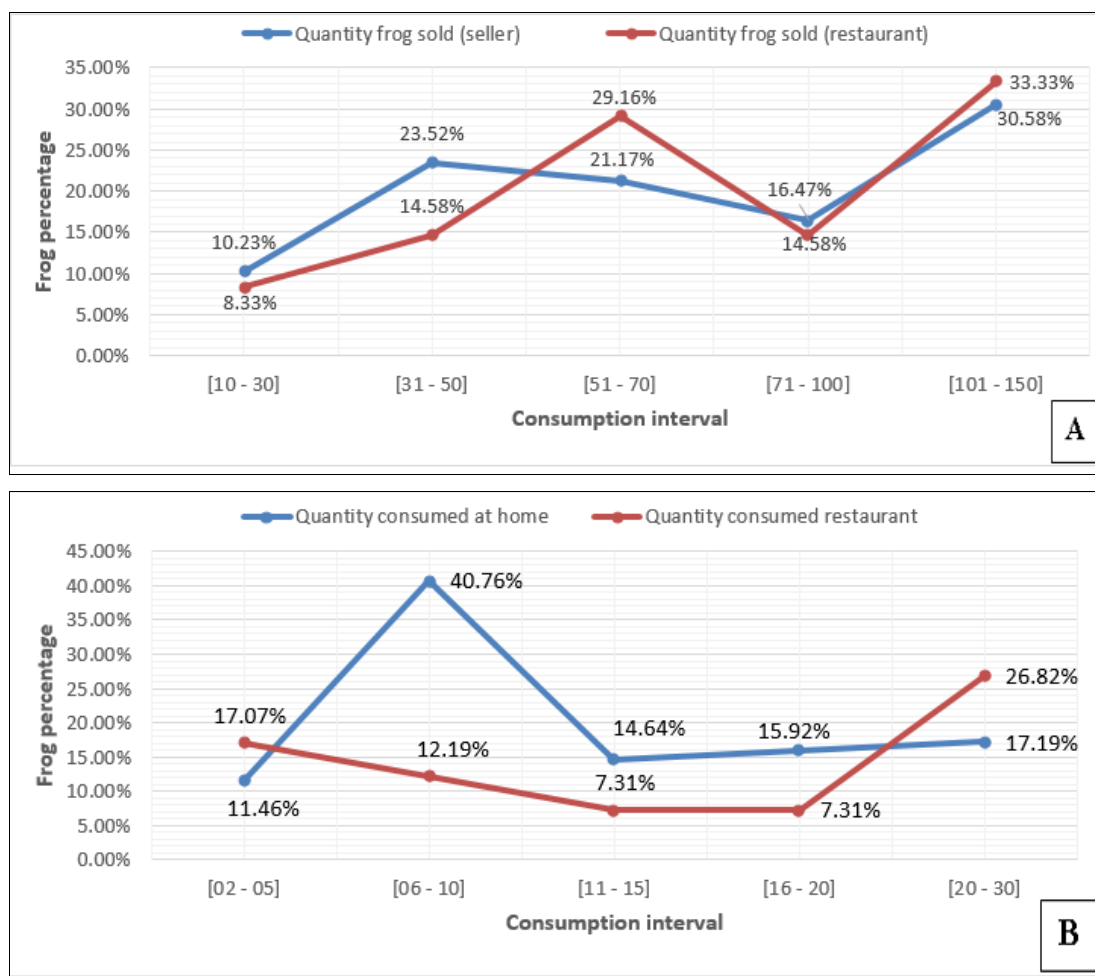


Fig 7: Percentages of frog quantities of *Hoplobatrachus occipitalis* sold (A) or consumed (B)

Wild stock

Quantity of frogs collected

For the weekday collection intervals of 10 to 30 and 31 to 50 frogs, fishing takes precedence overhunting and other

collection techniques with 40.78% and 54.09% (figure 8). For the higher ranges of 51-70, 71-100 and 101-150 frogs per week, hunting takes precedence over the other two techniques with 45.55%, 40.00% and 75.00% respectively.

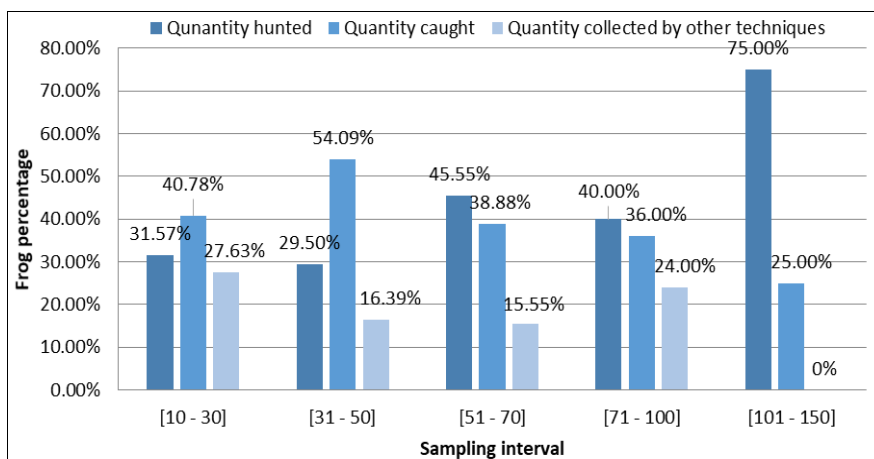


Fig 8: Percentage ranges of *Hoplobatrachus occipitalis* frog quantities as a function

Available wild stock

In lowlands, wild stocks of *Hoplobatrachus occipitalis* are lower than in rivers (Figure 9). Indeed, stocks are considered average from 30% to 50% and low from 70% to 50%. In the

rivers these values are lower with high stocks between 12.96% and 14.06%. In the city, stocks are low at 70% in the lowlands and 29.62% in the rivers, whereas they are less alarming in the periphery.

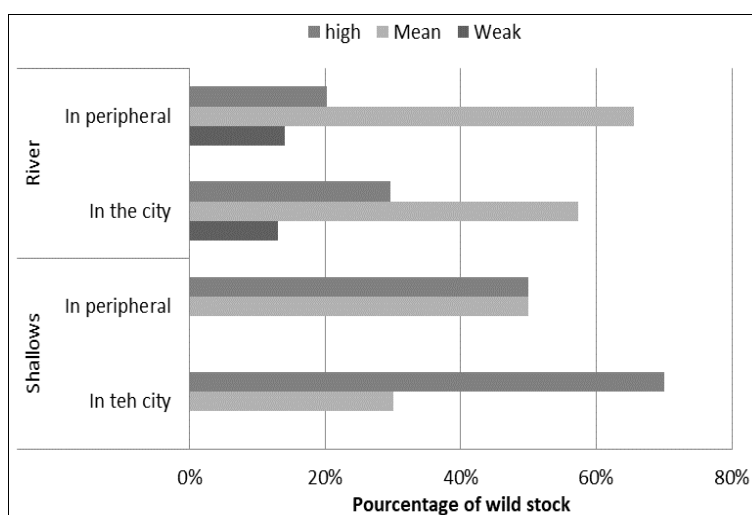


Fig 9: Stock availability of the frog *Hoplobatrachus occipitalis* in the Daloa city and its surrounding areas

Collection site

The survey results show that shallows are the most popular areas for collecting *Hoplobatrachus occipitalis* frogs in the city and its outskirts, with 74.60% and 62.63% respectively

(figure 10). The next most popular areas are rivers and temporary pools, with 7.60% in the city and 3.60% in the suburbs.

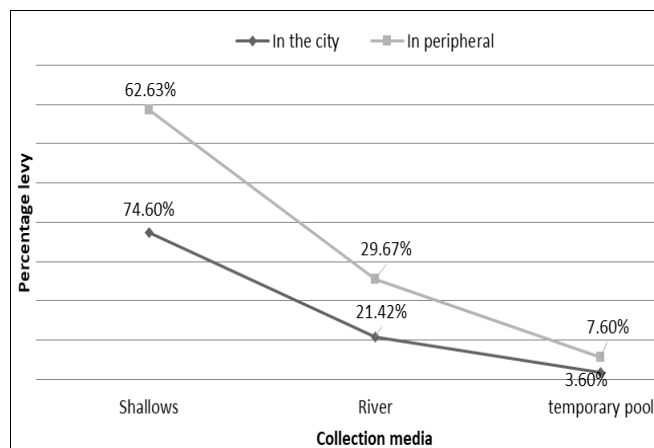


Fig 10: Stock availability of the frog *Hoplobatrachus occipitalis* in the city and its surrounding area

Discussion

The study sample consists of fishermen, hunters, sellers, restaurant owners and consumers. This shows that the frog consumption sector *Hoplobatrachus occipitalis* is well organized, with all links in the chain present. The consumers are the most numerous, with 168 people, because they create the demand, and the others, less numerous, actors work to satisfy it. Indeed, the meat of this frog is very much appreciated by the respondents (57%), especially the legs. This appreciation of the flesh of this frog is confirmed by two authors Mazyambo (1981) [15] and Blaustein and Wake [16]. According to the first author, the flesh of the species *Hoplobatrachus occipitalis* is much appreciated for human consumption and for the second author there is a high consumption of this frog because of its so-called pleasant taste. This attraction for frogs' legs was also confirmed by Hardouin (1991) [4], who stated that in Europe, frogs are mainly consumed as imported Asian legs, thus constituting a sought-after dish. But also, the frog *Hoplobatrachus occipitalis* can be eaten in different forms, in soup, smoked or grilled. This diversity allows consumers to vary the taste of frog meat and restaurant owners to offer different dishes based on frog protein. The most common techniques used to harvest frogs are hook and line fishing. This is due to the success of hook and line fishing during the day and arrow hunting at night. Indeed, fishing is the most used harvesting technique for quantities between 10 and 50 frogs with 40.78% and 54.09%. Hunting is the most used technique for larger quantities with a percentage varying between 45.55% and 75.00%. The impact of each technique on the frogs is proportional to the danger of the instrument used for collection. A machete and an arrow are respectively sharp and pointed instruments that can cause damage to all living things. There has been a general decline in stocks of the frog *Hoplobatrachus occipitalis* both in the city and in the suburbs, which could be explained by the massive harvesting of wild frog populations [17, 18, 19, 20], especially in the shallows and then in the rivers. Indeed, the most sold quantities by restaurant owners and vendors are 101 to 150 frogs per week, with percentages ranging from 30.58% to 33.33% and with profits ranging from 50% to 100%. This is confirmed by Kouamé *et al* [21], according to which *Hoplobatrachus occipitalis* is the most abundant and prized species because it is widespread in the various markets of Daloa. According to Nzigidahera (2006) [22], the exploitation of frogs is an undeniable source of income.

There is a drastic decrease in stocks in the lowlands and in the town compared to the rivers and the periphery respectively. This difference could be explained by the fact that the city and the shallows are the living environments favoured by the species studied because it is an amphibian characteristic of degraded habitats [23, 24]. This proximity makes it even more vulnerable to anthropogenic pressure, particularly fishing and hunting. Indeed, in the lowlands, frog populations in the city and on the outskirts of the city vary between 62.63% and 74.60%.

Conclusion

The study shows that several techniques are used to collect the frog *Hoplobatrachus occipitalis* in the natural environment. Unfortunately, the most commonly used techniques are those that cause the most harm to the frogs, i.e. the use of torches with machetes and arrows. *Hoplobatrachus occipitalis* is widely consumed at home and in restaurants, 9

the quantities taken and sold are enormous. This obviously reduces the natural stocks of this frog, especially in the shallows. In view of these alarming results, it is necessary and urgent to put in place policies to preserve wild populations of the frog *Hoplobatrachus occipitalis*, especially its breeding.

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