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## Dried or Fried: Amphibians in Local and Regional Food Markets in West Africa

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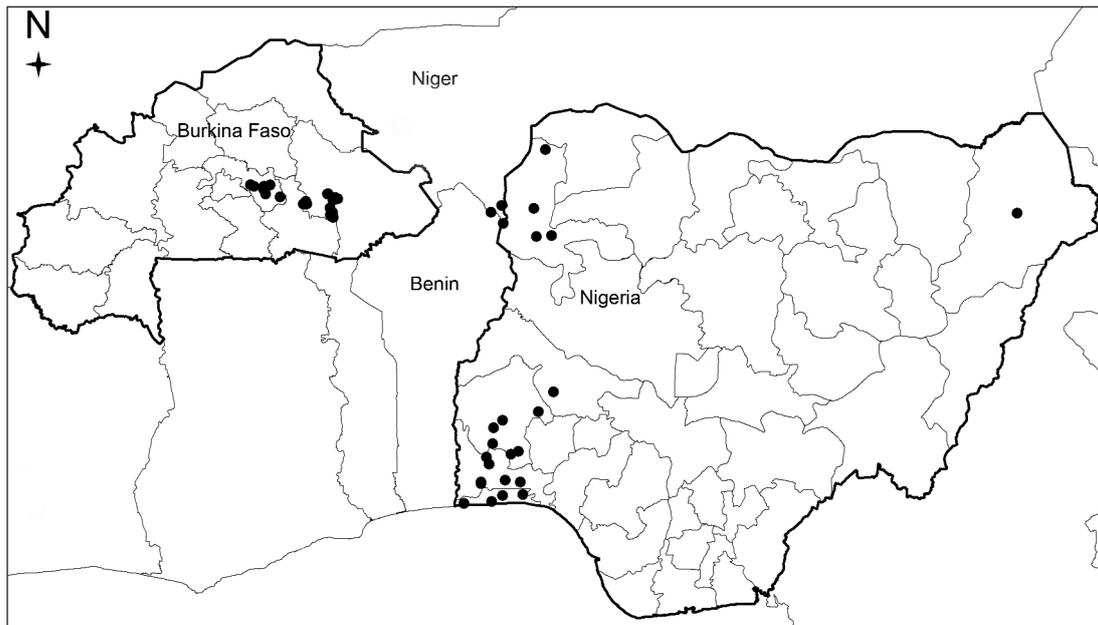
**O**verexploitation of amphibians is one of the reasons for their worldwide decline. In Africa, the consumption of frogs has not yet been the focus of scientific research. Herein the authors report on investigations carried out in Burkina Faso, Benin and Nigeria, West Africa, based on interviews with frog-collectors, stallholders and consumers. In Burkina Faso, the frog trade mainly takes place on a local scale. In northern Benin and Nigeria, an intensive cross-border trade of amphibians was detected. Frogs, predominantly the African Tiger Frog *Hoplobatrachus occipitalis*, are collected in the north of Nigeria and neighbouring countries, and are subsequently traded into the cities of southern Nigeria. It is likely that the numbers of frogs traded is not sustainable in some areas, and may have already caused declines in frog populations. The frog trade in West Africa needs more attention and detailed investigation in order to avoid any ensuing detrimental consequences for the region's ecosystem.

**Fig. 1.** Woman selling dried toads at a market in a village in the province of Ganzourgou, Burkina Faso. Photograph: Meike Mohnke

## INTRODUCTION

The sustainable use of natural resources is a strong political argument to preserve biological diversity (CBD, 2008). However, overexploitation of these resources is also one of the major threats to the conservation of nature (Cowlshaw, 2005; CBD, 2008). For example, overexploitation is mentioned as one of the reasons for the worldwide amphibian decline (Stuart *et al.*, 2004, 2008). Recently, Warkentin *et al.* (2009) summarized alarming data on numbers of Asian frogs collected for human consumption. In many countries, frogs have always been collected on a local scale as an essential source of animal protein (Angulo, 2008; Mohnke *et al.*, 2009). However, during the past decades frogs have become an important international trading item. By the end of the 1990s the international trade in frogs' legs involved more than 30 countries and in 1998 was valued at approximately USD48.7 million (Teixeira *et al.*, 2001). As it has been claimed that 95% of the traded frogs' legs originate from wild populations, there is growing concern over declining amphibian populations (Warkentin *et al.*, 2009), including potentially severe economic and social impacts (Mace and Reynolds, 2001).

As a consequence of decreasing frog populations, the collection of frogs from the wild was prohibited in various European countries (Neveu, 2004; Oza, 1990). India and



**Fig. 2. Map of the study sites in Burkina Faso and amphibian trading spots in Nigeria.** Each black dot refers to a village or town where interviews have been carried out. Malanville in Benin was included as a major trading spot for frogs going into the Nigerian food market.

Bangladesh subsequently became the world’s leading producers and exporters of frogs’ legs (Teixeira *et al.*, 2001). However, due to growing evidence that frog declines caused an increase in agricultural pests and mosquitos, these countries banned the collection and trade of frogs. Then, and to date, Indonesia became the world’s main exporter of frogs’ legs, followed by China, Taiwan and Viet Nam (Teixeira *et al.*, 2001; Kusrini, 2005). The local Asian frog trade may be sustainable (Kusrini and Alford, 2006). However, the actual numbers of harvested frogs and the socioeconomic importance of this harvest are largely unknown. This also concerns other parts of the world. In Africa, amphibians are used in medical treatments or for cultural reasons (e.g. Pauwels *et al.*, 2003; Gonwouo and Rödel, 2008), but their importance as human food has so far not been investigated.

The human population in Africa has doubled during the past 20 years (UNPD, 2009) and the need for resources has consequently resulted in an increasing rate of wildlife exploitation (Mace and Reynolds, 2001). African wildlife was traditionally regarded as a valuable

community asset, which was used and protected by customs and taboos. Today, some of these traditions and taboos have become weakened or have disappeared, and the wildlife they previously protected is now exposed to serious threats (Ntiamao-Baidu, 1987). Recently the authors became aware of dramatically increasing demand for frogs in several West African countries. The dimensions of and the actors within this frog market were unknown. The present study is the first to investigate the current market for frogs in the region. Based on interviews conducted in three West African countries, namely Burkina Faso, Benin and Nigeria, the study aims to get an overview of the amount of frogs collected, their use and trade, as well as the socioeconomic value of this market.

**METHODS**

The study was conducted in Burkina Faso, Benin and Nigeria (Fig. 2). In Burkina Faso, it focused on two

COUNTRY States/Places	BURKINA FASO		BENIN	NIGERIA				TOTAL
	Gourma	Ganzourgou	Malanville	Kebbi	Oyo	Ogun	Lagos	
Villagers	86	43						129
Stallholders	5	19		5	6	3	5	43
Fishermen/Collectors		22	7		17	12	3	61
Traders				5	10	8		23
Customers				5	8	4	3	20
Total	91	84	7	15	41	27	11	276

**Table 1. Overview of the numbers, geographic origin and frog-related occupations of the interviewees.**

regions: the provinces of Gourma and Ganzourgou. Gourma comprises an urban community—Fada N’Gourma—five rural communities and a total of 231 villages. In 2006, the human population was estimated to be 272 974. Ganzourgou includes an urban community—Zorgho—seven rural communities, 185 villages and about 36 969 households (INSD, 2006). Burkina Faso has few natural resources, often poor, depleted soil, and an unequal distribution of income, resulting in poor economic prospects. About 90% of the population is engaged in subsistence agriculture.

In 2007, the authors observed that large numbers of frogs were collected in Malanville, a city in the north-east of Benin, close to the border with Nigeria and Niger, and that these frogs were exported to Nigeria. The authors followed the trade route into Nigeria and conducted interviews, focusing mainly on the collecting points and trading spots in the State of Kebbi in the north-west of the country, and the larger cities and towns in south-western Nigeria (States of Ogun, Oyo, Lagos).

Eight semi-quantitative structured questionnaires were developed. In Burkina Faso, three questionnaires were applied, one for villagers, one for stallholders (all of whom were female), and one for fishermen. In Malanville, Benin, a slightly modified questionnaire was devised for the fishermen. These questionnaires were in French. In Nigeria, four questionnaires were applied; one for frog collectors, one for traders, one for stallholders and one for customers. These questionnaires were in English. To avoid communication problems, all interviews were carried out with the help of assistants speaking the local language. Photographs of frog species were used in each interview to identify those species that were collected, traded and consumed, respectively. To test the reliability of identifications, some species not occurring in the study areas were included. In general, the questionnaires comprised questions concerning the frog harvest (places and time, methods of harvest, species identities and numbers harvested), the economic and cultural importance of the frogs for the local population and the economic dimension (prices, etc.). On most occasions, people were interviewed in their homes. Owing to the patriarchal society that exists in these countries, interviews mostly took place with the male family heads or with their sons. Accordingly, interviews with women were rare; female market traders being an exception. Table 1 provides a summary of all the interviews carried out. These interviews were conducted between the following periods: January to March 2008 in Burkina Faso; March 2008 in Benin; March to May 2008 and February to March 2009 in Nigeria. To evaluate the development of frog collection in Malanville, an additional visit was undertaken in June 2009.

The exchange rate in Burkina Faso and Benin during the survey period was approximately FCFA503.59 to USD1.00. The exchange rate in Nigeria was NGN149.687 to USD1.00.

## RESULTS

### Species traded

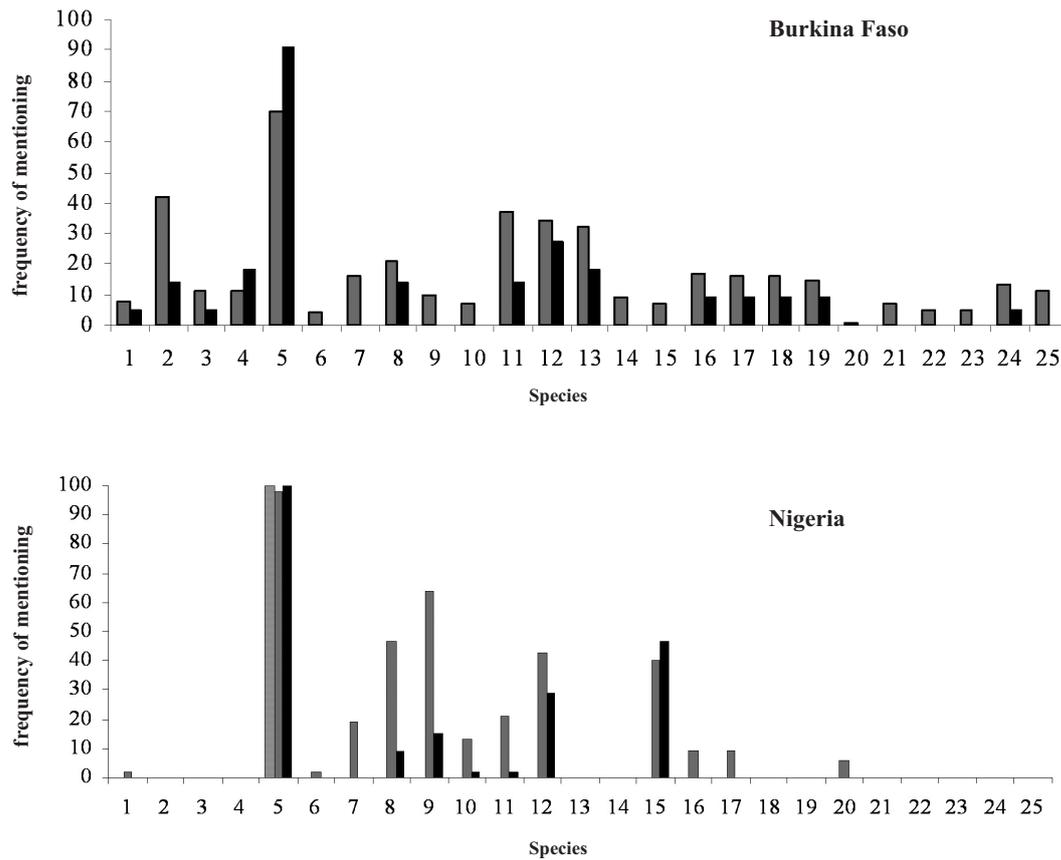
In Burkina Faso, the African Tiger Frog *Hoplobatrachus occipitalis* was the species that the greatest number of people stated that they had consumed, followed by *Pyxicephalus edulis*, *Ptychadena bibroni*, *P. oxyrhynchus* and *P. trinodis* (Fig. 3). Toads, *Ametophrynus* spp., also rank among the 10 species most often identified by people as being consumed, which is remarkable given the toxic compounds contained in toad skins. Toads seemed to be especially preferred by people in particular villages in Ganzourgou. In Malanville, Benin, *Hoplobatrachus occipitalis* was by far the most commonly caught and traded frog, followed by *Ptychadena* spp. and *Pyxicephalus edulis*. In Nigeria, people likewise preferred *Hoplobatrachus occipitalis* which was traded by all 23 traders interviewed (100%), followed by *Xenopus muelleri* (26%) and *Ptychadena oxyrhynchus* (13%) (Fig. 3). *Xenopus muelleri* seems to be avoided by customers and traders in Burkina Faso. In general, large frogs were preferred over smaller ones. Consumers did not discriminate between the sex of the frogs they consumed; however, females tend to be larger. In Nigeria, 44% of collectors caught frogs of all sizes available in order to meet demand.

### Collecting seasons, sites and methods

Collection methods generally differed between villagers catching frogs for self-supply and commercial frog collectors. Within the latter group, 13 of the 22 interviewed persons in Burkina Faso stated that they were fishermen. Eighty-two villagers in Burkina Faso provided details about collecting methods. They usually caught frogs in rivers or on river banks (61%). Many frogs, particularly *Hoplobatrachus occipitalis*, accumulate at rivers during the dry season (Spieler, 1997; Rödel, 2000). Other collecting locations were temporary ponds (29%), dams (24%), wells (21%), permanent ponds (22%) and swamps (5%). Usually frogs were collected in close proximity (less than one kilometre) to the collector’s home (78%).

In Burkina Faso, the frogs were usually collected during the dry season (57%). Here, the population mostly comprised farmers who cultivate their fields during the rainy season and thus do not have time to collect frogs. However, 29% of the villagers stated that they collect frogs all year round and 13% collected them exclusively during the rainy season. All of the professional collectors (n=22) caught frogs at rivers; 82% collected frogs during the dry season. One person (4%) caught frogs during the rainy season and three collectors (14%) caught frogs all year round.

In general, the consumption of frogs for villagers in Burkina Faso was more important than their sale. They



**Fig. 3. Species consumed and traded in Burkina Faso and Nigeria<sup>1</sup>** (consumed species: grey bars; traded species: black bars; species traded from Malanville, Benin, to Nigeria: grey patterned bar). <sup>1</sup>These figures reflect the number of times a species was identified in photographs by interviewees to show which species they consumed or traded. Species listed by numbers: 1. *Hemisis marmoratus*, 2. *Pyxicephalus edulis*, 3. *Tomopterna cryptotis*, 4. *Hildebrandtia ornata*, 5. *Hoplobatrachus occipitalis*, 6. *Hylarana galamensis*, 7. *Ptychadena schillukorum*, 8. *P. pumilio*, 9. *P. mascareniensis*, 10. *P. tournieri*, 11. *P. bibroni*, 12. *P. oxyrhynchus*, 13. *P. trinodis*, 14. *P. tellinii*, 15. *Xenopus muelleri*, 16. *Amietophrynus maculatus*, 17. *A. regularis*, 18. *A. pentoni*, 19. *A. xeros*, 20. *Hyperolius nitidulus*, 21. *Phrynobatrachus francisci*, 22. *P. natalensis*, 23. *Leptopelis viridis*, 24. *L. bufonides*, 25. *Kassina fusca*.

(n=82) usually caught frogs by hand (79%), but other methods used include the use of hooks (23%), fishing nets (17%), dip nets (7%), basket traps (6%), truncheons (5%), chasing frogs out of small water puddles (5%), pitfalls (bucket traps or simple holes in the ground) (1%) and placing buckets over the frogs (1%). Thirty-two percent of the professional collectors also caught frogs with their hands. However, they otherwise tended to apply different catching methods. Fishermen often caught frogs in the same nets they use to catch fish (50%), or with hooks (23%). Further methods comprised: pitfalls at the edge of dams (18%), basket traps (Fig. 4) which get placed in shallow water or swampy terrain overnight (9%) or special dip nets (5%). Collected frogs were usually sold to female market traders who fry most specimens in oil before selling them individually. Sometimes the frogs are disembowelled before being fried, however they are also fried and sold whole. Toads are skinned, beheaded, washed and then dried for sale.

In Malanville, northern Benin, almost all frogs collected for the Nigerian market originate from the banks and tributaries of the River Niger. In 2008, all collectors

in Malanville, whether from Benin or Nigeria, stated that they used basket traps to catch frogs (n=7). However, in 2009 the Nigerian frog collectors applied a different method: by the end of the dry season (June/July), they went out during the night and used torches to detect the frogs by eye shine. With the help of long wooden sticks they beat the frogs on their heads. Given the extremely high numbers of frogs caught (see “Dimensions of the frog trade”), this method seems to be the most efficient one. Frogs for the Nigerian market are either smoked or dried.

Within survey areas in Nigeria, the majority of frogs were caught from permanent ponds (81%; interviewees n=32), followed by temporary ponds (72%), rivers (48%), swamps (32%), forests (16%), and wells (13%). Of the 32 Nigerian collectors interviewed, 28% caught frogs all year round; 72% only collected frogs during the rainy season. They reported that the best time to catch frogs was during the night and/or the early morning hours. Frogs were caught by hand (80%) or with the help of fishing nets (75%), followed by hooks (35%) and basket traps (25%).

## Dimensions of the frog trade

In Burkina Faso, 80% of the 129 villagers interviewed stated that frogs are consumed in their villages. In Ganzourgou, 93% answered that frogs are consumed and 67% that they eat frogs themselves. In Gourma, 73% said that frogs are eaten and 48% reported that they themselves eat frogs. Twelve persons (9%) stated that they used to eat frogs in the past but stopped due to increasing prices or decreasing availability. Eighty-four householders (65%) stated that frogs are an important food source for their families. Forty-three provided details concerning the amount of frogs they consume. Together, the 43 households (on average seven persons) consumed 262 kg of frogs per week; that is six kilogrammes (approximately 120 frogs) per household per week. Children often collect frogs for their own consumption while herding cattle. Frogs thus seemed to be an important source of protein. Of 54 interviewees, 38 (70%) stated that they prefer to eat other meat like fish, beef, chicken, goat or sheep. Fifteen persons (28%) preferred frogs over other meat. Nearly one third of the villagers (29%) listed the frog trade as being a very important occupation. The majority of them depend on subsistence agriculture; however, 13 villagers (10%) stated that selling frogs was an important source of income during the dry season. In particular, some collectors and female market traders were dependent on the frog market.

The Burkina Faso frog economy is strictly partitioned between men and women. Whereas men are responsible for collecting, women are responsible for sale (Fig. 1). The only exception is the toad trade. Here, women are engaged in collecting, drying, and selling. Those interviewed stated that they sold frogs mostly during the dry season, although one fourth (25%; n=24) traded frogs all year round. During the respective selling periods, many of the women (42%) sold frogs on a daily basis; one third (33%) sold frogs on 10 days per month. Altogether, 22 of 24 women sold 65 920 frogs per month (approximately 564 640 frogs annually). This included mainly Tiger Frogs and to a lesser extent, toads. The price for one frog depended on its size and usually varied between FCFA25 for a small frog, up to FCFA250 (USD0.05 and USD0.50, respectively) for a large one. Although the toad trade was locally restricted, it often comprised high numbers, e.g. one woman was processing 200 toads, all collected during one day. According to her, she fills three sacks with toads per week, selling each sack for FCFA1500. Although the Burkina Faso frog trade is mainly a local one, orders are also received from restaurants. In Ouagadougou, most restaurants have frogs' legs on their menus at a cost of at least FCFA4000 a dish. In places like Mogtedo, located on main traffic axes, travellers often stop to buy larger numbers of fried frogs for their family and friends.

In Benin and Nigeria, the frog trade has a different dimension. In Nigeria, frogs are mainly consumed in the south of the country. In the States of the south-west, a total of 32 frog collectors were interviewed. On average they collected 97 frogs per week. Hence, these traders collected a total of 2780–3430 frogs per week, or



MEIKE MOHNEKE

FIG. 4. AFRICAN TIGER FROGS *HOPLOBATRACHUS OCCIPITALIS* CAUGHT WITH A BASKET TRAP IN SHALLOW PARTS OF THE RIVER NIGER, NORTHERN BENIN. THE SMALL FISH ARE USED AS BAIT.

2 738 610 frogs annually (this calculation includes only periods where frogs are collected according to the interviewees). However, most of the frogs traded originate from the northern savanna regions in Nigeria, as well as from neighbouring countries (Benin, Niger, Chad). These frogs are transported to trading spots in northern Nigeria (e.g. Lolo, Kano, Benu, Bagodo). At these places, exclusive frog markets are organized. The traders in Lolo receive their frogs mainly from Benin and Niger. Accurate numbers of harvested frogs could be obtained in Malanville, Benin, where frogs were collected exclusively for this Nigerian market. Many Malanville fishermen recently switched to the collection of frogs. On average, a daily fish catch produced USD3.00–4.00 income. Frogs were usually collected until at least one sack was filled (containing approximately 1000 frogs). In 2008 that took about one week and each sack fetched at least USD20.00. While the overall income was comparable to that which was earned from fish, the advantage of selling frogs was receiving a higher amount of money as a lump sum, thus providing more possibilities for spending the money. By contrast, the daily income from fish was often spent straight away. In addition to the fishermen, Nigerian traders employ young Nigerians, who travel to Malanville to collect frogs. In the latter case, traders provide the trapping tools and pick up the collected frogs once a week. In 2008, seven collectors filled on average 53 sacks of dried or smoked frogs per month. In 2009, the situation had changed drastically. An increased number of collectors, mainly from Nigeria, caught frogs. The authors accompanied a group of 30 collectors. A two-man team collected an average of 500 frogs per night, but these figures could be as low as 200–300 during a full moon, or as many as 1500 frogs. Based on the average numbers, these 30 collectors caught 450 000 frogs during their two-months-stay in Malanville (Fig. 5).

Country	Location	Stakeholder	Unit	Purchase price (local <sup>1,2</sup> )	Purchase price (USD)	Unit	Sale price (local <sup>1,2</sup> )	Sale price (USD)	
BURKINA FASO	Diabo	female market trader	3	100	(0.21)	1	50	(0.11)	
	Diabo	female market trader	3-5	100	(0.21)	1	25-50-75-100	(0.05-0.11-0.16-0.21)	
	Fada N' Gourma	female market trader	50 kg	10 000	(21.13)	1 (s)	50	(0.11)	
	Fada N' Gourma, Mogtedo	female market trader				3 (s)	100	(0.21)	
	Fada N' Gourma, Mogtedo	female market trader	1-3	50	(0.11)	1 (l)	100-150-250	(0.21-0.32-0.53)	
	Zorgho	female market trader	bowl	375	(0.79)	bowl	500	(1.06)	
	Zorgho	female market trader	5 bowls	2500	(5.28)	4	25-50-100	(0.05-0.11-0.21)	
	Zam	female market trader	2	50	(0.11)	1-3	100	(0.21)	
	Kabouda	female market trader	bowl	565	(1.19)	8-10 (l)	50	(0.11)	
	Kabouda	female market trader	bowl	500	(1.06)	8-10 (s)	25	(0.05)	
	Kabouda	female market trader	bowl	500	(1.06)	bowl	600	(1.27)	
	Kabouda	female market trader	bowl	500	(1.06)				
	NIGERIA	Iseyin, Ilorin							
		Ogbomosho Eruwa,							
		Oyo Town, Epe, Ibadan	collector				5-6 (l)	100	(0.67)
		Ado-awaye, Abeokuta	collector				6-7 (l)	100	(0.67)
		Eruwa, Ado-awaye, Abeokuta	collector				12-15 (s)	100	(0.67)
Iseyin, Ijebu Ode, Onidundun, Eruwa		collector				9-12 (s)	100	(0.67)	
Onidundun		collector				6-7 (m)	100	(0.67)	
Ijebu Ode, Iseyin, Eruwa,									
Ado-awaye, Abeokuta		collector				7-10 (m)	100	(0.67)	
Ijebu Ode		collector				6-8	100	(0.67)	
Epe		collector				8-9	100	(0.67)	
Iseyin		collector				sack(s)	500-600	(3.37-4.04)	
Iloron/Ogbomosho		collector				sack	700-800	(4.71-5.39)	

**Table 2. List of frog prices depending on the location and the stakeholder.** Prices for Burkina Faso are in FCFA (exchange rate: USD 1.00=FCFA503.593, FCFA 1000=USD 2.066).

<sup>1</sup>Prices for Nigeria are in Naira (NGN) (exchange rate: USD 1.00=NGN149.687; NGN1000=USD 6.745). The USD prices are displayed in parentheses. The frogs are listed in the respective unit in which they are sold (numbers of specimens; kg; bowls=50-70 specimens; sacks=approximately 1000 specimens; box=> 1000 specimens).

(s) = small; (m) = medium; (l) = large

Country	Location	Stakeholder	Unit	Purchase price (local <sup>1,2</sup> )	Purchase price (USD)	Unit	Sale price (local <sup>1,2</sup> )	Sale price (USD)
NIGERIA (ctd)	Ijebu Ode	collector	sack	200–800	(1.35–5.39)	sack	200–800	(1.35–5.39)
	Odo Jabore	collector	sack	800	(5.39)	sack	800	(5.39)
	Abeokuta	collector	sack	800–900	(5.39–6.06)	sack	800–900	(5.39–6.06)
	Epe	collector	sack	1000	(6.73)	sack	1000	(6.73)
	Lolo	trader	sack	6000–10 000	(40.40–67.34)	sack	6000–10 000	(40.40–67.34)
	Iseyin	trader	bundle 3–5	80–90	(0.54–0.61)	bundle 3–5	80–90	(0.54–0.61)
	Iseyin	trader	bundle 5–10	250–400	(1.68–2.69)	bundle 5–10	250–400	(1.68–2.69)
	Ogbomoshos	trader	bundle 6–7 (m)	80–100	(0.54–0.67)	bundle 8–10 (m)	100–200	(0.67–1.35)
	Ogbomoshos	trader	bundle 5–6 (l)	150–200	(1.01–1.35)	bundle 3–4	100–150	(0.67–1.01)
	Ijebu ode	trader	7–9 (m)	100–250	(0.67–1.68)	7–9 (m)	150–300	(1.01–2.02)
	Ijebu ode	trader	5–6 (l)	100–250	(0.67–1.68)	bundle 5–6 (l)	150–300	(1.01–2.02)
	Oyo Town	trader	bundle 8–10	100–250	(0.67–1.68)	4–5	60–150	(0.40–1.01)
	Oyo Town	trader	9–12	80–250	(0.54–1.68)	4	50–100	(0.34–0.67)
	Oyo Town	trader	6–8	100–300	(0.67–2.02)	4	50–100	(0.34–0.67)
	Abeokuta	trader	8–12	100–300	(0.67–2.02)	8–12	150–350	(1.01–2.36)
	Pakoto/Ibo	trader	5–10	100–300	(0.67–2.02)	5–10	150–350	(1.01–2.36)
	Sagamu	trader	8–12	150–300	(1.01–2.02)	8–12	200–400	(1.35–2.69)
	Lolo	stallholder	stallholder	6000–8000	(40.40–53.87)	5–6	6000–12 000	(40.40–80.81)
	Iseyin	stallholder	stallholder	150–200	(1.01–1.35)	300	300	(2.02)
	Ibadan, Oyo Town	stallholder	box	12 000	(80.81)	6	100	(0.67)
	Ogbomoshos	stallholder	box	10 000–13 000	(67.34–87.54)	5–7	100	(0.67)
	Badagry	stallholder	40	1200–1400	(8.08–9.43)	6–7	200	(1.35)
	Epe	stallholder	50	1500–2000	(10.10–13.47)	4–5	150	(1.01)
	Abeokuta, Sagamu, Ijebu	stallholder	5–6	100	(0.67)	8–12	200	(1.35)
	Oyo town	stallholder	box	9000–12 000	(60.61–80.81)	6	100	(0.67)

**Table 2 (ctd). List of frog prices depending on the location and the stakeholder.** <sup>1</sup>Prices for Burkina Faso are in FCFA (exchange rate: USD1.00=FCFA503.593, FCFA1000=USD2.066).

<sup>2</sup>Prices for Nigeria are in Naira (NGN) (exchange rate: USD1.00=NGN149.687; NGN1000=USD6.745). The USD prices are displayed in parentheses. The frogs are listed in the respective unit in which they are sold (numbers of specimens; kg; bowls=50–70 specimens; sacks=approximately 1000 specimens; box=> 1000 specimens).

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Either the collectors themselves travel to Lolo to sell the frogs, or traders purchase the frogs in Malanville and resell them in Lolo. Usually a flat tax fee of FCFA1200 has to be paid when crossing the Nigerian border. Between 70% and 80% of the frogs from the north are transported to Ibadan from where they are distributed to other towns in the south-west of the country. In Ibadan, frogs are also received from Chad all year round. These are collected at Lake Chad and pass through Maiduguri (capital of Borno State). From Kano (capital of Kono State) frogs are traded only during the rainy season. On average, five to 10 sacks of frogs per trader were traded at one market-day in Lolo, e.g. five traders in Lolo traded 36 to 39 sacks per week (Fig. 6). They earned a profit of between NGN1000–2000 (USD20.13–40.25) per sack, each sack costing NGN4000–6000 on purchase and NGN6000–10 000 at sale (Table 2). At subsequent trade centres, towards the south, the traded units got smaller. A unit comprised five to 12 frogs (depending on their sizes) packed in bundles when purchased and three to seven frogs when offered for sale. A bundle was between NGN80–300 on purchase and generated NGN100–400 when sold (profit margin: 50–100%). Market prices everywhere depended on the size and quantity of frogs, as well as on the clients' negotiating abilities. According to 19 traders (83%), prices have been increasing over the past five years. The majority of traders traded frogs all year round; 22% traded them during the rainy season only. The frog trade is predominantly for consumption, but some people (13%) also traded them for medicine. Eighteen of 31 Nigerian customers interviewed bought frogs to consume at home. Seven bought frogs to offer them to restaurants.

In addition to the economic value of amphibians, there is also a cultural worth. Certain frog species have a medicinal importance, i.e. they are used to cure specific illnesses. Traditional medication is especially important in areas where western medicine is either not available or affordable (van der Geest, 1997). In particular, toads and frog species that look similar to toads, such as *Kassina fusca* and *Leptopelis bufonides*, were the species most commonly used in medical treatments.

### Declining frog populations?

Based on informants' perception, certain amphibian species have been declining over recent years. Most villagers (n=129) in Burkina Faso thought that water shortage (46%) is the main reason for the frogs' decline, followed by human consumption (15%), habitat degradation (7%) and human population growth (5%). A different picture arose when asking fishermen (n=22) in the country, who believed that the main reason for the decline in amphibian species is habitat degradation (32%), followed by human consumption and water shortage (both 23%). The villagers had observed the highest decline rates in the largest species: *Pyxicephalus edulis*, followed by *Hoplobatrachus occipitalis* and *Ptychadena oxyrynchus*. According to interviewees, toads showed the lowest decline rates. Some villagers even believed that toad numbers were increasing. When a decline was perceived, it was said that frog populations started to decline during the past two decades. These interviewees stated that reduced population numbers of particular frog species was the reason for their low presence in markets currently and that consumption of

FROGS COLLECTED IN MALANVILLE, NORTHERN BENIN, ARE EITHER SMOKED OR DRIED BEFORE BEING EXPORTED EXCLUSIVELY FOR THE NIGERIAN MARKET. *HOPLOBATRACHUS OCCIPITALIS* WAS BY FAR THE MOST COMMONLY CAUGHT AND TRADED FROG AT ALL THE STUDY SITES.



Fig. 5. Piles of frogs, principally *Hoplobatrachus occipitalis*, drying in the sun, Malanville, Benin, June 2009. At least 18 piles of frogs—collected by 30 Nigerian frog collectors—were observed by the authors on one visit.

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frogs had been more common in the past. In northern Benin, some interviewees stated that they had observed a decline in frog populations. In Nigeria, only three of 32 persons perceived a decline in amphibian species, namely in *Hoplobatrachus occipitalis*, *Ptychadena oxyrynchus* and *Xenopus muelleri*, all species dominating the Nigerian trade. These three persons thought that the decline was due to over-hunting and habitat degradation. However, in Nigeria only the frog collectors were asked this question. In both Benin and Nigeria, the largest decline was perceived for the most exploited species.

## DISCUSSION

Recent investigations by Warkentin *et al.* (2009) suggest an unsustainable exploitation of frogs in Asian countries. The present report documents for the first time the local small-scale use of frogs in Burkina Faso and an intensive large-scale, cross-border frog trade between Nigeria and its neighbouring countries. Although the number of frogs traded is smaller than reported by Warkentin *et al.* (2009), the rate of collection in West African amphibians is likely to be unsustainable in the long term. Even during the authors' comparatively short period of observation, a dramatic increase in the number of frogs collected for the Nigerian food market was observed. While frogs are sold in markets in the province of Ganzourghou, frog use is for the most part not a commercial activity in Burkina Faso, e.g. in Gourma most frog consumers catch frogs for themselves. However, for some species even this local consumption seems to be unsustainable and interviewees in Burkina Faso indeed perceived a decline of frog populations, in particular of those species that were consumed. Reports of increasing difficulties in catching frogs, and increasing prices, suggest that current harvest rates are unsustainable. Similar indications have been recently reported from western Cameroon and eastern Nigeria, where even tadpoles are collected for food (Gonwouo and Rödel, 2008). With the data collected for this survey, it is not possible to judge whether the perception of a decline in frog numbers is accurate, and if so, whether it can be attributed exclusively to overexploitation, or what effect other factors such as habitat degradation, pesticide use, and climate changes (i.e. different rainfall patterns), may have. Currently, there are no regulations in any West African countries governing the harvesting of frogs, neither concerning season nor the species, numbers and/or size of specimens harvested. Even more exploiters may enter the system as there is still a net return from the harvest. As there is a huge social and commercial interest—frog collection and consumption being a very important part of villagers' lives—it will be difficult to control or limit this harvest (Ludwig, 2001).

The methods used for collecting frogs varied by area and tradition, and, in particular, in the intensity of the harvest. If frogs were used for self-supply only, or for local consumption or sale, catching them by hand was sufficient. In the areas with the most intense frog collecting activities, as in Malanville, Benin, basket traps

seemed to be a preferred and efficient method. Recently, Nigerian collectors have switched to an even more effective method. They use torchlight to find the frogs at night (Kusrini, 2005; Teixeira *et al.*, 2001), which they then kill by beating their heads with long sticks. This method of killing frogs is not applied in Asia since damaged specimens, especially those collected for export, would be rejected (Kusrini, 2005).

The species of frog preferred varied: the majority of customers and collectors favoured large specimens, but to meet the demand often all available sizes were collected. *Hoplobatrachus occipitalis* is a large frog and the main species used for food at all the study sites. Specimens of *Ptychadena* spp. were often consumed but were not usually traded. *Xenopus muelleri* was the second-most traded frog species in Nigeria. Congeners of this species are also harvested for food in western Cameroon (Gonwouo and Rödel, 2008). By contrast, *Xenopus muelleri* are rarely eaten in Burkina Faso, although they occur there as well. Toads are only consumed in certain villages, e.g. in the Ganzourghou area in Burkina Faso, whereas in the neighbouring Gourma region no respondent ate toads.

Since large specimens are preferred for consumption, the current rate of collecting may well lead to an altered population structure of *Hoplobatrachus occipitalis*, or even result in local extinction. Unfortunately it is not known at what age this species reaches sexual maturity. It is likely that frogs can already reproduce once they have reached about half their maximum size (males 110 mm, females 160 mm; Spieler, 1997; Rödel, 2000). Judging from other species of similarly sized frogs, this is at around two years' old. The largest adults may well be 10 years and older. Overexploitation of *H. occipitalis* may not only have consequences for the human diet, but also for the frogs' ecosystem. A loss of predators may weaken control of prey populations (Allan *et al.*, 2005). In *H. occipitalis*, this may apply to all life stages. This species has predatory larval stages preying on a variety of other aquatic animals such as tadpoles and mosquito larvae, and is thus an important element in the trophic cascade of temporary savanna ponds (Spieler and Linsenmair, 1997; Rödel, 1998). Adult specimens of *Hoplobatrachus occipitalis* feed on a variety of organisms, including potential pest insects (Inger and Marx, 1961; Lescure, 1971). Abdulali (1985) provides a detailed account on the ecology of some rice field-dwelling amphibians in India (including another *Hoplobatrachus* species), highlighting their role as bio-control agents of rice insects. Since India banned the processing and export of frogs, the frog populations have recovered and insecticide imports have dropped by 40% (Teixeira *et al.*, 2001), indicating the large economic value of intact frog populations for pest control.

Ideally, any harvesting of wild species should be done sustainably (Waites, 2007). On a global scale, an increasing number of internationally traded frogs are produced on frog farms (Teixeira *et al.*, 2001; Daszak *et al.*, 2006). While efforts to set up frog farms in Central Africa have been initiated (Munyuli Bin, 2002), the

authors could find no such initiative in West Africa. According to their data, all West African amphibians used for food are from the wild. Although toads are consumed in some countries (Daszak *et al.*, 2006), ranoid frogs, and especially the American Bullfrog *Lithobates catesbeianus* and the Indian Tiger Frog *Hoplobatrachus tigrinus* are the species most commonly bred for consumption. The breeding of non-native species always bears the risk that a) specimens escape and harm native species and ecosystems (Kiesecker *et al.*, 2001; Beebe and Griffiths, 2005) and b) specimens import diseases (Daszak *et al.*, 2004). However, as a species native to West Africa, it might be possible to breed *Hoplobatrachus occipitalis* in captivity. Efforts to cultivate wildlife, in particular fish, are currently being undertaken in northern Benin. It would be worthwhile trying to combine these efforts with breeding frogs.

Cultivation of *Hoplobatrachus occipitalis* would not only help to secure wild populations but would also offer long-term socioeconomic advantages. The inland fishery sector can be indicative of the economic importance of the local frog trade. Besides the income that is gained from the fish catch, the processing of fish encompasses further economic benefits, i.e. employment. In other words, if fish can be produced and processed locally, the net income benefit to the area may be more than twice the value of the fish sales (FAO, 2009). Similar advantages may be expected from the establishment of a captive breeding and processing programme for frogs. However it is important to recognize the potential drawbacks to farming, such as loss of income to villagers not involved in farming, land use and pollution from farms, as well as disease and health risks.

In West African countries, small-scale fishers provide the majority of the national fish catch and contribute to about a quarter of the total protein intake. Hence small-scale fishing plays a vital role in nutrition, trade and economic activity (Marquette *et al.*, 2002). However, due to overexploitation in many inland waters, fish stocks have drastically declined (Brashares *et al.*, 2004; Allan *et al.*, 2005). According to the data collected during this survey, amphibian collection rates increased in Malanville after fish populations in the River Niger declined. Similarly, years of poor fish supply in Ghana coincides with increased hunting rates in that country and has resulted in the decline in biomass of wildlife (Brashares *et al.*, 2004). The increasing West African demand for frogs may therefore be an indirect sign of a decrease of other natural resources and deserves more attention.

Although most decision-makers in West African countries are well aware of the need for wildlife conservation, they are mostly confronted with more pressing problems, such as poor education, failing crops, lack of food and poor health. Having limited funding available, wildlife conservation usually takes low priority (Ntiemoa-Baidu, 1987). However, the dimension of the frog trade in parts of West Africa may not only be a sign of further problems in nature conservation. The decline or even potential loss of frogs in particular areas may have direct and indirect effects on rural communities, such as

increasing mosquito populations, less bio-control of agricultural pest species or negative effects on freshwater ecosystems such as temporary ponds (Mohnke and Rödel, 2009). To address these questions in more depth, more basic data are urgently needed on the quantity of frogs traded, their origin and their customers, as well as information relating to natural frog abundances, population structure, and life history, in order to develop management programmes for sustainable harvests and breeding programmes.

## RECOMMENDATIONS

- The basic biology and natural history of the species involved in trade (e.g. life expectancy, mortality and fecundity) needs to be better understood.
- The motivation of the people who are exploiting frogs has to be carefully considered and alternative labour options should be explored.
- Further investigation of the amphibian trade, especially in Nigeria but also in neighbouring countries such as Niger and Chad, should be carried out to provide a complete overview of the dimensions of the frog trade.
- When overexploitation is likely, the respective authorities need to be informed in order to start monitoring the collection and to impose harvesting rules (for example, restricting harvest to particular places, certain seasons, etc.).
- Public awareness concerning the role of amphibians and their ecosystem services should be raised locally.
- Efforts to assess potential costs and benefits of cultivation of the native *Hoplobatrachus occipitalis* involving local stakeholders should be undertaken. To maintain their livelihood, efforts could be made to involve former frog collectors in such activity.

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**Fig. 6. Frog market in Lolo, northern Nigeria.**

Traders at the frog market in Lolo receive their frogs mainly from Benin and Niger. On average, five to 10 sacks of frogs per trader were traded on one market-day, e.g. five traders traded between 36 and 39 sacks per week. From Lolo, the frogs are transported to the south of the country.

Photograph: Abiodun Onadeko



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