Long-term comparison reveals trends in turtle trade in bushmeat markets of southern Nigeria
(Testudines: Pelomedusidae, Testudinidae, Trionychidae)

Langzeitvergleich verdeutlicht Trends im Handel von Schildkröten auf den Buschfleisch-Märkten von Südnigeria
(Testudines: Pelomedusidae, Testudinidae, Trionychidae)

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KURZFASSUNG

Die Feuchtwälder des Niger Deltas (südliches Nigeria) beherbergen als Teil des Hotspots "Westafrikanischer Wald" eine artenreiche Schildkrötenfauna, die gegenwärtig durch Entwaldung, Ölkatastrophen, und den Fleischkonsum der Bevölkerung gefährdet ist. Die vorliegende Arbeit vergleicht Erhebungen über das Angebot an Land- und Süßwasserschildkröten der Jahre 1996-2002 mit solchen der Jahre 2011-2012, die beidemale auf denselben neun Buschfleisch-Märkten erfolgten. Untersucht wurden mögliche Veränderungen in der Erschließung dieser Nahrungsquelle durch die ortsansässige Bevölkerung. Die Anzahl gehandelter Schildkröten nahm in dieser Zeit signifikant ab, wobei zwei Arten (*Trionyx triunguis* und *Cyclanorbis elegans*) in der jüngeren Erhebung vollständig vom Markt verschwunden waren und das Angebot bei zwei weiteren (*Kinixys homeana* und *Kinixys erosa*) massiv eingebrochen war, während auf dem im Jahr 2012 vergleichsweise überprüften Markt von Lomé (Togo) zahlreiche Schildkröten gehandelt wurden. Befragungen einheimischer Jäger ergaben für den Zeitraum des vergangenen Jahrzehnts keine auffälligen Änderungen beim Schildkrötenfleischbedarf im Vergleich zu anderen Fleischsorten. Allerdings meinten die Jäger, Schildkröten wären in den letzten Jahren bedeutend schwerer zu finden gewesen als noch ein Jahrzehnt davor. Diese Beobachtungen lassen vermuten, daß der Zusammenbruch des Buschfleischmarktes mit Schildkröten auf den starken Rückgang der Populationsgrößen, insbesonders der *Kinixys*-Arten, zurückzuführen ist. Das Ergebnis des unmittelbaren Vergleichs der Daten von heute und vor zehn Jahren macht Untersuchungen der Populationsstruktur der betroffenen Arten dringend erforderlich, um das gegenwärtige Ausmaß in der Abnahme der Populationsgrößen in diesem Teil Afrikas einschätzen zu können.

ABSTRACT

The moist forests in the Niger Delta (southern Nigeria) are part of the West African forests biodiversity hotspot; they house a rich chelonian diversity, currently threatened by deforestation, oil spills, and human consumption supplied by the meat trade. In this paper, field surveys in nine bushmeat markets in the years 1996-2002 are compared with surveys in the same markets in 2011-2012, in order to perceive potential differences and similarities in the trends of local people's exploitation of terrestrial and freshwater chelonians. The number of traded chelonians significantly decreased, with two species (*Trionyx triunguis* and *Cyclanorbis elegans*) having fully disappeared from the market and two others (*Kinixys homeana* and *Kinixys erosa*) that did almost so. On the other hand, several chelonian carcasses were observed in 2012 in the market of Lomé, Togo. Interviews with local hunters revealed that demand for turtle meat did not change considerably in the last ten years, compared to other wildlife meat, and that tortoises are more difficult to encounter in the field than it was in the previous decade. These findings suggest that the collapse of chelonian supply in bushmeat markets may be due to an overall, strong decline of the population abundance of these animals, and in particular, of tortoises of the genus *Kinixys*. Direct comparison of current trends with 10-year-old datasets urge immediate demographic research to evaluate the current level of population reduction for these wild tortoise populations in this part of Africa.

KEY WORDS

Reptilia: Testudines: Pelomedusidae, Testudinidae, Trionychidae; *Kinixys noguey*, *Kinixys homeana*, *Kinixys erosa*, *Pelomedusa subrufa*, *Pelusios niger*, *Pelusios castaneus*, *Trionyx triunguis*, *Cyclanorbis elegans*; tortoises, turtles; trade, bushmeat market, ecology, population decline, conservation, Nigeria

INTRODUCTION

Despite being underrepresented in IUCN lists because of poorly funded conservation research at the global scale, Sub-Saharan African chelonians are currently in massive decline due to overharvesting and habitat loss (BRANCH 2008; LUISELLI 2009).

In particular, the bushmeat trade can be a serious source of decline for tortoise and turtle populations in Africa (Luiselli 2003a, 2003b; Luiselli et al. 2006a), as well as for other wildlife (e.g., Njiforti 1996; Wilkie & Carpenter 1999; Fa et al. 2002; Willcox & Nambu 2007). Hence, current IUCN lists are likely to be seriously biased towards lower threat categories, not representing the level of threat the African turtles and tortoises are actually experiencing.

Indeed, previous studies revealed that frequency of occurrence of species in bushmeat markets is strongly linked to the relative availability of the species in the wild (Anstey 1991). For instance, this relationship between availability in the field and presence in the markets was demonstrated from a decade-long study of a Central African bushmeat market, in which the progressive depletion of large-bodied wildlife species and the increasing importance of small-bodied species came up to a point where rodents comprised 37 % of the biomass merchandised (Fa et al. 2000).

The lowland forest block in southeastern Nigeria is part of the Upper Guinean forest biodiversity hotspot (Myers 1998; Myers et al. 2000). At the same time it represents a very fragile environment because it is affected concurrently by intensive industry activity (this area being the most productive petrochemical region of Sub-Saharan Africa; De Montclos 1994), huge increase in human population, and consequently rampant habitat loss and intensive hunting for subsistence and bushmeat trade (e.g., Asibey 1974; Martin 1983; Akani et al. 1998, 1999; Eniang et al. 2008; Oates 2011; Tee et al. 2012).

In the years 1996-2002, some of the main bushmeat markets of the Niger Delta region were surveyed in order to understand patterns of human consumption of wildlife

(Akani et al. 1998; Angelici et al. 1999), including chelonians, *Kinixys* species in particular (Luiselli 2003a). Strong bushmeat consumption was one of the main causes of the apparent heavy decline of *Kinixys homeana* Bell, 1827, which indeed was uplisted to the category Vulnerable (VU) by the IUCN due to the results of these studies (Luiselli et al. 2006a, 2006b).

Surveys of bushmeat markets demonstrated that, when a certain type of wildlife tends to disappear from the wild, it is hence substituted in the markets by other kinds of animals caught adjacent to the sites where the primary prey animal had become rare (Kümpel 2006). Thus, monitoring of the same bushmeat markets at intervals may show population trends for selected wildlife (Rowcliffe et al. 2003). This type of monitoring should ideally be continued over many years in order to highlight long-term trends, but unfortunately is nonexistent for African chelonians, impeding efficient conservation strategies for these species.

During the present study, the authors re-surveyed the same bushmeat markets which were target of their studies in 1996-2002, in order to verify potential changes in the intensity of trade (= number of animals traded) and the direction of trade (= species traded; population characteristics of the traded animals, etc.) of chelonian species. Direct comparison with earlier data provided a unique opportunity to understand how a meat consumption-driven trade of chelonians changed in this part of Africa, with potential profound conservation implications at the regional scale. In addition, given that a remarkable change in bushmeat trade was evident during the surveys (see below), a set of interviews with hunters was carried out in order to get some preliminary indications of the possible reasons behind these probable changes.

MATERIALS AND METHODS

Study areas

The study was carried out in the Niger Delta area of Nigeria, West Africa. These territories are densely populated, with remnant patches of rainforest and swamp forest interspersed among wide plantations (yam, cassava, pineapple, oil palms, banana, plantains, etc.) and forest-derived savannah vegetation (NDES 1998). Mangroves are found along the coastal areas with brackish water channels and rivers. This is also one of the
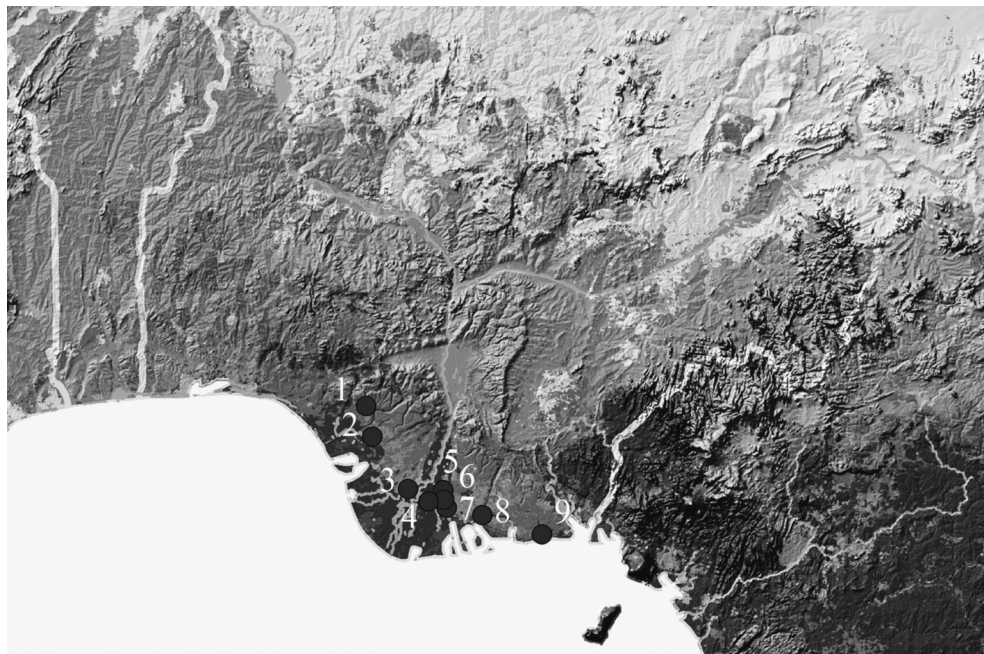
Fig. 1: Location of the bushmeat markets in the Niger River Delta (Nigeria) explored during the present study.
Abb. 1: Die Lage der in der vorliegenden Untersuchung bearbeiteten Buschfleischmärkte
im Delta des Niger-Flusses (Nigeria).

1 - Mosogar; 2 - Patani; 3 - Oredo; 4 - Imo River Bridge; 5 - Omagwa; 6 - Akabuka;
7 - Ahoada; 8 - Mbiama; 9 - Eket Bridge.

most developed regions of Sub-Saharan Africa due to oil and petroleum industry (DE MONTCLOS 1994), and this industrial development has considerably affected the natural habitats and the biodiversity (NDES 1998; for reptiles see AKANI et al. 1999).

Bushmeat market survey protocol

The authors explored all nine of the main bushmeat markets situated along the main roads and the courses of the main rivers and urban centers (Mosogar, Patani, Oredo, Imo River Bridge, Omagwa, Akabuka, Ahoada, Mbiama, Eket Bridge; Fig. 1). In all the surveyed markets, bushmeat was supplied by hunters active mainly in the lowland deltaic forest area of the River Niger Delta (AKANI et al. 1998; ANGELICI et al. 1999). Each of these markets was surveyed twice (typically once in the wet and

dry seasons), and the interval between the two surveys was at least 90 days. This procedure avoided multiple counts of one and the same animal or a strong influence of seasonality on the data. Every traded chelonian was identified to species, and examined for age, sex, size, and other biological information. Methods were the same as those already presented in LUISELLI (2003a).

In addition, in July 2012, the fetish market of Lomé (Togo, West Africa) was explored to evaluate the abundance of chelonians in a comparative market and have a snapshot on the trends in another country with similar cultural beliefs as Nigeria. The market of Lomé is one of the largest wildlife markets for the whole of West Africa. This latter survey was done together with Dr Jamie CARR (UNEP, Cambridge) and Prof John F. OATES (CUNY, New York).

Hunter interview protocol

After the strong change (viz., reduction as compared to the situation in 1996/2002) in the frequency of traded chelonians at the markets had become apparent (see 'Results' below), 46 declared hunters (providers of bushmeat animals) were interviewed to subjectively explain why the number of traded chelonians was lower in the current surveys. In particular, focus was put on their opinion on whether this change was due to a shift in demand (= economical reasons) or in a shift in production (= change in abundance of animals in the wild; ecological reasons).

The questions asked to each hunter were:

(1) What's your village, occupation apart from hunting (if any), age, and ethnic group? (identity was not asked to ensure privacy because hunters use to be reluctant and suspicious to disclose their identity; see Akani et al. 2013).

(2) Do you think that people's demand for turtles is high or moderate in your area compared to other wildlife (mammals and birds)? Three options were possible: high demand, average demand, low demand.

(3) Do you think that people's demand for turtles has changed in the last years? Three options were possible: No, yes (higher than before), yes (lower than before).

(4) Do you think that turtles are as easy to find now as it was 10 years ago at your site? Three answers were allowed: No, easier than before, no, less easy than before, yes, as easy as was before.

Statistical analyses

The frequencies of traded chelonians belonging to forest species were compared with frequencies of traded chelonians belonging mainly to savannah species by observed-versus-expected χ^2 test. Because of the different survey efforts in 1996-2002 with 2011-2012 (18 visits of 9 markets in 2011-2012 versus 41 visits of the same 9 markets in 1996-2002), the mean numbers of chelonians traded in each market per survey in the two periods were compared by a Monte Carlo Wilcoxon test, after 100,000 random iterations. Variation in the mean number of specimens traded per visit and per species between the two survey periods was evaluated by Mann-Whitney U-test. Frequencies of the different answer options by respondents for each of the four interview questions were compared by observed-versus-expected χ^2 test. In the text, means are always indicated with ± 1 Standard Deviation. Data were processed by a Statistica™ version 8.0 PC package, with all tests being two-tailed and alpha set at 0.05.

RESULTS

Chelonian bushmeat
2011-2012 dataset

Numbers of tortoises observed in the various markets and in the two surveys carried out during this project are shown in Table 1. During 18 visits, the authors observed 22 turtles traded in nine bushmeat markets in the Niger Delta, with a mean of 1.22 ± 0.97 specimens per visit, whereas in the market of Lomé (Togo), 54 turtle specimens were identified (Table 1) in a single visit. Although the Lomé market is roughly estimated at least three times larger than any market examined in Nigeria, species diversity was higher in Nigeria (six species belonging to two families: Testudinidae and Pelomedusidae) than in Togo (just four species belonging to the same two families).

Interestingly, and despite the bushmeat markets in Nigeria surveyed here were inside the forest zone, there was a similar number of traded individuals from chelonian species inhabiting mainly forest (*Kinixys homeana* Bell, 1827, *Kinixys erosa* [Schweigger, 1812], *Pelusios niger* [Duméril & Bibron, 1835]; *n* = 12) versus savannah (*Kinixys nogueyi* [Lataste, 1886], *Pelomedusa subrufa* [Lacépède, 1788], *Pelusios castaneus* [Schweigger, 1812]; *n* = 10) ($\chi^2 = 0.18$, *df* = 1, *P* = 0.669). Because of the low numbers observed, it was impossible to analyze the population structure of the sampled species at a statistical level.

Table 1: The mean number of chelonian specimens recorded per visit in nine markets of the Niger River Delta in the present study (2011-2012; 18 visits) and an earlier study (1996-2002; 41 visits). True counts of chelonian specimens are given in parentheses. Comparative counts made on the market of Lomé (Togo) during a single visit in 2012 are shown. Note that part of the dataset collected in 1996-2002 (regarding *Kinixys* species only) is presented in LUISELLI (2003a). * - Savannah species, # - Forest species, + - Forest species in Nigeria (LUISELLI et al. 2000).

Tab. 1: Mittlere Anzahl von Schildkröten, die je Besuch auf neun Märkten im Delta des Niger-Flusses in dieser Untersuchung (2011-2012; 18 Besuche) und zehn Jahre zuvor (1996-2002; 41 Besuche) festgestellt wurde. Die wahren Zählwerte stehen in Klammern dahinter. Zum Vergleich sind die Werte einer einzelnen Zählung auf dem Markt von Lomé (Togo) im Jahr 2012 angegeben. * - Savannenbewohner, # - Waldbewohner, + - In Nigeria nur Waldbewohner (LUISELLI et al. 2000).

Species / Arten	Niger Delta 2011-2012	Niger Delta 1996-2002	Lomé (Togo) 2012
Kinixys noguey *	0.167 (3)	0.171 (7)	(21)
Kinixys homeana #	0.389 (7)	3.463 (142)	(0)
Kinixys erosa #	0.167 (3)	0.976 (40)	(0)
Pelomedusa subrufa *	0.167 (3)	0.146 (6)	(9)
Pelusios niger #	0.111 (2)	0.220 (9)	(0)
Pelusios castaneus *	0.222 (4)	0.293 (12)	(15)
Pelusios cupulatta * BOUR & MARAN, 2003	0.000 (0)	0.000 (0)	(9)
Trionyx triunguis +	0.000 (0)	0.146 (6)	(0)
Cyclanorbis elegans *	0.000 (0)	0.024 (1)	(0)
Mean Total	1.222 (22)	5.439 (223)	(54)

Comparisons between 1996-2002 and 2011-2012 chelonian bushmeat datasets

Notwithstanding different survey intensities, there was a clear decrease in the overall number of specimens observed in the markets (viz. 22 versus 223 in the earlier study). The mean number of specimens per species per visit found at the nine Niger Delta bushmeat markets, in the two periods, is presented in Table 1, along with the true numbers of specimens. Contrary to what was found for the 2011-2012 period, there was a significantly higher number of specimens of forest species than savannah species in the earlier study (197 versus 26 specimens; $\chi^2 = 134.91$, $df = 1$, $P < 0.000001$).

Comparing trends of the two periods, the mean number of chelonian specimens observed in each market per visit per species declined strongly (Monte Carlo Wilcoxon: $z = 2.24$, $W = 34$, P (same median) = 0.0237), with also the overall richness being reduced (two species less in 2011-2012 than in 1996-2002). This latter difference may however be due to chance, given that the two missing species (*Trionyx triunguis* [FORSKÅL, 1775] and *Cyclanorbis elegans* [GRAY, 1869]) were observed only six

and one times, respectively, during the 41 visits of 1996-2002 and may have escaped the present surveys only due to a reduced number of visits.

There were also remarkable species-specific shifts in the apparent abundance patterns of turtles in the markets: for four species, the frequency of occurrence did not change noticeably between the two survey periods, whereas trading of *K. homeana* and *K. erosa* collapsed significantly in the 2011-2012 survey (Mann-Whitney U-test, $P < 0.01$ for *K. homeana* and $P < 0.05$ for *K. erosa*).

Hunter interview dataset

Question 2. According to the interviewee's opinion, the question whether people's demand for turtles in the area is high, average or low compared to other wildlife (mammals and birds). There was a significantly uneven distribution of answers by the respondents across the three allowed answers ($\chi^2 = 27.05$, $df = 2$, $P < 0.0001$): most of the 46 respondents ($n = 32$) considered that the demand for turtles by rural people is 'average' in the Niger Delta area, with a very few hunters thinking that there is a high demand

for turtle meat ($n = 4$) and also a low number of hunters thinking that the demand for turtle meat is very scarce ($n = 10$).

Question 3. According to the 46 interviewee's opinion, the question whether people's demand for turtles has not changed in the last years, or is higher or lower than before. Also in this question, the distribution of the respondents' answers across the allowed options was significantly uneven ($\chi^2 = 71.51$, $df = 2$, $P < 0.0001$), with nearly all respondents ($n = 43$) considering that the demand for turtle meat has not changed over the last 10 years. The number of respondents answering that, instead, the demand for turtle meat has changed, was extremely low (higher: $n = 2$, lower: $n = 1$).

Question 4. According to the interviewee's opinion, the question whether turtles are now as easy, easier or less easy to find at his hunting sites compared to the situation ten years ago. Once more, the distribution of the answers across the allowed answers was significantly uneven ($\chi^2 = 54.06$, $df = 2$, $P < 0.0001$). It was evident that the great majority of the 46 respondents ($n = 38$) considered turtles currently to be less easy to find than a decade earlier, with not even a single respondent thinking that the chelonians are more easy to find now than before. However, there was a moderate number of hunters ($n = 8$) thinking that the likelihood of finding turtles had not changed over the years.

DISCUSSION

The dataset collected during the present study is noteworthy because it provided information on tortoise consumption by humans in a specific, but wide, region of the African continent over 10 years, whereas other, even more general, studies on West African bushmeat markets, albeit detailed, did not provide such temporal series of data and did not focus on chelonians (e.g., Fa 2000; Fa et al. 2002, 2003, 2005, 2006). Hence, this study may be an example of what to do for many other tropical regions where chelonians are particularly at risk.

The study clearly showed that:

(i) the number of chelonian specimens has considerably decreased during the last decade in an identical set of nine bushmeat markets;

(ii) the frequency of occurrence of four species, however, did not change remarkably in this timespan;

(iii) bushmeat trade of two species (*K. homeana* and *K. erosa*) collapsed and two other, previously rarely traded, species were no longer observed on the markets;

(iv) according to interviews with hunters, demand for turtle meat did not change over the years and remained 'average' when compared to other types of bushmeat (mammals, birds, crocodiles, snakes);

(v) according to interviews with hunters, the likelihood for finding turtles decreased considerably over the last 10 years.

Thus, it is reasonable to conclude that the regional drop in the apparent availability of meat from the two above-mentioned *Kinixys* species is likely due to the regional decline of their populations, as previously observed in a very few sites where hunting by humans was rampant (Luiselli 2003b).

Of course, it suggests itself that not only hunting by humans but also continued forest habitat loss is responsible for the postulated declines of these two tortoise species, which are indeed ecologically interconnected to swamp forest and moist lowland forest habitats in southern Nigeria and Africa in general (Luiselli 2003b; Luiselli et al. 2006a; Branch 2008).

Recommendations for future years

Appropriate surveys are urgently needed for comparisons between demography and abundance traits of *K. homeana* and *K. erosa* in the same study sites where they were studied approximately ten years ago (e.g., Luiselli 2003b; Luiselli et al. 2008). This study must be designed to demonstrate whether the drop in traded numbers really reflects population abundance collapses in the wild. This is a priority action, given that southern Nigeria is an important region of distribution for at least *Kinixys homeana* (Luiselli et al. 2006a), and population col-

lapses of chelonians in this region may have larger-scale implications at the continental scale (Luiselli 2009; Bombi et al. 2011). For instance, the Niger Delta populations of *K. homeana* connect the eastern forest populations of the Equatorial Guinea-Cameroon block with those, much more isolated, of the western forest block (Benin and Togo) and are essential to secure the gene-flow among all of these populations. Indeed, the populations in Togo and Benin are extremely fragmented and endangered (Luiselli et al. unpublished data), and it is assumed that

their decline would be even more accelerated in case of a collapse of conspecific populations in south Nigerian forests.

In general, both in Nigeria and elsewhere, the authors suggest to continue monitoring of bushmeat markets at regular intervals to detect signs of changes in the frequency of occurrence of selected wildlife species. These changes may highlight real changes in demographic aspects of wild populations: they may be crucial to perceive early stages of population decline and, hence, improve conservation plans.

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