



Interviews on the status of West African forest tortoises (genus *Kinixys*), including preliminary data on the effect of snail gatherers on their trade

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The forest hingeback tortoises *Kinixys homeana* and *Kinixys erosa* are two of the most declining African chelonians. Although the population size trends of these species have received attention in some specific areas of West Africa, an overall perception of their declining trajectories are still largely unexplored. We used interviews with rural people (hunters, farmers and snail gatherers) in order to explore the general perception that these experienced people have on the population trends of these threatened tortoises. Overall, we interviewed over 2000 people in three West African countries (Côte d'Ivoire, Togo and Nigeria), which mostly supported the notion that these tortoises are heavily declining in Togo and Nigeria, but less so in Côte d'Ivoire. In addition, many respondents suggested that snail gatherers are the main providers of tortoises to the bushmeat trade. Indeed, our market surveys revealed that, in Nigeria, there was a significantly positive correlation between number of wild snails traded by individual sellers and numbers of sold tortoises in their 'shops'.

Key words: Chelonians, *Kinixys erosa*, *Kinixys homeana*, interviews, snail trade, Côte d'Ivoire, Togo, Nigeria

INTRODUCTION

Standardised or informal interviews with indigenous communities or with selected people (e.g., hunters, farmers, fishermen, etc.) from local villages have been widely employed by conservation biologists (Gadgil et al., 1993; Gros et al., 1996; Gros, 1998; Gilchrist et al., 2005; Pan et al., 2015) in order to obtain information on threatened species at the local scale. In this regard, these studies valued local ecological knowledge for scientific reasons (e.g., Begazo & Bodmer, 1998; Aiyadurai et al., 2010; Rist et al., 2010). Local ecological knowledge (LEK) can also be informative for detecting population trends of target species (e.g., Meijaard et al., 2011; Akani et al., 2013). Therefore, it is generally assumed that LEK can be usefully integrated with complementary scientific knowledge to improve species management.

In this paper, we used interviews with a large number of rural people for uncovering the population trends of threatened species from a logistically difficult region of the world. Target species of our study are two forest tortoises (genus *Kinixys*: Testudinidae), *Kinixys homeana* and *Kinixys erosa*. Hinged tortoises (genus *Kinixys*) are endemic to tropical Africa, and are characterised by

having hinged carapace (Branch, 2007). *Kinixys homeana* and *K. erosa* habitat is typically tropical forests (Branch, 2007; Luiselli & Diagne, 2013, 2014). Indeed, both *K. homeana* and *K. erosa* are known to inhabit exclusively remnant mature moist forests in the region (Luiselli & Diagne, 2013, 2014). Heavy over-exploitation of the forest, habitat loss and massive harvesting for domestic consumption in West Africa have caused a considerable decrease in populations of the two species in the last two decades (Luiselli, 2003a, 2003b; Luiselli et al., 2006). Another major problem that impacts on these species is that they are also heavily exploited through opportunistic capture by snail-gatherers (Akani et al., 2015b), and also a target of the international pet trade (Auliya et al., 2016). Due to all these factors, in the IUCN/SSC TFTSG Red List Workshop for African chelonians (held in Lomé, August 2013), *K. homeana* was assessed as Critically Endangered (CR) and *K. erosa* as Endangered (EN), and there was a wide agreement among experts that both species are seriously threatened (for example, Luiselli and Diagne, 2013, 2014). However, these red list status updates have not yet been published in the IUCN (2018) Red List web site.

Whereas studies on the occurrence of *Kinixys* tortoises

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in bushmeat markets have already been carried out (e.g., Luiselli, 2003a; Luiselli & Diagne, 2013, 2014), there are no studies exploring the effects of snail gathering on the tortoise trade in the West African regions. Snail gathering is a substantial economic activity in many areas of West Africa (e.g., see Adaigho & Nwadiolu, 2016; Amani et al., 2016), and thus its effects on tortoise trade may be considerable despite being neglected so far.

One of the prerequisites for LEK surveys is that the species is distinct from any other species in the same landscape and can be distinguished easily by the interviewees from whom LEK is being gathered (e.g., McKelvey et al., 2008; Newing, 2010; Turvey et al., 2015). In our case, the interviewees have distinct vernacular names for the two species in comparison with other chelonian species, but some people consider the two taxa (that are indeed similar from the morphological point of view and, anyway, similarly threatened) as a single species. Since the two species show a nearly identical distribution in West Africa (Luiselli & Diagne, 2013, 2014), are almost invariably sympatric and syntopic (Luiselli et al., 2008), and both are declining and of high conservation concern (Luiselli & Diagne, 2013, 2014; Turtle Taxonomy Working Group, 2017), any eventual decline/increase of population sizes detected by local people would indicate a shared pattern between the two species.

Our aims in this paper are twofold:

(1) Understanding whether people from forest areas of three West African countries (Côte d'Ivoire, Togo, and Nigeria) consider that *Kinixys* populations are stable, increasing or declining in the surroundings of their settlements;

(2) providing preliminary data on a possible novel threat for forest tortoises, i.e. the opportunistic hunting made by snail gatherers for the bushmeat markets of southern Nigeria.

MATERIALS AND METHODS

Study areas

The field study was conducted in south-western Côte d'Ivoire (Bas-Sassandra region), not far from the political border with Liberia, south-western Togo (Missahohe forest area, surroundings of Kpalimé and Badou) and southern Nigeria (Niger Delta region, Bayelsa and Rivers State) (Fig. 1). The general habitat of these regions is similar, being characterised by forest-plantation mosaics, with remnant forest patches that become more isolated year-by-year (e.g., Akani et al., 2014; Luiselli et al., 2015), thus severely fragmenting the connectivity of the tortoise populations in this part of Africa (e.g., Segniagbeto et al., 2015).

Protocol

Local markets and small human settlements sparsely spread in the forest zones of Côte d'Ivoire, Togo, and Nigeria were regularly visited in order to gather data on the bushmeat trade and its correlates with human societies between February 2013 and December 2017 (e.g., see Akani et al., 2015a; Luiselli et al., 2017a, 2017b). Overall, 51 settlements were visited during this study.

All these settlements were located inside the known distribution range of the two *Kinixys* species (Luiselli & Diagne, 2013, 2014), and were widespread across most of the distribution range of the two target species in Nigeria and Togo (whereas for Côte d'Ivoire we surveyed a much smaller portion of the tortoises' ranges). We conducted face-to-face semi-formal semi-structured interviews (Newing, 2010) with only hunters, farmers, snail gatherers, and bushmeat market sellers that may have had direct experience with tortoises and are therefore considered as 'experts' (Davis & Wagner, 2003) (Table 1). Thus, people not directly involved in activities within forest patches were not considered in our analysed data. Hunters and farmers were pooled in our statistics because the same people often conducted both the activities. During interviews, we also obtained profiles of the respondents' age, profession, education, and gender. Our sampled interviewees were dominated by men aged 21-35 years because this was the category mostly conducting activities in bush/forest and thus the most experienced with tortoises. In particular, we focused our surveys and our interviews in sites of small human settlements situated inside, or in the immediate surroundings of, forest patches (Fig. 1), in order to maximise the chances to meet with people already experienced with these chelonians. Coauthors and assistants fluent in the local language undertook the surveys. No minors were interviewed (youngest was 21 years of age), and all interviewees were informed of the aims of the project and their consent was obtained before proceeding. Their identity was kept anonymous in order to assure full privacy to the interviewees and to minimise the risk of obtaining false answers. All interviews were conducted in the local language. Overall, our interviews followed the ethical guidelines developed by the British Sociological Association. In all cases, the discussion with the interviewees was not pre-arranged, but was performed opportunistically when appropriate people were met during our surveys. In all cases, we noted the response after we conducted the interview with the respondent. We conducted single interviews for the various tortoise species.

In the interviews, we asked each interviewee, although not using a formal questionnaire, the following questions:

- 1) Are terrestrial tortoises present near your village?
- 2) If present, do you consider the tortoises to be plentiful or rare?
- 3) Has the population increased, decreased, or stayed the same over the last ten years?

Together, the three answers would indicate stable, increasing or declining populations according to the perception of the respondent.

In question (1), the possible answers were 'yes' or 'no'. Concerning question (2), the possible answers were 'plentiful' or 'rare'. The scope of this question was not to understand the interviewees' perception on whether the tortoise populations are declining (that is covered by question (3)) but to get a non-quantified indication on whether the apparent population status is still good at the local level (answer: plentiful) or whether these reptiles are apparently uncommon (answer: rare). Obviously, 'plentiful' or 'rare' is subjective. So, we asked

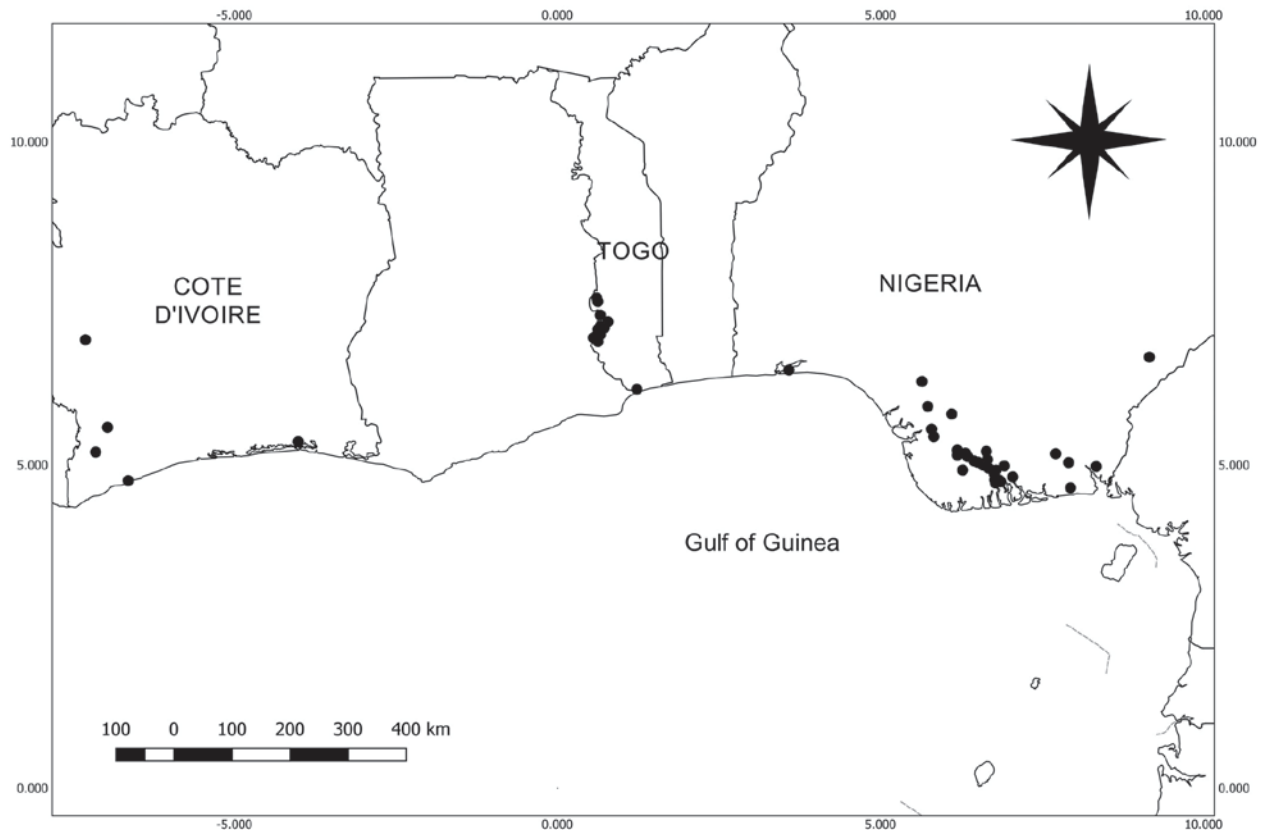


Figure 1. Map of the study area showing the sites where interviews were performed

Table 1. Distribution of the various categories of interviewees by country, by sex and by age class. Numbers would indicate the numbers of interviewed people.

	Nigeria	Togo	Côte d'Ivoire
Number of settlements	31	13	7
Number of people	1033	703	341
Men	774	562	240
Women	259	141	101
21-35 ys old	781	511	233
36-50 ys old	153	107	66
>50 ys old	99	85	42
Hunters/farmers	911	543	256
snail gatherers	35	131	65
Bushmeat market sellers	87	29	20

the respondents to grossly quantify their 'estimates': we defined 'plentiful' when the respondent said that he/she encountered tortoises at least once every month, and 'rare' when the encounter rate was less than that. In almost all cases, the interviewees did provide answers that were easy to classify within one of the two categories, as those claiming that tortoises are 'plentiful' stated that tortoises can be seen on almost a daily basis, whereas those claiming that they are 'rare' said that tortoises can be observed much less than once every month (often, 3-4 individuals per year). When respondents were uncertain between 'plentiful' and 'rare' ($n = 41$ cases),

we deleted their answers from our analyses. Note that in many cases, the respondents stated that freshwater species (*Pelomedusa subrufa*, *Pelusios* spp.) were much more common than forest tortoises in the forest patches surrounding their villages.

During the early years of our field research in West Africa (years 1996-2003), we noticed in > 30 instances that several tortoises for sale in local markets were carried there by snail gatherers (*Achatina* and *Arcachatina* sp.) (Luiselli & Diagne, 2013, 2014; Akani et al., 2015b). In the years 2016-2018, we then decided to explore quantitatively, albeit in a preliminary way, this potential threat for tortoise survival in West Africa. In order to explore this issue, we acknowledge that the best protocol should have been to select a few specific markets in the country and select shops at random to be systematically surveyed and identify whether they sold tortoises. However, this approach was not possible due to logistic constraints, as the snail sellers are unhappy to be visited and disturbed on a very regular basis for a time-consuming operation such as counting their snails. In this regard, snail sellers are usually more disturbed by scientists than how bushmeat sellers are because counting the traded snails requires more time and is more invasive towards the routine selling activities than just examining the fewer bushmeat carcasses that are sold.

Therefore, we decided to focus only on the 'shops' selling tortoises in the explored markets. So, when in a given survey day and in a given shop, we found *Kinixys* specimens for sale, we contextually recorded whether

also snails were traded and, if so, we counted the number of snails that were there for sale. Thus, in each shop, we counted in the same day both the number of tortoises available for sale and the number of traded snails. Our assumption was that, if tortoises are collected especially by snail gatherers, it would have been uncovered a positive relationship between number of traded tortoises and number of traded snails per shop. Indeed, following this rationale, the number of traded snails per shop would be a proxy of the search intensity made by the seller/provider of the seller for gathering snails in the field. These data were collected very early in the morning (0700 – 0800 hr) in order to avoid that our counts were affected by snails and tortoises sold out. Unfortunately, the sample size of cases was small and referred only to the Niger Delta (Nigeria). In many cases, in fact, snails are provided by snail farms (that represent a lucrative novel business in the region; e.g. see <https://www.vconnect.com/nigeria/list-of-snail-farming_c96>, last accessed on 08 January 2018), and so it was not possible to indiscriminately count all the snails exposed for sale in the markets. Thus, we firstly identified ‘shops’ with tortoises for sale, then we asked whether there were also snails and, if so, whether they were farmed or collected from the wild, and if the latter, we counted also the snails for contrasting their number with that of the traded tortoises.

Statistical analyses

Frequencies of the different types of answer were compared by observed-versus-expected χ^2 test. Variables were tested for normality by Shapiro-Wilk W test, and when non-normal ($P < 0.05$), they were log-transformed to achieve normality. After this, parametric tests were used. The relationship between number of traded snails and number of traded tortoises in each ‘shop’ was analyzed by Pearson’s correlation coefficient. All tests were performed by the software PAST version 3.0, with alpha set at 5%.

RESULTS

Population trends as perceived by local people

Question 1: are terrestrial tortoises present or not in the surroundings of your village?

Overall, 2,077 independent interviews were performed, including of 341 in Côte d’Ivoire, 703 in Togo and 1033 in Nigeria. Despite 37.2% of Ivorian, 16.7% of Togolese and 20.4% of Nigerian respondents not knowing whether tortoises are found around their settlements, the majority of respondents considered hingeback tortoises to be present (62.8% in Côte d’Ivoire, 83.9% in Togo, and 79.6% in Nigeria). These inter-country differences were statistically significant ($\chi^2 = 16.36$, $df = 2$, $P < 0.001$), with the percentage of ‘yes’ respondents in Côte d’Ivoire being lower than in the two other countries.

Question 2: do you consider the tortoises to be plentiful or rare in the surroundings of your village?

After considering only the respondents that confirmed the presence of tortoises in the surroundings of their settlements ($n = 214$ in Côte d’Ivoire, 590 in Togo, and 822 in Nigeria), most of them considered the tortoises

to be rare: 66.8% in Côte d’Ivoire, 81.0% in Togo, and 86.0% in Nigeria. The differences among countries were statistically significant ($\chi^2 = 27.64$, $df = 2$, $P < 0.0001$), with responses ‘rare’ being more dominant in Togo and Nigeria than in Côte d’Ivoire.

Question 3: Do you think that tortoises are as plentiful as before, more plentiful than before or less plentiful than before?

Most of the interviewees considered the sighting frequency of these tortoises to be decreasing, with fewer people considering them to be stable and almost nobody thinking that these tortoises are nowadays more easily encountered than before ($\chi^2 = 105.39$, $df = 3$, $P < 0.0001$) (Fig. 2). In this regard, however, it should be pointed out that many interviewees had no precise opinion (Fig. 2).

The differences in the frequency of answers by country were statistically significant ($\chi^2 = 199.68$, $df = 6$, $P < 0.0001$), with a comparatively lower frequency of respondents suggesting a declining trend in the Côte d’Ivoire than in the other two countries.

Effects of snail gatherers on tortoise trends

Interestingly, in the market ‘shops’ of Nigeria in which we counted snails for sale, we found a significant positive correlation with the number of traded tortoises (both *Kinixys* species pooled; $r^2 = 0.746$; $P < 0.000$; Fig. 3).

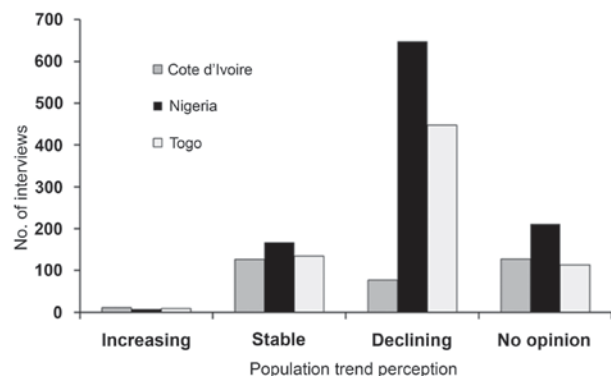


Figure 2. Distribution of the answers by interviewees concerning the temporal trend in the frequency of sightings of the hingeback tortoises in the surroundings of their village, during the last 10 years, in three West African countries.

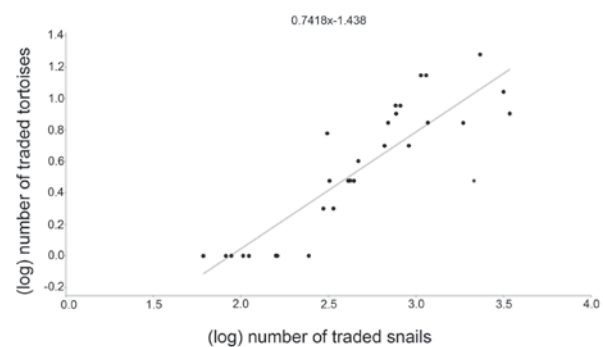


Figure 3. Relationship between the number of traded snails and that of traded tortoises in the surveyed bushmeat markets, years 2016-2018. Variables were log-transformed to achieve normality. For the statistical details, see the text.

DISCUSSION

Methodological shortcoming

Another threatened tortoise species (the Vulnerable *Kinixys nogueyi*) may occasionally occur sympatric or contiguously parapatric with the two target species (Ségniagbeto et al., 2015), and can possibly be confused with the two targets from some interviewees. This would introduce some potential biases to our respondents' answers, and the resulting precision may be lowered (O'Donnell et al., 2010). However, this latter species has different morphology and habitat usage (being a Guinea savannah species; Segniagbeto et al., 2015). This latter species is more habitat generalist than the two target species, and may be also sympatric or contiguously parapatric with them (Ségniagbeto et al., 2015). Therefore, it cannot be ruled out the possibility that the true abundance of the two target species is even less than what appeared from the performed interviews.

Population trends as perceived by local people

Although the answers made by interviewees cannot be considered as a straightforward evidence of any population size trend (Anadón et al., 2009), it is noteworthy that the perception of the rural people was that: (i) *Kinixys* tortoises still inhabit the forested surroundings of several villages in all the three countries; (ii) there was a general agreement that the tortoises are uncommon in most areas, and (iii) the tortoises were declining, with a comparatively lower number of respondents considering these chelonians to be declining in Côte d'Ivoire than in the other two countries.

Consistently among countries, very few interviewees stated that *Kinixys* tortoises are more easily found nowadays than in the past (3.2% in Côte d'Ivoire, 0.7% in Nigeria, and 1.3% in Togo). This fact is unexpected given that several hunters and collectors usually tend to minimise declining patterns of their target animals and human perception of rarity is skewed and scale-dependent (Hall et al., 2008). Thus, this fact would really indicate an overall declining pattern for these species. Obviously, since our interviews could not discriminate between *K. homeana* and *K. erosa*, the declining trend should be attributed to both species, as also indicated by field ecological studies in some sectors of their range (Luiselli et al., 2008; Luiselli & Diagne, 2013, 2014).

The comparison with Togo and Nigeria is very interesting: in these two latter countries (where indeed a heavy decline of the population sizes of the two target species has been observed by detailed field studies; e.g. see Luiselli et al., 2016), the great majority of the respondents considered the species in decline, whereas the same was not true in Côte d'Ivoire. Considering that (i) some field studies showed a heavy decline of *K. erosa* and *K. homeana* in Nigerian sites where these species are hunted for subsistence (Luiselli, 2003b), and that (ii) there is a consensus among reptile traders operating in Togo, Ghana, and Benin that the abundance of *K. erosa* and *K. homeana* has declined over the years (Auliya et al., 2016), the hypothesis that they are less threatened in Côte d'Ivoire than elsewhere should be considered for

further studies, in order also to enhance the conservation perspectives of these species in West Africa. Up to now, there are still few geo-referenced field records for the two target species in the Côte d'Ivoire (Iverson, 1992; Maran, 2004), but it is certain that several additional sites can be easily discovered by intensifying field efforts. Indeed, four new presence sites for *K. homeana* and five for *K. erosa* have been discovered during recent field surveys in the southern regions of the country (Luiselli et al., 2018, unpublished report to Turtle Conservation Fund). We do not know why Ivorian populations of these tortoises should be less threatened than Togolese and Nigerian populations. It seems unlikely that deforestation rates/habitat alteration at a large scale may have any effect in explaining this pattern, as deforestation rate during the period 2001-2015 has been much greater in Côte d'Ivoire (5.81%) than in Nigeria (0.50%) and Togo (0.58%) (data source: www.globalforestwatch.org; last accessed on 12 March 2018). Also, snail gatherers are common all throughout the West African countries (e.g. Sodjinou et al., 2002; Adaigho & Nwadiolu, 2016; Amani et al., 2016), and thus it is likely that small-scale factors (i.e. overhunting and excessive snail gathering at the village scales) may be responsible for the observed patterns.

Effects of snail gatherers on tortoise trends

Despite its logistical constraints (see methodology), our study demonstrated a clear positive relationship between number of traded snails (when these came from the wild and not from farms) and number of traded tortoises. In our opinion, this is the first clear demonstration that *Kinixys* tortoises are often located while people search for snails (as also suggested by Luiselli & Diagne, 2013, 2014; Akani et al., 2015), and that, therefore, snail searchers (generally men and farmers; Amani et al., 2016) may be at least as dangerous, if not even more dangerous, than normal hunters for the continued survival of these chelonians. Indeed, (i) people hunting for larger animals may give low priority in collecting small animals like tortoises when they are occupied with time-consuming searches of much larger and economically more attractive wildlife; and (ii) snail gatherers may collect high numbers of tortoises, especially by wet season and including also the hidden and inactive specimens, because they scout exactly the same microhabitats that are preferred by tortoises (snails and tortoises share the same microhabitat preferences; Akani, Luiselli & Eniang, unpublished observations). Small scale opportunistic catches of threatened species due to similar habitat shared by a common species with commercial interest were already observed in aquatic ecosystems, for instance for fish (e.g., Palmeira et al., 2013), sea turtles and cetaceans (e.g., Bard et al., 2002; Panagopoulou et al., 2017), penguins and seabirds (Anderson et al., 2011), but not in terrestrial tropical ecosystems.

While the hypothesis that snail collectors are driving tortoise harvesting is, in our opinion, reasonable, we should highlight that we just presented here a correlation between the number of snails and tortoises, which does not constitute proof without a more detailed examination of the strategy and economics behind snail and tortoise

collecting. Unfortunately, the data available on the economics behind snail and tortoise collecting are too few to stress any final considerations in this issue. Based on the evidence presented in this paper, we plan to investigate more in detail the relationships between snail searching and tortoise catches not only in Nigeria, but also in other West African countries, in the years to come.

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