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SHORT COMMUNICATION

Continued availability and sale of pangolins in a major urban bushmeat market in Cameroon despite national bans and the COVID-19 outbreak

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1 | INTRODUCTION

Bushmeat (or 'wild meat', defined as the meat of wild animals) is a major source of protein for rural people across sub-Saharan Africa (Ingram et al., 2021), yet some species suffer unsustainable levels of exploitation often to meet the demands of increasing urban populations (Coad et al., 2019; Wilkie et al., 2016). As in the rest of Central Africa, Cameroon has a long history of bushmeat consumption and trade (Bahuchet & Ioveva, 1999; Randolph, 2016). Pangolins (Family: Manidae) have been one of the many groups of species exploited as they are highly valued for food and, in some countries, used as traditional remedies (Soewu et al., 2020). Pangolin meat is favoured for its taste and it remains commonly offered for sale in Cameroonian markets and restaurants (Ingram et al., 2018; Nguyen et al., 2021). Furthermore, Cameroon has become one of the major export countries for the illegal trade in pangolin scales from Africa to Asia (Ingram et al., 2019a), to supply the market for Asian traditional medicines, for example in traditional Chinese medicine (Wang et al., 2020). All African pangolin species are now considered to have declining population trends (Ingram et al., 2019b; Nixon et al., 2019; Pietersen et al., 2019a, 2019b).

Among the species of pangolin that occur in Cameroon, two are listed as endangered (white-bellied, *Phataginus tricuspis*, and giant, *Smutsia gigantea*; Nixon et al., 2019; Pietersen et al., 2019b) and one as vulnerable (black-bellied, *Phataginus tetradactyla*; Ingram et al., 2019b) on the IUCN Red List of Threatened Species. All African pangolin species were transferred to Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora in January 2017 (CITES, 2017). In Cameroon, the giant pangolin has been fully protected since 2006 (listed as a Class A species; Order No. 0648/MINFOF of 18 December 2006), and in 2013, a *Lettre Circulaire* suspended the circulation and exportation of pangolin scales (No.0153/LC/MINFOF/SG/DFAP/SDVEF of 27 June 2013). Following the transfer of all pangolin species to CITES Appendix I

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in 2017, pangolins (listed as *Manis spp.*) were listed as integrally protected in Cameroon (*Lettre Circulaire* No. 0007/LC/MINFOF/DFAP/SDVEF/ of 11 January 2017), prohibiting any capture, detention or trade of live or dead pangolins at the national level. This was confirmed in April 2020 when all three species of pangolin were officially listed separately as Class A on the Cameroonian protected species list (*Arrêté* No. 0053/MINFOF of 1 April 2020).

In 2020, the world's attention focussed on the trade of wild animals during the global pandemic of the novel coronavirus disease (COVID-19). Pangolins received considerable public attention when they were implicated to be an intermediate host of the virus (Heighton & Gaubert, 2021; Zhang et al., 2020). These initial claims have since been questioned as further research emerges (Cyranoski, 2020; Frutos et al., 2020); however, the trade of wild animals remains strongly implicated as a source of the outbreak (Contini et al., 2020; Jacob et al., 2020). In West and Central Africa, outbreaks of other zoonotic diseases such as the Ebola virus disease (EVD) led to a temporary collapse in Nigeria's bushmeat trade in 2014 (Akani et al., 2015). Following the EVD outbreak, local rules banning bushmeat were put in place (McNamara et al., 2020), as with COVID-19 (Koh et al., 2021). However, the effects of such local rules were short-lived and were considered to have made trade more covert (McNamara et al., 2020). Anecdotal media reports have suggested that pangolin sales to Asian customers in Libreville, Gabon, have declined since COVID-19, whereas local Gabonese people are not thought to have been deterred, as they stated they were unaffected by eating bushmeat during EVD (France24, 2020). During the peak of the COVID-19 outbreak, bushmeat markets, which sell pangolins, continued to operate in Nigeria (Meseko et al., 2020); however, the impact of the outbreak has yet to be quantified elsewhere.

Since 2017, the national wildlife legislation pertaining to pangolins has changed in Cameroon, and in 2020, public opinion on pangolins may have changed due to publicised purported links with the coronavirus outbreak. Our objective is to investigate market availability and trends of African pangolin sales since the changes in national legislation and during the COVID-19 outbreak. Using one of the main bushmeat markets in the capital city of Cameroon, Yaoundé, as a case study, we: (1) investigate the rate at which pangolins were brought to the market in 2017/2018; (2) compare the daily availability of pangolins in 2017 and 2020; and (3) investigate trends in pangolin availability on the market as the coronavirus pandemic progressed.

2 | METHODS

2.1 | Market surveys

We investigated the availability of pangolins at one of the main open bushmeat markets in the capital city of Cameroon, Yaoundé (Bahuchet & Ioveva, 1999; Edderai & Dame, 2006; Randolph, 2016). Between 2017 and 2020, the bushmeat market had a total of 22 tables of various sizes, inclusive of the main sheltered market and tables in the surrounding streets where bushmeat was sold.

We first compiled market survey data that already existed for the same market from surveys conducted by the Zoological Society of London – Cameroon (ZSL; Aka'a, (2018); Round 1: 10 February 2017 – 19 March 2017 [12 survey days], Round 2: 2 October 2017 – 27 November 2017 [54 surveys days], and Round 3: 5 June 2018 – 7 August 2018 [39 survey days]) and from Juul Jensen (2017); 11–29 July 2017 [14 survey days]. The market operated Monday–Saturday from approximately 8 am–6 pm, and it was closed on the last Wednesday of every month for cleaning. Animals were brought to the market by suppliers (middlemen) early in the morning, and all market surveys took place in the morning between 08:00 and 10:00 to ensure that most animals were counted before being sold. Two survey methods were used across studies, and in each case, the species, number of carcasses, state (live, dead/fresh and smoked), unit (number of individuals and pieces) and price (in CFA) were recorded. In the ZSL Round 1 and the Juul Jensen (2017) surveys, all pangolins that were openly offered for sale were counted by an undercover Cameroonian researcher. In the ZSL Round 2 and 3 surveys, pangolins were counted by a market trader as they arrived to the market from middlemen between 07:30 and 18:30. This method meant that only new animals each day were counted, avoiding possible double counting. Traders were trained to identify pangolins and record data in the survey form by the research team and were incentivised with a per diem. Pangolins were identified using morphological characteristics only, following Kingdon (2015). In nearly all cases pangolins could be easily identified. Arboreal pangolins were mostly fresh or live and were always whole. When arboreal pangolins were smoked, we could not distinguish the species and were identified to Genus level only. Giant pangolin pieces were identified based on characteristic markings on the meat where scales had been removed, and informal discussions with market traders.

For this study, we also monitored the availability of pangolins openly offered for sale at the same market for 60 survey days between 30 March 2020 and 26 August 2020. Our market survey therefore started 24 days after the first reported COVID-19 case in Cameroon and spans the following 5 months of the exponential growth phase of the first wave (Mbopi-Keou et al., 2020). Two alternating undercover Cameroonian researchers (who are experienced in identifying pangolins) conducted the market surveys each morning, collecting the same data (except price) as in the earlier surveys. To avoid possible double counting of carcasses in this survey, the market was not surveyed on consecutive days.

2.2 | Analyses

All statistical analyses were conducted in R version 3.6.1. We used data from all survey days (including days when no pangolins were observed for sale) to calculate the mean daily number of arboreal pangolins on the market on any given day before (2017) and during (2020) the pandemic, testing for differences between the two groups using a Welch's two-sample *t*-test. Given the differences in methods, we only included ZSL Round 1 and Juul Jensen (2017) in

the 2017 calculations. As the arboreal pangolins were not identified to species level in ZSL Round 1, we grouped the arboreal species together for this analysis. We did not conduct this analysis for giant pangolins given that they were mostly found in pieces, and it was therefore not clear how many individuals the pieces belonged to.

To investigate trends in the pangolins offered for sale during the 2020 pandemic, we investigated monotonic trends in the daily number of pangolins available overall and per state (live, fresh or smoked) on the market by running Mann-Kendall trend tests using the R package 'kendall'. Autocorrelation was assessed in the data and for time series that were found to be autocorrelated within a 10-day period, a 'Mann-Kendall Test of Pre-Whitened Time Series Data in Presence of Serial Correlation Using Yue and Wang (2002) Approach' was run using the 'modifiedmk' R package (Patakamuri & O'Brien, 2020).

3 | RESULTS

3.1 | Survey summaries

All three species of pangolin present in Cameroon were recorded in the market surveys (Figure 1). For the two open-market studies that actively minimised double counting and identified all pangolins to species level (Juul Jensen[, 2017] and this 2020 study), we calculated the pangolin species composition at the market. In the Juul Jensen (2017) surveys, 98.3% of all pangolin individuals on the market were white-bellied pangolins, whilst giant and black-bellied pangolin accounted for 1.3% and 0.4% respectively. During the 2020 surveys, 99.6% of pangolin individuals were white-bellied pangolin, 0.4% were black-bellied pangolin, and we observed no giant pangolins. Giant pangolins (or pieces of them) were available on 15% of survey days (12/80) in 2017, 18% in 2018 (7/39) and 0% in 2020 (0/60). Arboreal pangolins were available on 81% of survey days in 2017 (65/80), 95% in 2018 (37/39) and 72% in 2020 (43/60). Across all survey days in 2020, arboreal pangolins were live in 62% of cases, followed by fresh (34%) or smoked (4%). In the ZSL surveys (2017/2018), pangolin scales were observed for sale on 7 days, although mostly on subsequent days suggesting fewer independent batches of scales. Giant pangolin scales were nearly double the price of arboreal pangolin scales per kilogram in 2017/2018 (Table 1). During the 2020 survey, white-bellied pangolin scales were also visibly offered for sale on two survey days.

3.2 | Market turnover in 2017/2018

During 54 survey days in October/November 2017 (ZSL Round 2), a total of 333 arboreal pangolins arrived to the market. Two whole giant pangolins were recorded in October, and in November smoked giant pangolin morceau were recorded on 5 days (three or four morceau per day). For the morceau, we cannot derive the exact number of individual giant pangolins. On 39 survey days in June-August 2018 (ZSL Round 3), a total of 477 arboreal pangolins and smoked giant pangolin morceau were recorded on seven days (four – six morceau per day). On average, this equates to 6 new arboreal pangolins arriving to the market each day in the 2017 survey and 12 new arboreal pangolins per day in the 2018 survey.

FIGURE 1 Photographs of the surveyed bushmeat market in Yaoundé, Cameroon, showing: (a) Live white-bellied (left) and black-bellied pangolins (right) in 2020 and (b) whole fresh white-bellied pangolin and pieces of giant pangolin in 2017. Photo credits: (a) Franklin T. Simo and (b) Timm Sonn-Juul

3.3 | Pre- and during COVID-19 comparison

Arboreal pangolins were documented in both the 2017/2018 surveys and the 2020 survey, whereas giant pangolins were only observed during the 2017/2018 surveys. We found a significant decrease in the mean daily market counts of arboreal pangolins during COVID-19 when compared to 2017 (Figure 2; $t[26.7] = 4.98$, $p < 0.001$). The mean in 2017 was 16.5 pangolins (median = 12.5), whereas in 2020 it was 3.75 pangolins (median = 3).

3.4 | Pangolins on the market during the COVID-19 pandemic

We documented the persistent presence of arboreal pangolins at the market during 2020 from March-August (Figure 3). We found no significant monotonic trends in the daily number of arboreal pangolins

Genus	No. prices	Part	Unit	State	Mean unit price ± SD (CFA)
Phataginus	5	Scales	Kg	Fresh	8100 ± 11,177
Smutsia	3	Scales	Kg	Fresh	15,000 ± 8660
Smutsia	12	Meat	Morceau	Smoked	18,833 ± 15,440
Phataginus	118	Whole	Whole	All states	10,758 ± 4276

TABLE 1 Prices of pangolins and their derivatives in 2017/2018 Central African Francs (CFA) on the surveyed market, Cameroon

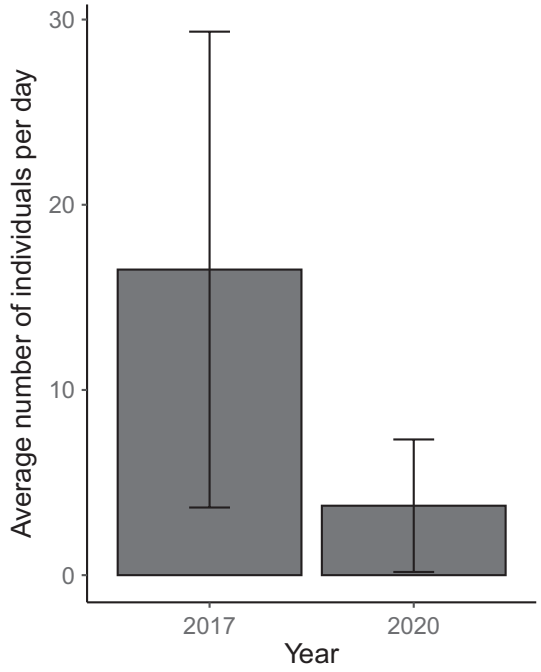

FIGURE 2 Mean daily count ± standard deviation of arboreal pangolins (*Phataginus* spp.) identified on market surveys in 2017 and 2020

present on markets during the coronavirus pandemic ($\tau b = -0.14$, $p = 0.13$). When separated by state, we also found no significant monotonic trends in the daily market counts for live ($\tau b = 0.0018$, $p = 0.99$), fresh ($\tau b = -0.16$, $p = 0.071$) or smoked ($\tau b = -0.12$, $p = 0.28$) arboreal pangolins.

4 | DISCUSSION

We have documented the availability of pangolins in a major urban bushmeat market in Cameroon following national bans in the trade of the species and during the COVID-19 pandemic. We identified a significant decrease in the average number of arboreal pangolins offered for sale per day at a major bushmeat market in the capital city between 2017 and 2020, but we cannot distinguish whether this was specifically due to the national bans or the coronavirus outbreak. However, despite the prohibition of pangolin trade, new legislation listing all pangolins as integrally protected species within Cameroon, and the COVID-19 pandemic, we found that arboreal pangolins were persistently and openly offered for sale throughout 2020, and the daily number of pangolins available during this period remained consistent. Arboreal pangolins were observed on 72% of survey days in 2020, and most pangolins were alive (62%). Furthermore, despite national bans in giant pangolin trade since 2006, pieces of giant pangolin meat and some whole carcasses were observed in 2017/2018, although not during the 2020 survey (however one whole giant pangolin was observed by the researchers on the market on a non-survey day –27 May). These results are likely indicative of the infrequent enforcement of protected species laws at the market, as also observed in a year-long ethnographic study of the same market in 2009/2010 (Randolph, 2016). Given that giant pangolins have been legally protected for longer, trade in giant pangolins is highly likely to have gone underground. At our survey market, many traders have private storerooms and freezers for meat (Randolph, 2016), and in the past other protected species such as gorillas and elephants were available as smoked meat at the same market (Bahuchet & Ioveva, 1999). Our results may also reflect a decline in wild giant pangolins (Nixon et al., 2019), which has been reported in some parts of Cameroon (Abugiche, 2008; Laurent, 1992; Mouté, 2010; Ngoufo et al., 2014).

The widespread media reports that COVID-19 purportedly originated from pangolins (Cyranoski, 2020; Frutos et al., 2020; Zhang et al., 2020) could have had an impact on the availability of pangolins at this market by either (1) reducing consumer demand or (2) impacting bushmeat supply chains from rural to urban areas, as we found a significant decrease in the average number of arboreal pangolins available per day between 2017 and 2020. However, from our data, we are not able to tell whether this decline is due to the change in laws or the COVID-19 outbreak. Given that we documented persistent availability of arboreal pangolins (all states) throughout the 2020 survey during the pandemic, our results likely reflect the belief that bushmeat is safe to eat as it has been 'eaten for generations without consequences' as reported elsewhere (Bonwitt et al., 2018; France24, 2020; Saylors et al., 2021; Subramanian, 2012). Our results mirror those found for other investigations of bushmeat trade or consumption during zoonotic disease outbreaks despite to a much lower extent. The most recent zoonotic outbreak before COVID-19, EVD is thought to originate from bushmeat. As a first step to control the EVD outbreak in 2014, a blanket ban on bushmeat hunting and consumption was ordered in West Africa (Akani et al., 2015; Bonwitt et al., 2018; Leroy et al., 2009). In urban markets in the Niger Delta region of Nigeria during the EVD outbreak, an immediate cessation in the availability of bushmeat species associated with the disease was documented (Funk et al., 2021). In Guinea, there was a significant reduction in the reported consumption of bats and

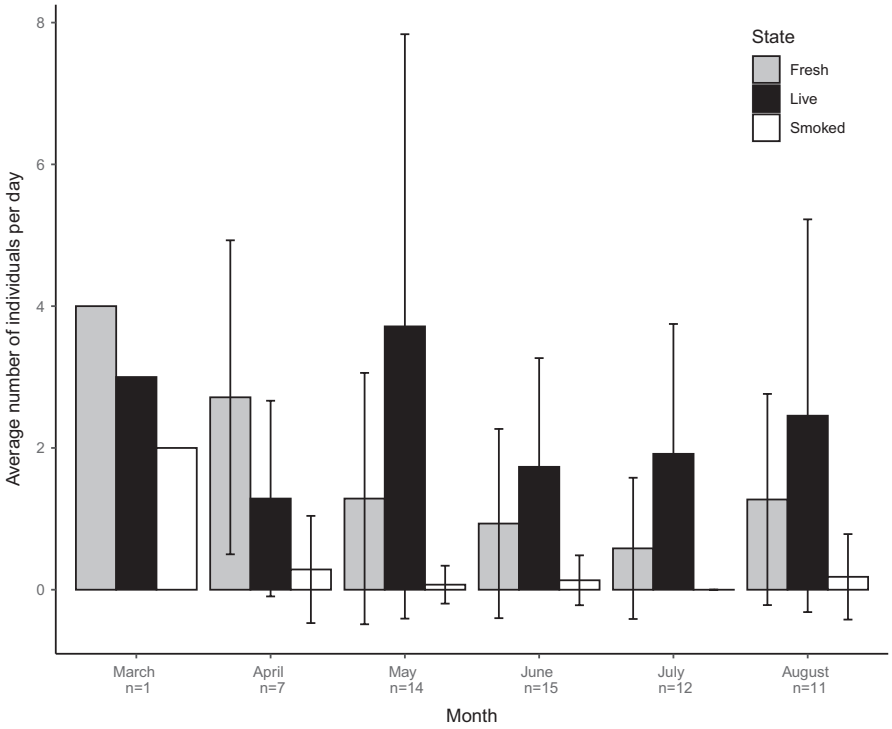

FIGURE 3 Mean ± SD daily market counts of the number of arboreal pangolins (*Phataginus* spp.) offered for sale during March–August 2020, separated by the state of the individual. Total survey days within each month (*n*) are presented below the bars

chimpanzees (which were reportedly associated with EVD) among rural and urban residents during an EVD outbreak, but no changes in reported consumption of five other faunal groups investigated (Duonamou et al., 2020).

In conclusion, we observed that pangolins were available at a major bushmeat market in the capital city of Cameroon despite both national bans and a zoonotic disease outbreak. The continuation of the bushmeat trade in general is likely due to embedded socio-cultural factors around the consumption of bushmeat, and the opportunities for informal employment of the bushmeat trade offers (Chausson et al., 2019; Ingram, 2020; Randolph, 2016). Our results suggest that the trade in pangolins for bushmeat is ongoing, albeit at a lower rate, driven by high sales value of meat and scales, consumer demand, and is enabled by a lack of law enforcement. Our findings suggest that increased enforcement of protected species regulations is required in Cameroon, especially in urban areas, to ensure such species are not sold in urban markets and restaurants. Research is also needed to assess urban wild meat consumers' attitudes towards wild meat/pangolin consumption, zoonotic disease risk and new national legislations, to allow more critical analyses of urban consumption behaviours. Further actions will also be needed to reduce consumer demand for bushmeat in urban areas and transition bushmeat traders into alternative livelihood avenues.

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CONFLICT OF INTEREST

None declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the data providers upon request.

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