Animal Conservation. Print ISSN 1367-9430

FEATURED PAPER

Patterns of bushmeat hunting and perceptions of disease risk among central African communities

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Keywords
hunting; bushmeat; endangered species; conservation; zoonosis; cross-species transmission; education; public health.

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Received 1 February 2005; accepted 12 January 2006

doi:10.1111/j.1469-1795.2006.00030.x

Abstract

There is a great need to determine the factors that influence the hunting, butchering and eating of bushmeat to better manage the important social, public health and conservation consequences of these activities. In particular, the hunting and butchering of wild animals can lead to the transmission of diseases that have potentially serious consequences for exposed people and their communities. Comprehension of these risks may lead to decreased levels of these activities. To investigate these issues, 3971 questionnaires were completed to examine the determinants of the hunting, butchering and eating of wild animals and perceptions of disease risk in 17 rural central African villages. A high proportion of individuals reported perceiving a risk of disease infection with bushmeat contact. Individuals who perceived risk were significantly less likely to butcher wild animals than those who perceived no risk. However, perception of risk was not associated with hunting and eating bushmeat (activities that, compared with butchering, involve less contact with raw blood and body fluids). This suggests that some individuals may act on perceived risk to avoid higher risk activity. These findings reinforce the notion that conservation programs in rural villages in central Africa should include health-risk education. This has the potential to reduce the levels of use of wild animals, particularly of certain endangered species (e.g. many non-human primates) that pose a particular risk to human health. However, as the use of wild game is likely to continue, people should be encouraged to undertake hunting and butchering more safely for their own and their community's health.

Introduction

Hunting for bushmeat or wild game has led not only to declines but also to local extinctions of some wild species (Maisels *et al*., 2001; Milner-Gulland, Bennett & SCB, 2003). The increased accessibility of forests (Wilkie, Sidle & Boundzanga, 1992; Wilkie *et al*., 2000), the increasing ease of transportation (Wilkie *et al*., 2000; Wolfe *et al*., 2000) and the widespread use of new hunting technologies (such as cable snares and guns) have drastically changed traditional hunting patterns. In certain areas these changes have even resulted in subsistence hunting becoming locally unsustainable (Fimbel, Curran & Usongo, 2000). Regional influxes of workers for natural-resource exploitation projects have also created a greater demand for bushmeat (Thibault & Blaney, 2003). In Cameroon, hunting and deforestation are the major factors contributing to the conservation status of 27 endangered mammal species (IUCN, 2003). Despite the apparent unsustainability of hunting of wild animals in central Africa, local current domestic animal production is insufficient (Fa, Currie & Meeuwig, 2003; de Merode, Homewood & Cowlishaw, 2004) and the hunting of wild animals will likely continue at current levels at least until domestic animal production increases.

Contact with wild animals, including hunting, butchering and keeping of pets, can lead to the transmission of diseases that have potentially serious consequences for the health of both individuals and communities. The cross-species transmission of microbes during hunting and butchering has been linked to human outbreaks of monkeypox (Jezek, 1986) and ebola (Leroy *et al*., 2004) and infections with simian foamy virus (Wolfe *et al*., 2004*b*) and primate T-cell lymphotropic

Table 1 Characteristics of the rural Cameroonian villages sampled in the current study (from Wolfe *et al.*, 2004*a*)

Site number	Latitude (°)	Longitude (°)	Altitude (m)	Habitat type	River basin	Language group	End of the road	Number of interviews
I	5.8	10.7	1180	Savanna	(Noun)Sanaga	Shu-pamen	Yes	198
II	5.3	11.0	730	Mosaic	(Mbam)Sanaga	Shu-pamen	No	203
III	4.8	10.8	800	Lowland	Wouri/Sanaga	Tunen	Yes	525
IV	4.2	12.7	680	Lowland	Nyong	Beti-fang	Yes	182
V	3.4	10.6	120	Lowland	Nyong/Lokoundje	Kwasio	No	209
VI	2.3	10.4	400	Lowland	Ntem	Beti-fang	Yes	208
VII	2.4	11.8	560	Lowland	Ntem	Beti-fang	No	173
VIII	2.2	14.1	630	Lowland	(Dja)Congo	Kawzime	No	524
IX	2.4	15.0	330	Lowland	(Dja)Congo	Mpo	Yes	226
X	6.1	9.8	1500	Mosaic	(Cross)Calabar/Niger	Esimbi	Yes	158
XI	6.3	10.8	1700	Savanna	Niger	Limbum	Yes	166
XII	5.2	9.4	350	Lowland	(Cross)Calabar	Kenyang	No	181
XIII	4.9	8.9	100	Lowland	Ndian	Oroko	No	202
XIV	4.5	10.3	200	Lowland	(Dibamba)Wouri	Bassa	No	207
XV	3.7	9.7	0	Mangrove	Sanaga	Duala	Yes	203
XVI	3.4	12.7	650	Lowland	(Dja)Congo	Beti-fang	Yes	203
XVII	5.2	13.6	640	Mosaic	Sanaga	Gbete	Yes	202

viruses (PTLV) (Wolfe *et al.*, 2005). Additionally, hunted primates are known to have a high prevalence of simian immunodeficiency virus (SIV) (Peeters *et al.*, 2002), and contact with fresh bushmeat, during hunting and butchering, is a potential pathway for the interspecies transmission of these viruses. Such interspecies transmissions of SIV represent the most likely explanation for the origins of human immunodeficiency virus (HIV; see Hahn *et al.*, 2000).

Microbial transmission can occur at a number of points in the hunting and butchering process (Wolfe *et al.*, 2000). During hunting, individuals are at risk from the bites and scratches of animals captured alive and from animal blood entering the bloodstream if the hunter has open wounds, particularly on the hands and forearms or the torso when carrying bleeding carcasses. Individuals who undertake butchering are in contact with the animal's blood and body fluids during skinning, opening of the body cavity, removal of organs and cutting of meat. They risk infection through open wounds or through injuries from knives and bone fragments.

Few studies have quantified people's perception of the risks associated with contact with non-domesticated animal blood or body fluids, or the relationship between this perception and associated behaviors. Effective communication of the health risks associated with hunting and butchering may act to reduce the hunting of taxa, which pose a particular risk of disease to humans (e.g. primates; Wolfe *et al.*, 1998). Additionally, some of these taxa are regarded as threatened (e.g. gorillas and chimpanzees; IUCN, 2003) and a reduction in the levels of hunting of these species would have conservation benefits. A better understanding of health risks would also permit individuals to undertake hunting and butchering more safely for their own and their community's health.

To determine the factors influencing hunting, butchering and eating of bushmeat, we collected behavioral data as part of an HIV education and research program in a number of rural areas in southern Cameroon. Individuals in these communities have high levels of contact with non-human primate body fluids (Wolfe *et al.*, 2004*a*) and some volunteers were found to be infected with non-human primate retroviruses, probably contracted during hunting or butchering (Wolfe *et al.*, 2004*b*, 2005). In order to determine the relationship between risk perception and behavior, people were also asked if they perceived a risk when in contact with bushmeat blood.

Methods and materials

Study sites

Seventeen rural village sites in southern Cameroon were selected for this study (Table 1, Fig. 1). Each of these sites represented a small number of villages, each usually less than 5 km apart and located in isolated rural areas, often at the end of winding, unpaved roads. The sites were chosen in different vegetation zones, including two moist savanna sites, two savanna/forest mosaic sites, one mangrove site and 12 rainforest sites. The 17 sites include two each in the south-west, north-west, west, littoral and centre provinces, three in the south province and four in the east province.

Gorillas and chimpanzees (both regarded as endangered, IUCN, 2003) occur in the study area, *Pan t. troglodytes* south of the Sanaga River, *P. t. vellerosus* north of the Sanaga River and *Gorilla gorilla gorilla* on both sides of the Sanaga River (*Gorilla gorilla diehli* occurs in the Takamanda area near the Cameroon–Nigerian border, although not near any of the study sites).

Questionnaires and data collected

Trained Cameroonian staff, including representatives from the Ministry of Public Health and the Ministry of Defense, undertook the health education meetings, enrollment,

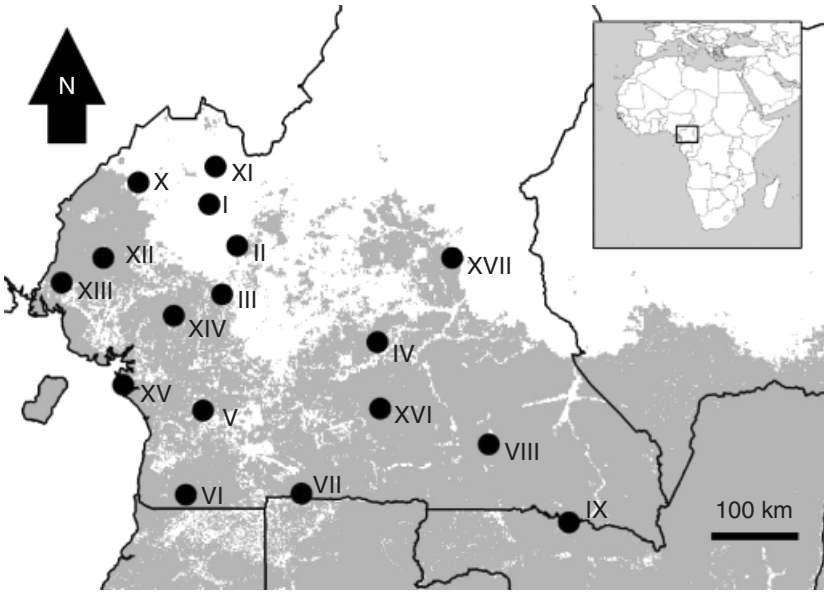

Figure 1 Map showing locations of study sites and the distribution of lowland forest in central Africa (see Wolfe *et al.*, 2004). The vegetation data are taken from Mayaux *et al.* (1997).

documentation of informed consent, questionnaire administration, along with HIV testing and counseling. All data-collection and data-entry staff were trained before fieldwork to ensure data-collection consistency. Enrollment was undertaken during village health education meetings and, as participation was not limited by household, was representative of the surveyed villages. Local translators were used where necessary. Following the education sessions and the informed consent process, individuals were asked to respond to a behavioral questionnaire. The questionnaire was designed to provide basic demographic information and the following data were collected for use in the present analysis for each individual (response is yes/no unless otherwise indicated): age (in years), sex (male/female), top three daily activities (open response), born in district where living, spouses (number), living children (number), religion (Christian, Muslim, animist), from a pygmy ethnic group (i.e. Ba'ka, Bakola, Bagyeli), speaks one of the official languages (French/English) or pidgin, undertook military service, has traveled to a major city in Cameroon or an adjoining country, house roof type [(1) grass, thatched; (2) corrugated tin/tile/tar roof with unfinished ceiling; (3) corrugated tin/tile/tar roof with finished ceiling] and education level [(1) less than 4 years of formal education; (2) 4–6 years of formal education; (3) 7–9 years of formal education; (4) 10–12 years of formal education; (5) secondary school level, (6) university or higher]. Information relating to interactions with wild animals was also collected. Respondents were asked whether they participated in hunting, butchering or eating wild game in general. They were asked whether they took precautions during hunting and butchering and to describe them. Additionally, respondents were asked whether they perceived touching blood from bushmeat as not risky, somewhat risky, risky, very risky or don't know. Because of low responses to the categories somewhat risky and very risky, these two were grouped with risky and two response criteria were used in the analysis: not risky and risky. The vegetation type surrounding each site – moist savanna, savanna/forest mosaic, forest or mangrove – was also noted. Each site was classified on the basis of its altitude [(1) 0–499 m, (2) 500–999 m, (3) 1000–1499 m, (4) 1500 m and over].

We did not measure the effect of price on hunting, butchering and eating of bushmeat during this study. Urban and rural consumers may switch to alternatives (such as fish), where they exist, if the price of bushmeat increases (Wilkie *et al.*, 2005). As many of the rural villages in this study have only a minor export market economy, the effect of price has little relevance as most bushmeat is likely to be consumed directly or exchanged for other goods rather than sold.

Backwards stepwise binary logistic regression was used to determine which demographic, socioeconomic and environmental factors were significantly associated with the hunting, butchering and consumption of bushmeat. Analyses were performed using *logistf* (Firth's bias-reduced logistic regression; Heinze & Schember, 2002) in RGui (2.1.0). All variables were initially included in the models; however, only significant variables (at the $P = 0.05$ level) were retained in the final model. All tests were two tailed.

Demographics

A total of 3970 individuals was interviewed in the 17 sites (average of 234 per site). Men and women volunteered in approximately equal numbers (46% females, 54% males). Participants' ages ranged from 16 to 97 (median = 35). The participants were not equally distributed with regard to age, with a greater representation of younger age groups. Participants reported between zero and six spouses (median = 1) and zero and 26 living children (median = 3). Twenty-eight per cent of participants lived in the same district as they were

born, and 21% of individuals did not speak French or English (the official languages) or pidgin (a language somewhat similar to English and used in the English speaking provinces). Eighty-two per cent of individuals had traveled at least once to a major town in Cameroon or to another country and less than 1% of individuals reported any military service. The majority of the population reported a Christian religion (87%), 12% reported being Muslim and 1% were animist. Three per cent were from pygmy ethnic groups (Ba'ka, Bakola, Bagyeli). In terms of education, 19% reported no formal education, 8% less than 4 years of education, 32% 4–6 years, 28% 7–9 years, 7% 10–12 years, 4% secondary level and less than 1% university education. In terms of house roof type, 26% lived in houses with a thatched or woven roof without a ceiling, 61% in houses with a metal/tile/tar roof without a ceiling and 13% in houses with a metal/tile/tar roof with a ceiling.

Results

Hunting and other activities

Agriculture (for home use) was the most common daily activity reported by respondents (71% of $n = 3970$). Figure 2 shows the 10 most commonly reported daily activities. Agricultural, domestic, hunting and fishing activities were the most important daily activities, with 93% of respondents listing them in their top three daily activities.

A total of 98% of respondents reported eating bushmeat, 83% reported butchering bushmeat and 42% reported hunting bushmeat. Ten per cent of the individuals interviewed reported hunting bushmeat for sale/barter or for markets and 17% reported hunting bushmeat for home consumption in their top three daily activities (some individuals reported both). Each hunter ($n = 1660$) employed numerous hunting techniques, with 81% of hunters reporting the use of wire snares, 31% guns, 25% machetes, 18% hand capture, 4% bow and arrow and 4% non-wire snares. For the purposes of the following results, a hunter is someone who reported hunting activities, regardless of the reported top three daily activities.

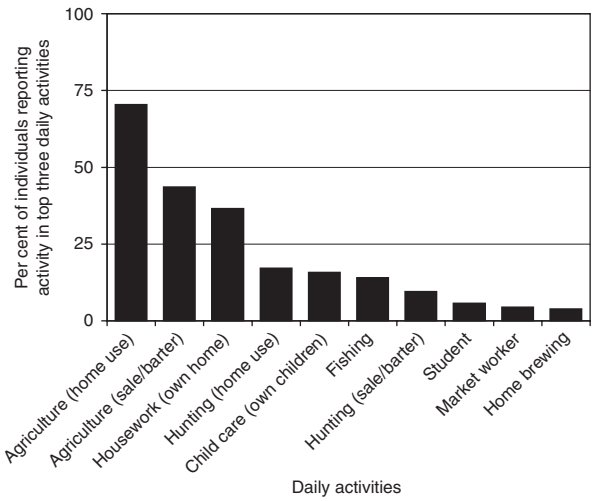

Figure 2 Per cent of individuals reporting different daily activities (the top 10 are shown).

Risk perception and avoidance

A majority (74% of $n = 2003$) of respondents reported that they perceived contact with bushmeat blood or body fluids as risky. Only 4% of hunters ($n = 1660$) and 2% of people reporting butchering ($n = 3281$) indicated that they took precautions against contact with animal blood and fluids while hunting and butchering. During hunting, the most common precautions that hunters ($n = 1660$) reported included generally being careful (2%), washing hands (1%), avoiding contact with blood (1%), draining blood from carcasses (0.4%) and suitable clothing (0.1%). During butchering, the most common precautions that people reported were similar and included ($n = 3281$) generally being careful (0.6%), washing hands (0.5%), suitable clothing (0.1%) and avoiding contact with blood (0.1%).

Factors influencing hunting, butchering and eating of bushmeat

Table 2 shows the behavioral and socioeconomic factors significantly related to reporting of hunting, butchering and eating of bushmeat, the odds ratio of each variable and its statistical significance.

Table 2 Factors affecting participation in the hunting, butchering and eating of bushmeat determined by binary logistic regression models

Model	Predictor	OR (95% CI)	*P*-value
Hunting[a]			
	Savanna	0.25 (0.14–0.44)	<0.0001
	Forest	3.82 (2.92–5.05)	<0.0001
	Altitude	1.65 (1.42–1.93)	<0.0001
	Male	39.25 (30.27–50.91)	<0.0001
	Roof type	0.44 (0.38–0.52)	<0.0001
Butchering[b]			
	Mangrove	0.30 (0.20–0.44)	<0.0001
	Savanna	0.44 (0.29–0.67)	<0.001
	Forest	1.88 (1.40–2.48)	<0.0001
	Male	0.39 (0.31–0.49)	<0.0001
	Local	0.73 (0.58–0.90)	<0.01
	Travel	1.92 (1.46–2.48)	<0.0001
	Roof type	0.53 (0.45–0.62)	<0.0001
	Risk	0.79 (0.71–0.89)	<0.0001
	Education	1.13 (1.04–1.21)	<0.01
Eating[c]			
	Mangrove	0.13 (0.08–0.23)	<0.0001
	Roof type	0.60 (0.41–0.89)	<0.05
	Education	1.36 (1.14–1.63)	<0.001

Odds ratios (OR) and 95% confidence intervals (CI) are given for each predictor variable.
[a]Likelihood ratio test = 1490.278, 3 d.f., $P = 0.0001$, $n = 2937$.
[b]Likelihood ratio test = 314.6293, 9 d.f., $P < 0.0001$, $n = 2937$.
[c]Likelihood ratio test = 57.55793, 3 d.f., $P < 0.0001$, $n = 2937$.

Gender was one of the most important factors related to bushmeat hunting and butchering. Men were 39 times more likely to hunt than women and women were two times more likely to butcher than men. Surrounding vegetation type (moist savanna, forest, mangrove) was also important: people living in the forest were almost four times more likely to hunt and almost twice as likely to butcher wild animals compared with those living in villages surrounded by other vegetation types. Residents of higher altitude areas were more likely to report hunting.

In terms of socioeconomic influences, individuals living in houses with roofs made from corrugated iron and houses with interior ceilings were less likely to report hunting, butchering and eating wild animals than individuals living in homes with thatched roofs.

Individuals who had spent more time in formal education were more likely to butcher and eat wild animals and individuals born and living locally were less likely to be involved in butchering than individuals who had migrated into the district. Individuals reporting travel to a large city in Cameroon or an adjacent country were almost twice as likely to report butchering wild animals.

Perception of risk was also a significant factor: individuals who thought there was a risk were 27% more likely to report butcherng wild animals than those who thought there was no risk.

Discussion

Of the factors related to involvement in hunting and butchering of wildlife, gender and the type of landscape surrounding the village were the two most important.

Although men were much more likely to be involved in hunting than women, around 10% of women reported hunting activities and, compared with men, women were twice as likely to be involved in the butchering of wild animals. The involvement of women in these activities is reinforced by the recent finding (in the same villages) that three out of 10 individuals who were infected with simian foamy viruses, probably from bites from non-human primates, were women (Wolfe *et al*., 2004*b*). This highlights the importance of involving local women in conservation and healthy-hunting education campaigns, and also in the development of local hunting management plans, an involvement that may sometimes be difficult given the social structures in some rural central African villages.

People from villages in rainforest areas were more likely to hunt and butcher wild animals than people from villages in other regions. Although other studies have suggested that the savanna has higher wild animal production potential (Robinson & Bennett, 2004), there are a number of reasons as to why hunting may be lower in the Cameroon savanna sites of this study. Meats of domestic animals (such as goat and beef) are generally more available in drier areas of Cameroon compared with forests because of the difficulties of cattle production in lowland forest and the lack of pastures. Additionally, higher human population densities in more arid regions, in part because of more productive soils (Maisels *et al*., 2001), may have led to a reduced supply of wild animals (Fa *et al*., 2003). The relationship between house roof type and hunting, butchering and eating of bushmeat may also be associated with population density as access to roofing materials was not uniform across the study sites. More remote, less populated areas are less likely to have access to materials for tin roofing and plywood ceilings and more access to forests for hunting, butchering and eating wild animals. Additionally, in the mangrove site, the higher availability of fish, a bushmeat substitute (Wilkie *et al*., 2005), probably decreases the demand for bushmeat in that site.

Travel and migration were important factors influencing the butchering of wild animals. People who reported travel to a major city and people who were not born in the area where they lived were more likely to butcher wild animals. Although we did not examine reselling or transporting of wild animals, this indicates that a better knowledge of external markets and transport networks probably allows people who have migrated or traveled to become effective intermediaries in the bushmeat commodity chain (Cowlishaw, Mendelson & Rowcliffe, 2005).

Altitude influenced participation in the hunting of wild animals, with people at higher altitudes more likely to be hunting. This may have been driven by the fact that the very remote sites in this study, which rely heavily on bushmeat, were inland sites of medium altitude. A number of the sites at lower altitudes (0–350 m) were in coastal or hinterland areas, where markets for fresh and dried fish may be more accessible. In these areas people may rely less on hunting for daily food requirements.

Education influenced both butchering and eating of wild animals. People with higher education were more likely to butcher and eat bushmeat; these individuals may be more likely to have salaried employment or to be participating in more lucrative activities and hence have more money available to buy fresh or prepared bushmeat.

Significantly, among the many individuals reporting hunting and butchering bushmeat, we found that a high percentage acknowledged there was a risk associated with exposure to the blood and body fluids of wild animals. Further, individuals perceiving contact with blood and body fluids of wild animals as risky were significantly less likely to be involved in butchering wild animals than those not perceiving a risk.

The eating and hunting of wild animals involves significantly less contact with raw blood and body fluids than butchering, which can include sprays of blood during cutting, contact with blood during handling of organs and meat cuts, and also involves risks of cuts from cutting utensils (usually a machete in rural areas) or injuries from claws and bones. Given the acute nature of body fluid contact during butchering, some individuals may be acting on their perception of risk by not participating in this higher risk activity. However, at least one of the zoonotic retroviruses identified in this population, SFV, (Wolfe *et al*., 2004*b*) is most likely transmitted through saliva during bites from live wild primates (Jones-Engel *et al*., 2005), indicating

that both hunting and butchering may be key activities for cross-species transmission of zoonotic pathogens.

We did not investigate why individuals in these communities perceived contact as risky, and this perception may in fact be cultural or mystical rather than medical. However, the high percentage of individuals acknowledging the risk and who already report taking steps to avoid infections suggests that the population may be receptive to public health campaigns which discuss the health risks of hunting and butchering. Although additional research is necessary to determine if changes in the perception of risk would affect participation in risky behaviors, education programs acting to deepen the understanding of potential pathogens and the routes of infections associated with hunting and butchering may lead to a reduction in the apparently frequent cross-species transmission of pathogens (Wolfe *et al*., 2004*b*, 2005).

Despite the health and conservation issues at stake, the use of wild animals will probably continue in many communities because of the underproduction and undersupply of domestic animal meat (Fa *et al*., 2003; de Merode *et al*., 2004). Meanwhile, neither health- and conservation-education campaigns nor law enforcement are likely to have much impact on reducing hunting and wild animal use. As such, education programs should encourage individuals who choose to hunt and butcher wild animals to do so more safely for their own and their community's health. For example, individuals should be encouraged to avoid butchering or handling meat if they have injuries on their hands or arms and to immediately wash any bites, scratches, cuts or injuries obtained during hunting or butchering.

Given the results of this survey, it is of particular importance to reinforce the potential for infections during hunting and butchering as this may be overlooked by some hunters. Individuals can be placed at risk of zoonotic infection from the bites and scratches of live animals, and from direct contact with fresh blood draining from animals that are being transported, as well as from blood and body fluids during the butchering process.

Any community health education programs should be particularly careful to use culturally appropriate language and methods. Popular media treatment of the connection between emerging infections and the hunting of monkeys and apes in central Africa has suffered wide cultural divides and insensitive reporting. For example, reporting on the origins of HIV in chimpanzees sometimes includes references to hunting as a form of cannibalism (see McNeil, 1999; Peterson, 2003). Such arguments have alienated some central African politicians, researchers and health workers (e.g. see Schoofs, 1999), many of whom consume bushmeat and some of whom are responsible for education and communication within their communities. Such alienation will prevent the delivery of important health messages and the potential health and conservation benefits.

We recommend education interventions that would act to reduce unsafe contact with wild animal blood and body fluids, through changes in hunting and butchering behaviors. Particular efforts should be made to include women in these interventions. However, we also recommend that these interventions take place within the context of broader programs that aim to improve rural people's livelihoods and infrastructure, and reduce poverty and corruption. Without efforts to resolve these related problems, the unsustainable harvesting of bushmeat will continue.

Acknowledgements

These studies were conducted in the context of a community-based HIV research and prevention campaign. The study protocol was approved by the Johns Hopkins Committee for Human Research (CHR), the Cameroon National Ethical Review Board and the HIV Tri-Services Secondary Review Board (HSRRB). In addition, a single project assurance was obtained from the Cameroonian Ministry of Health and accepted by the US National Institutes of Health Office for Protection from Research Risks. We thank the government of Cameroon for permission to undertake the study. Financial support for this work was provided by a grant from the Johns Hopkins Bloomberg School of Public Health Center for a Livable Future (to N. W.), the V. Kann Rasmussen Foundation (to D. B.), the National Institutes of Health Fogarty International Center (grant # 5 K01 TW000003-05 to N. W.) and the NIH Director's Pioneer Award Program (DP1-OD00370). We thank the US Embassy in Yaoundé for their support, the staff of Walter Reed Johns Hopkins Cameroon Program for assistance with fieldwork, data collation and specimen processing, the peer reviewers and editor for their constructive input and finally we also thank the study participants.

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Animal Conservation. Print ISSN 1367-9430

CORRIGENDUM

Patterns of bushmeat hunting and perceptions of disease risk among central African communities

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In LeBreton *et al.* (2006), the following error was published in the last sentence of the Results section (page 5 of the online paper).

Perception of risk was also a significant factor: individuals who thought that there was a risk were 27% more likely to report butchering wild animals than those who thought there was no risk.

The text was incorrect and should have read:

Perception of risk was also a significant factor: individuals who thought that there was no risk were 27% more likely to report butchering wild animals than those who thought there was a risk.

We apologize for this error.

Reference

LeBreton, M., Prosser, A.T., Tamoufe, U., Sateren, W., Mpoudi-Ngole, E., Diffo, J.L.D., Burke, D.S. & Wolfe, N.D. (2006). Patterns of bushmeat hunting and perceptions of disease risk among central African communities. *Anim. Conserv.* DOI:10.1111/j.1469-1795.2006.00030.x

