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An Exploration of Bats Consumption Behaviour and the Awareness of Zoonotic Diseases in Bamenda, Northwest Region, Cameroon

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Abstract**—** *The recent increase in zoonotic viral disease outbreaks among humans have mainly been accounted to human bushmeat consumption. Many of the recently emerging highly virulent zoonotic diseases like Ebola have a likely bat origin. The study has shown a significant relationship, $X^2 = 23.870$ df = 1 at $P < 0.05$ on the killing of bats due to their zoonotic diseases. In addition, the study revealed a positive correlation, $R^2 = 0.972$ at $P = 0.05$ on bats killing due to their nuisance. The research has also shown a significant relationship, $X^2 = 10.848$ df = 3 at $P = 0.013$ on the killing of bats to control their population. The research has shown a correlation $R^2 = 0.312$ at $P < 0.05$ on the prevention of bats population increase. The results further revealed that bats are well known (54.23%) in zoonotic disease transmission. Moreso, the study showed that many people kill these animals for food (51.41%) though they know very well that they might be infected with zoonotic diseases by eating them. Educational efforts are needed in order to prevent future spillovers of bat-borne viruses to humans, and to further protect bats from unnecessary and destruction. The national government of Cameroon can use the prevention of bats consumption campaigns due to their zoonotic infection to enhance the conservation of bats.*

***Keywords*— Ebola, zoonotic diseases, Bat consumption, disease transmission, Conservation.**

I. INTRODUCTION

Over the past decades, the emergence of zoonotic viruses (those that are naturally transmitted between vertebrate animals and humans) from bats have been the subject of increasing attention from both scientists and the general public (Quammen 2013). Identification of bats as natural hosts for emerging viruses has important implications for bat conservation. Wildlife populations constitute a large and often unknown reservoir of infectious agents (Chomel, *et al*. 2007), playing a key role in emergence by providing a "zoonotic pool" from which previously unknown pathogens may emerge (Morse, 1995). The emergence of many zoonoses can be attributed to predisposing factors such as global travel, trade, agricultural expansion, deforestation and urbanization; such factors increase the interface and the rate of contact among human, domestic animals and wildlife populations, thereby creating increased opportunities for spill-over events to occur (Daszak, *et al*, 2000; 2001). Lederberg, *et al.* (1992) describe these changes as providing an "epidemiological bridge" that facilitates contact between the agent and the naive population. Daszak, *et al.* (2000) suggest that disease emergence from wildlife sources is primarily an ecological process, with emergence frequently resulting from a change in the ecology of the host or the agent or both. They suggest that most emerging diseases exist within a finely balanced host-agent continuum among wildlife, domestic animals and human populations. Any changes in the environment or host behaviour provide agents with favourable new ecological niches, allowing them to reach and adapt to new hosts and spread more easily between them (Morens, *et al*. 2004). Pathogen adaptation and virulence are additional dynamics that have direct linkages to the ecological systems in which they occur. Regardless of whether the system is natural or agricultural, the key to pathogens' survival is their ability to adapt to the ever-changing environment. In natural systems, loss of biodiversity, changes in landscape ecology, climate change and other variables pose innate adaptation challenges for pathogens.

Emerging infectious diseases (EIDs) are defined as infections that have newly appeared in a population or have existed previously but are rapidly increasing in incidence or geographic range (Morens, *et al.*2004). Emerging infections have been a familiar threat since ancient times, with pandemics of cholera, influenza, smallpox and measles causing the deaths of millions of people worldwide. Since the 1940s, the incidence of EIDs has risen significantly and more than 300 infectious diseases have emerged (Jones *et al.,* 2008), most of which are viruses (Taylor, *et al.*2001). More than 60 percent of EIDs are of zoonotic origin (Jones et al., 2008), and in the last decade of the twentieth century zoonotic EIDs constituted 52 percent of all EID events (Taylor, *et al.*2001). Of all EIDs, zoonoses from wildlife represent the most significant, growing threat to global health. Among the zoonotic EIDs to emerge since the 1940s, the majority of EID events have originated in wildlife (71.8%) and their incidence has continued to increase (Jones *et al.,* 2008). Emerging zoonotic pathogens have been identified in ungulates, carnivores, rodents, primates, bats and other mammal and non-mammal species (Woolhouse *et al.* 2005). The best known EID of modern times, acquired immunodeficiency syndrome (AIDS), emerged from non-human primates around the early twentieth century (Worobey *et al*., 2008). AIDS, which is caused by infection with one of two types of the human immunodeficiency virus (HIV), now threatens to surpass the Black Death of the fourteenth century and the 1918 to 1920 influenza pandemic, each of which killed 50 million people (Morens, *et al.*.2004). Other recently emerged diseases, including Ebola virus, hantavirus, Nipah virus, West Nile virus, severe acute respiratory syndrome (SARS) coronavirus and highly pathogenic avian influenza (HPAI) virus, are examples of emerged or emerging zoonoses that have had (or threaten to have) a significant impact on human health. Understanding the factors that lead to pathogens jumping species or to increased contact among wildlife, livestock and humans is critical to understanding how diseases emerge from wildlife.

Historically, wildlife diseases have been considered important only when agriculture or human health are threatened (Daszak, *et al.*2000). However EIDs are also a significant threat to species conservation and biodiversity. While wildlife species can be considered reservoirs of pathogens with the potential to infect humans and livestock, wildlife populations are themselves also threatened by introduced pathogens. Spill-over of infectious agents to wildlife populations is a particular threat to endangered species, where the presence of infected reservoir hosts can lower the pathogen's threshold density and lead to local population extinction (Daszak, *et al*.2000). For example, white nose syndrome, an emerging fungal pathogen of hibernating bats in northeastern North America first observed in 2006, has caused unprecedented bat mortality leading to losses of up to 95 percent in some hibernacula (Blehert *et al.,* 2009; Wibbelt *et al*.,2010). Another (non-bat) example of the impact of EIDs on wildlife populations is high-pathogenicity avian influenza. While low pathogenic avian influenza was probably introduced from free-ranging waterfowl into poultry, the change from low to high pathogenicity occurred in poultry and spill-back into wildlife populations. This scenario has been responsible for a population-level impact on bar-headed geese (*Anser indicus*), as more than 6 000 individuals died during a single outbreak at Qinghai Lake in 2005 (Chen *et al.,* 2006; Zhou *et al.,* 2006).

In recent years, bats have been implicated in numerous EID events and are increasingly recognized as important reservoir hosts for viruses that can cross species barriers to infect humans and other domestic and wild mammals (Calisher *et al*., 2006). Bats are second only to rodents in numbers of living genera and species, and are the largest order of mammals in overall abundance (Sulkin and Allen, 1974). They are unique in their vagility (potential for long-distance travel), and often aggregate in very large colonies (Turmelle and Olival, 2010). However, despite their abundance, relatively little is known about the species from which zoonotic viruses emerge to cause human disease (Calisher *et al.,* 2006). Much of the information gathered on the role of bats in the maintenance and spread of viruses has been from species of Microchiroptera (insectivorous bats), and there is relatively little information available for members of the suborder Megachiroptera (flying foxes and fruit bats), Mackenzie, Field and Guyatt (2003). The role of bats in viral disease is well established (Sulkin and Allen, 1974), particularly their role as hosts for alpahviruses, flavirviruses, rhabdoviruses and arenaviruses (Mackenzie, *et al*. 2003). Calisher *et al*. (2006) report on 66 viruses that have been isolated from or detected in bat tissues of 74 species.

Bushmeat consumption is a long standing tradition in Cameroon and other parts of Sub-Saharan Africa where the population of wildlife has served as a protein source for centuries. Consequently, the population of wildlife has decline drastically to the edge of extirpation, a possibility of some species extinction. However, the consumption of wildlife such bats has recently been met with unprecedented challenges due to the research declaration of Ebola's origin from bats and the primates. Hence, the purpose of this survey in Bamenda city was to explore the conservation link on bats consumption and the awareness of the potential risk of contracting a zoonotic disease such as Ebola.

II. MATERIALS AND METHOD

Description of the study area

Bamenda is the capital of the North-west Region of Cameroon, with a population of approximately 400 thousands, it is located between latitude 4°50' - 5°20'N and

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longitude 10°35’ - 11°59’E. The altitude ranges between 950-1500 m above sea level, with flat woody lowland in some areas. The drainage system is very rich with streams and springs emanating from the northern belt. The zone has two seasons, the dry and wet seasons ranging from November - April and May – October respectively. The mean annual rainfall is about 2200 mm with July, August and September registering the highest rainfall and December the lowest. Also, the mean annual temperature is about 20.67°C with January and February registering the highest and July, August and September the lowest temperature (Yuninui, 1990). Unsustainable farming practices have largely destroyed the forest vegetation to an extent and depleted soil fertility. Similarly, years of overgrazing, burning of grasses, and increasing herd size, has severely degraded the remaining patches of grasslands. According to (Yuninui, 1990), the vegetation of this region is both natural and cultivated. The cultivated vegetation consists of planted trees like cola nut, eucalyptus, raffia palm and other fruit trees. The wildlife species in this area is dominated by rodents and bats.

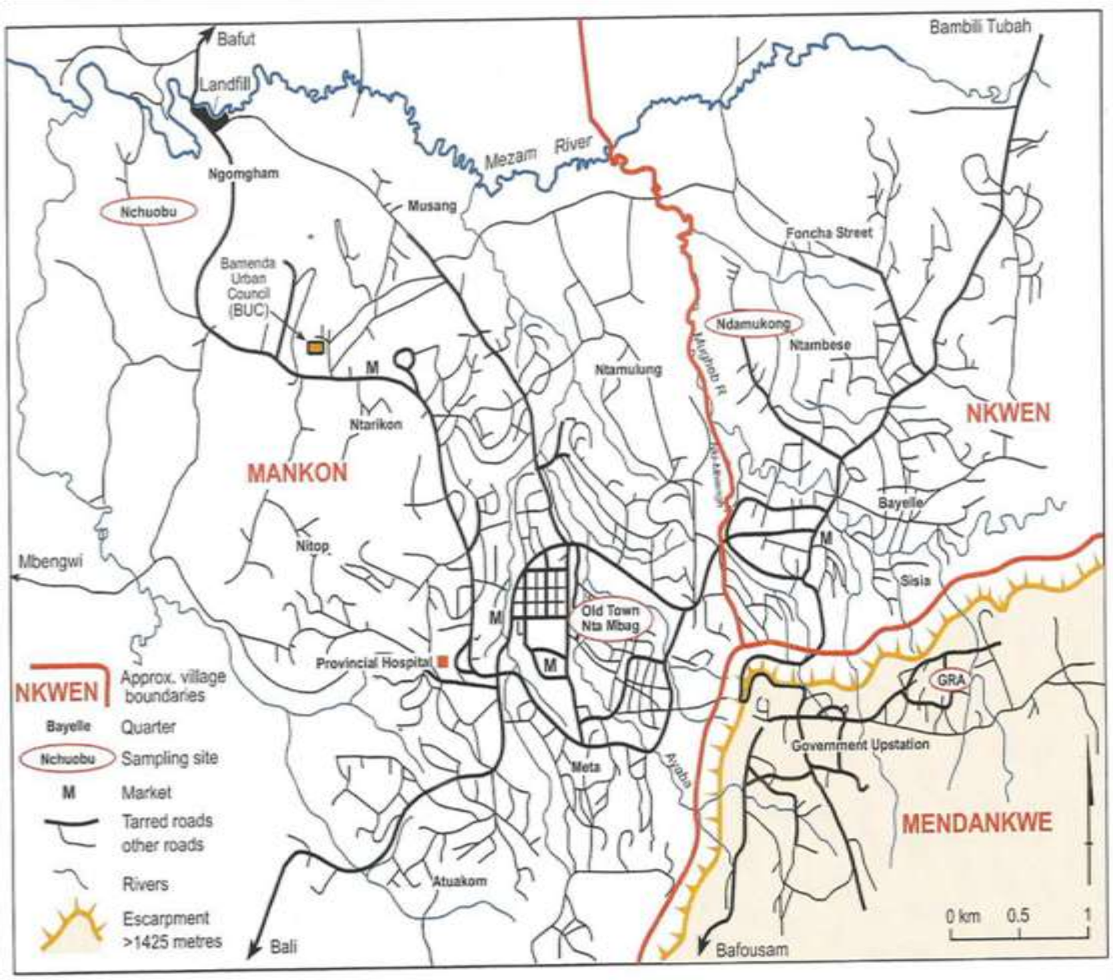

Fig.1: The map of Bamenda city

Source: Bamenda City Council (2011)

Data Collection and analysis

During the data collection process the communities selected for questionnaire administration have been assessed to be where there were bats roosting sights (Ajabji *et al.*,2008). The questionnaires were all written and administered in English language. Prior to the the administration of questionnaires a meeting was organized in each of the target communities for familiarization and to discuss on the purpose of the survey. This facilitated the clarity and knowledge on the purpose of the study and also encouraged respondents to open up during questionnaire administration. The survey was also conducted on a one-on-one interview in which the interviewer filled the questionnaire based on the respondents’ answers, especially for the illiterate respondents. This approached helped to minimize misunderstanding of questions by the respondents,

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increasing the reliability of collected information. Due to time and resource restrictions convenience sampling was most appropriate method for the distribution of questionnaires. Despite this, the sampling frame baseline information was available and sample characteristics were monitored throughout data collection. This meant sampling effort could be targeted as the data collection period developed. Targeted sampling was based upon a cluster sampling approach using the five neigbourhoods for the sampling. Population figures were known for each of the regions and so representative proportions for each could be calculated in relation to the overall sample (Paul Barnes, 2013). A total of 525 questionnaires were administered to respondents. The data collected was analyzed by using chi-square and correlation statistical models and results displayed on bar charts and tables.

III. RESULTS

The result has shown that bats are well known 54.23% in zoonotic disease transmission (fig. 2). Though bats might be a source of human infection, the question why so many people across the entire nation are consuming bats is yet to be understood. The bats consumption preference might also have some traditional roots. Some say that their ancestors consumed these bats for decades and did not contract or die of Ebola. Some, who do not believe these animals could be a potential source of zoonotic infection, serve as a source of bat-eating encouragement motivation to potential consumers. It is also believed that even those who do not eat bats are not doing so because of the fear of contacting zoonotic diseases but for reasons of the bats morphological unattractive structure. As many bat-borne viral diseases have high lethality rates for humans, preventing spillover events are of central importance. In particular, spillover by direct contact to bats, such as via bites or bat consumption, may bear severe risks to humans that could be minimized by educational programs (Kingston 2016). Reducing the risk of outbreaks of zoonotic viruses may also lead to more positive attitudes towards bats, which may further be increased by highlighting their ecological importance as pollinators, seed dispersers and pest control for agriculture (Ghanem and Voigt 2012). Moreover, conservation measures that promote the preservation of bat habitats serve a dual role as they can decrease the contact zone between bats and humans, thus reducing the risk of spillover.

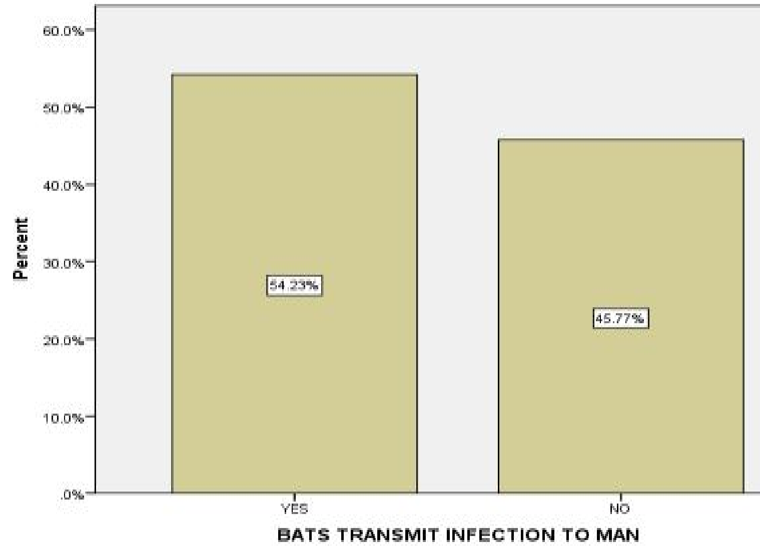

Fig. 2: Bats are considered to transmit infections zoonotically

One of the key issues both for conservation and public health is the direct transmission of Ebola via wildlife markets. In South-East Asia, flying foxes are hunted regularly for the purpose of food (Mickleburgh *et al.* 2002; Mildenstein *et al*. 2016), sometimes even authorised by the local Wildlife Department such as in Malaysia (Breed *et al.* 2006). Likewise, fruit bats are consumed regularly throughout Africa (Mickleburgh *et al*. 2009; Mildenstein *et al*. 2016). Since bats are suggested as potential reservoir for the recent outbreak of Ebola. Guinea banned the selling of bats in markets(Gatherer 2014). Educational efforts to reduce the threat both to public health by zoonotic diseases and to the conservation of local bat populations are challenging, as they are usually impeded by the lack of understanding of entrenched cultural behaviours and social components (Pooley *et al.* 2015; Kingston 2016).

In Ghana, for example, where the consumption of bats is part of the local culture and traditions, a survey revealed that knowledge about the ecological and economical value of bats would not make people refrain from killing and eating bats. Some trees with colonies of *Eidolon helvum* in Yaoundé, Cameroon have been cut down after bats were suspected to be the source of the recent Ebola outbreak in western Africa (Pooley *et al.* 2015). Usually, the direct economic benefit from selling hunted bats is more valuable to an individual person than the indirect, not always obvious economic value of bats, for example, for agriculture. However, about half of the hunters stated they would stop hunting bats if they could make them sick (Kamins *et al.* 2014). This highlights the potential effectiveness of public education, but careful consideration is needed to avoid demonising bats in the process (Pooley *et al.* 2015). The recent Ebola epidemic in western Africa for example has led to an increase in the persecution of bats, with roosts being destroyed and colonies being killed by communities. Although preventing bats from being consumed may have higher priorities due to public health reasons, the culling of whole colonies as a likely result may be much more of a threat for the conservation of bats than the bushmeat trade (Pooley *et al*. 2015).

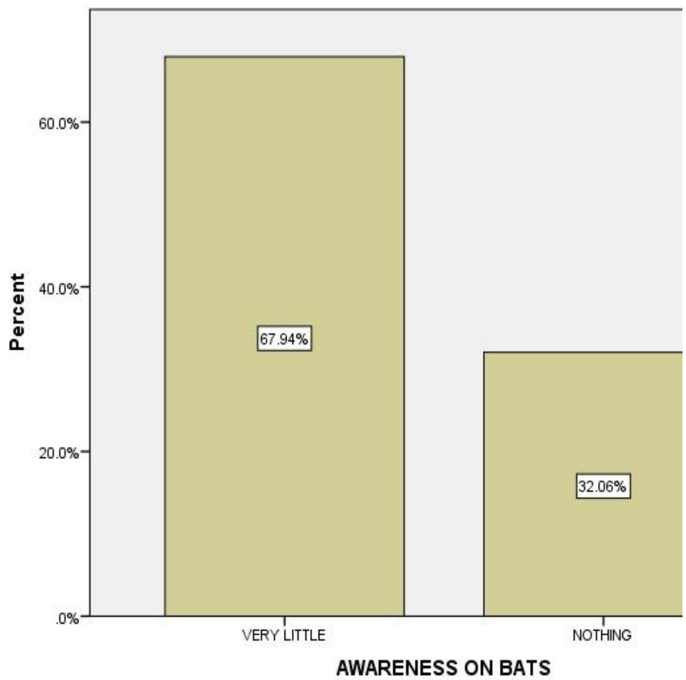

Fig.3: The inhabitants Awareness of bats existence

The survey has shown that the inhabitants are aware of the existence of bats in Bamenda city 67.94% according to figure 3. However, the knowledge on bats is restricted to the morphology, with very little knowledge on the ecological activities of the animals. The farmers in this area have known a little about the activities of bats because of the locations of their farms, where the bats would always be flying around eating farm fruits like ripe banana, avocado, apple etc. Some of these farmers even stated that the bats should be eradicated due to the destruction caused to their farm crops resulting to a relative low yield. The study also found that about 32.06% of the respondents do not know that bats are existing in Bamenda city. This might also be due to the fact that they do not farm where they supposed to encounter these animals. Given that bats spend roughly half their lives in the roosting environment, it is not surprising that roost sites play a large role in the biology and ecology of bats. Most bat species choose concealed roost sites, such as caves, mines, cavities or crevices in rocks and trees, under foliage, and in modified human-made structures (Kunz and Pierson, 1994). Some colonially roosting megachiropteran species form conspicuous aggregations (also called "camps"), often using exposed tree branches (Mickleburgh, Hutson and Racey, 1992). Roost site occupation may be seasonal (during hibernation or maternity periods) or perennial, lasting year round in the same location for many years (Kunz and Pierson, 1994). In addition to their day-time roost locations, many bats also aggregate in night-time roosts, which are temporary and often close to feeding locations. Bats are known for forming the largest aggregations of all mammals. Depending on the species, season, and location of the roost, colony sizes range from a few to millions of individuals. As with roost site occupancy, aggregating behaviour is a species-dependent trait, occurring seasonally.

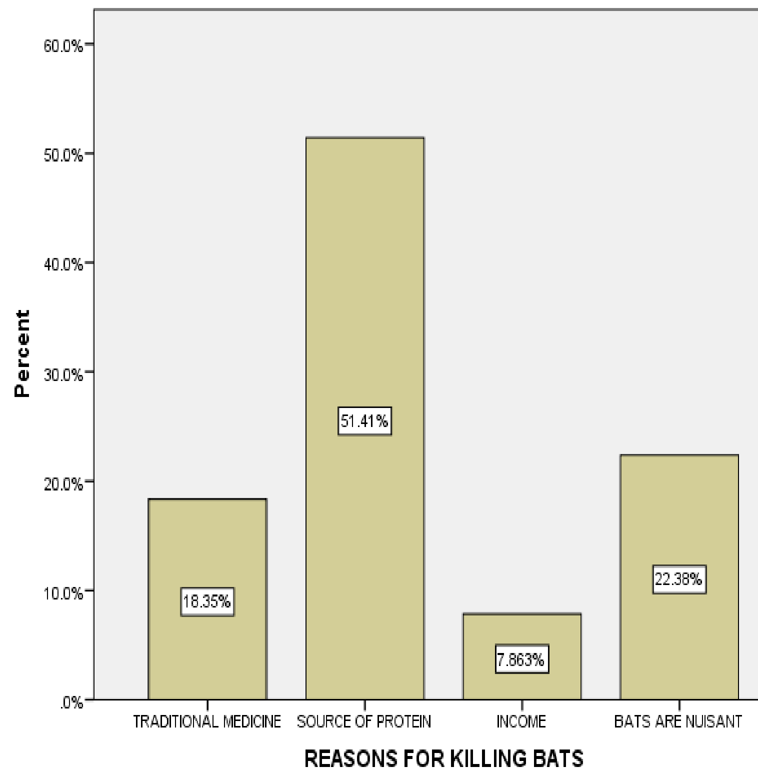

Fig.4: The reasons for bats killing

The results have revealed that 51.41% of the people kill these animals for food though they know very well that they might be infected by eating them (fig.4). The reasons why bats are stilled killed and consumed in some parts of Cameroon even with knowledge on the risk of contacting Ebola are unknown. It might also be due to the craving love that so many people have developed for bushmeat consumption over time. The bats consumption rather seems to be growing around the country due to the growing hunger and poverty. So many people seem to be diverting their source of protein feeding-interest to the bats as an alternative source of protein due to poverty. About 22.38% of the respondents stated that they kill bats because they are considered to be a nuisance. Bats are a serious crop pest in Cameroon and most farmers are suffering low yields because of their destructive activities in the farms. Thus, an average farmer seems to consider this method as the only means of crop protection. The respondent population of 18.35% stated that the bats are useful in the traditional medicine. The recommendation for bats by the spiritualists to their clients might be for treatment and protection for those who still believe in this spiritual healing tradition. Today, most of these traditional practices are rejected by the practical Christian class of the society. This class seems to be of the opinion that bats should be conserved for watching and not killing them for unnecessary reasons. Only 7.86% of the respondent population acknowledged that bats are killed for income generation. This explains the reason why bats are not common in the local markets and even when seen are smoked. Bats harbour viruses that may become zoonotic. Circumstances facilitating spillover include direct contact with bats (bites, scratches, consumption of bats), contact with material contaminated by bat saliva, faeces or urine and amplification via intermediate hosts such as domestic animals or other wildlife species. Conservational actions are not only important to prevent spillovers, but also because emerging zoonotic viruses often lead to persecution of bats. In order to reduce the transmission risk of viruses from bats to human and livestock and to protect bat species at threat, educational efforts are needed. However, entrenched cultural and social components often act as barriers to efficient changes on how people think about and respond to bats.

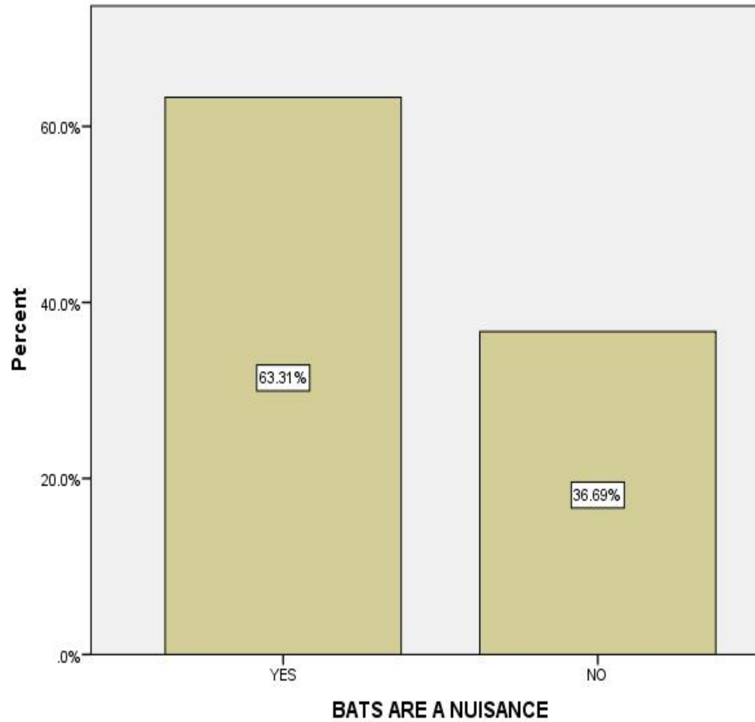

Fig.5: Bats consideration as nuisance

As revealed by a respondent score of 63.31%, bats are a source of problems in farms, gardens, buildings due to their destructive activities and perching for roosting especially in the day period (fig.5). So many people in Cameroon do not enjoy seeing bats in their residential areas. In farms bats are reducing crop yields by their feeding on a variety of fruits in the night period. The nocturnal activities of bats in residential areas are known to be very disturbing and noisy, littering the environment. However, 36.89% of the respondents seem not to buy the idea of bats consideration as a nuisance. The reasons might be because they are a source of bushmeat for many families, thus, the bat population growth be through conservation. The huge roosting colonies built on some compound trees like the palms sometimes litter these compounds, thus, regular and routine clean-ups were some of the challenges sighted by the inhabitants.

Table.1: Killing of bats due to their nuisance

Correlation Tests					
		Value	Asymp.Std Error[a]	Approx. T[b]	Approx. Sig. (2-sided)
Interval by Interval	Pearson R -	.002	.045	- .035	.972[c]
Ordinary by Ordinal	Spearman Correlation	.001	.045	.033	.974[c]
Linear-by-Linear Association					
N of Valid Cases	406				

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on normal approximation.

The study has revealed a positive correlation, R^2 = 0.972 at P = 0.05, on bats killing due to their nuisance activities (tab.1). So many people in this area and other parts of Cameroon believe that bats are a nuisance, thus, they should be killed. The crop destruction caused by bats during their feeding activities at night has been of great concern to the farmers. The farmers has always complained and accused the bat-presence for their low yields in the farms, often attacked by the bats.

Table.2: Bats killing to control their population

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.848	3	.013
Likelihood Ratio	11.548	3	.009
Linear-by-Linear Association	2.912	1	.156
N of Valid Cases	496		

The survey has also shown a significant relationship, X^2 = 10.848 df = 3 at P = 0.013, on the killing of bats to control their population (tab.2). The inhabitants of the city of Bamenda seem to believe the only way out of the nuisance and problems caused by the bats population is killing them. But most seem to do this for the purpose of consumption, a cheaper source of protein. It is believed that the killing of bats is increasing with the human population increases.

Table.3: Bats killing to prevent zoonotic infections

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.870	1	.000
Likelihood Ratio	24.370	1	.000
Linear-by-Linear Association	23.822	1	.000
N of Valid Cases	496		

Table 3 has shown a significant relationship, X^2 = 23.870 df = 1 at P < 0.05, on the killing of bats due to their zoonotic diseases. However, not all Cameroonians are aware of the zoonotic potential ability of bats to humans, but some who know prefer to kill them especially when they colonize their residential areas. This killing seems to be as a measure purposed to scare the bats from their gardens and farms. The direct persecution of bats often seems to be the most effective way to deal with bat-borne diseases to members of the public. Killing of bats has long been acceptable, even if they are protected. Even though culling may be officially banned and thus not supported by authorities or governmental programs, large-scale killing of bats or the destruction of roost trees may still be commonly practiced in areas where zoonotic diseases are spreading. In Australia, for example, flying foxes are frequently harassed and killed, both legally (under permits issued by state wildlife management agencies) and illegally. This happened most prominently during periods when Hendra virus emerged in Australian flying fox populations (Roberts *et al.* 2012). Half of the flying fox species native to Australia have declined about 30 % in population size during the last decade, and killing of bats usually does not lead to legal measures (Booth 2005). Instead of reducing the viral prevalence, this may therefore lead to the exact opposite. In the attempt to reduce rabies incidences, vampire bats are regularly culled in many parts of Latin America (Streicker *et al.* 2012). In Brazil, for example, governmental programs are in action

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that involve targeted campaigns against vampire bats. During these measures, vampire bats are captured and poisoned or coated with anticoagulant and released, so that allogrooming kills their conspecifics (Medellin 2003). Furthermore, bat roosts are destroyed using fire and explosives (Mayen 2003), which also leads to dramatic declines of non-target bats (Furey and Racey 2016). Besides the questionable methods involved, instead of reducing viral abundance in the population, culling of wildlife can lead to an increase in viral spreading. New hosts are recruited and the dispersal probability of infected individuals increases, which results in transmission of the disease to naïve hosts (Donnelly *et al.* 2005; Choisy and Rohani 2006; Streicker *et al.* 2012). This was the case for vampire bats in Peru, where culling failed to reduce seroprevalence of rabies in bat populations, but rather had the opposite effect (Streicker *et al.* 2012). Therefore, persecution of bats as potential carriers of zoonotic diseases has been denounced as useless and even counterproductive by both conservationists and experts on disease transmission (Hutson and Mickleburgh 2001; Knight 2008).

Table.4: The prevention of bats population increase

Correlation Tests

			Value	Asymp.Std Error[a]	Approx. T[b]	Approx. Sig. (2-sided)
Interval by Interval	Pearson R	-	.046	.045	-1. 013	.312[c]
Ordinary by Ordinal	Spearman	Correlation	- .041	.045	- .045	.361[c]
Linear-by-Linear Association						
N of Valid Cases		495				

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on normal approximation.

Also, the research has shown a positive correlation, R^2 = 0.312 at P < 0.05, on the prevention of bats population increase (tab.4). Following the agricultural problems caused by bats, some people are of the opinion that the animal population be reduced by killing them for bushmeat purpose. Unfortunately, this method is strongly against the wildlife conservation legislations in Cameroon. The wildlife authorities in Cameroon are fighting wildlife poaching both in conserved and unconserved forest areas, a struggle aimed at achieving a sustainable population growth of bats. Combining knowledge about the ecology of the host species as well as the disease dynamics of the virus may be crucial for establishing efficient disease prevention programs (Plowright *et al*. 2015). Here, it needs to be noted that the emergence of zoonotic diseases from bats also seems to be a consequence of anthropogenic alteration of natural environments (Daszak *et al*. 2001). For example, in Central and South America, the conversion of forested habitats into pastures shifted the dominant food source for vampire bats from native vertebrates to livestock. This has increased rabies transmission from vampire bats to livestock and domestic animals in many parts of Latin America (Schneider *et al*. 2009). Where bat habitats have been converted largely into agricultural farmland, the remaining bat populations are forced to concentrate in patches that provide them with resources they need. Where natural habitats are scarce, flying foxes may use fruiting or flowering trees in agricultural, suburban and urban areas, which increases the contact zone and spillover risk between bats and livestock or humans (Daszak *et al*. 2006; Plowright *et al*. 2015). Indeed, contact between bats and naïve hosts as a consequence of human landscape modification and encroachment likely sparked the transmission of Hendra viruses to horses (Epstein *et al.* 2006) and Nipah virus to pigs (Chua *et al.* 1999; Field *et al.* 2001).

Generally, the public perception of bats as aesthetically less appealing mammals as well as folklores that often associate bats with negative stigma makes bat related conservation efforts time-consuming and demanding (Fenton 1997; Allen 2004; Knight 2008). The recent outbreaks of viral zoonotic

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diseases with the identification of bats as putative natural hosts have further complicated bat conservation efforts (Li *et al*. 2005; Knight 2008). Therefore, it is important to highlight the context of bat-associated infections in order to provide more evidence-based information about the emergence and transmission of bat related zoonotic diseases, which may lead to a more balanced reputation of bats. The education of local communities needs to carefully balance information about the potential risk of acquiring infectious diseases by consuming bushmeat, without implying that bats need to be eradicated in order to prevent spillovers. The recent outbreak of Ebola resulting in several thousand human victims and with bats frequently being reported as the likely source of origin, has undoubtly led to severe loss of reputation of bats on this continent, which makes the conservation of threatened populations and species even more challenging, not only in Africa, but also worldwide.

IV. DISCUSSION

Humans rely on natural ecosystems for the services they provide (clean air and clean water), and bats play key roles in securing these important services by supporting the ecosystems that produce them. Bats maintain their habitats by regulating insect populations and cycling nutrients (insectivorous bats) and by pollinating flowers and dispersing seeds (nectivorous and frugivorous bats). Because bats are highly mobile, they perform these ecological roles across wide landscapes, supporting forest regeneration and maintenance at large scales (Salonga, 2009). However, the killing of bats for human consumption is a long standing tradition in so many parts of Cameroon where the population of bats aggregate in large colonies on trees like the red palms in the day after their nocturnal activities. The aggregation behaviour makes them to be vulnerable to humans for killing especially in the day. This survey has shown that the main reason for their killing is due to their damaging activities on fruit trees in farmlands in Bamenda and other areas in Cameroon. However, it seems that so many other people kill them for consumption purpose only. Bats are predominantly nocturnal, resting during the day and feeding at night, although some bat species are partially or completely diurnal (Kunz and Pierson, 1994). Most species of Microchiroptera and Megachiroptera depart from roost sites at early dusk to forage, and return to their day roosts by dawn (Kunz, 1982). The distance that bats travel during their foraging activities varies by species, habitat type, location, season, colony size and food availability. Microchiroptera have been tracked travelling 10 to 15 km from their day roost during foraging activities and may venture as far as 80 km (Kunz and Pierson, 1994). Megachiropteran species have been known to travel as far as 87.5 km from their day roost for foraging (Epstein *et al.,* 2009). Female bats are likely to travel shorter foraging distances during lactation periods, as they are limited by the increased weight of carrying their young (especially some species of Megachiroptera) and/or the need to return to the roost to nurse young left behind. In addition to their daily movements, some bat species are also known for long-term,long-distance migration (Bisson, *et al.* 2009).

The bats aggregation establishment on fruit trees like red palms in Bamenda municipality is considered to be unclean to the environment especially when this happens in residential compounds where their nocturnal noisy feeding and dropping litter these places. Bats are disliked and feared in many regions of the world (Kellert, 1980), probably owing to a history of negative mythology and lack of understanding about bats. Some cultures maintain positive feelings about bats, such as in China, where they are symbols of happiness and longevity, and Poland, where they are believed to bring good luck. Elsewhere, bats are associated with death and darkness, and traditional stories have evolved in which bat like characters play sinister roles causing harm to people. In Malaysia, for example, bats are considered dirty and are associated with evil spirits and vampires. Of the Malaysians interviewed, most had negative feelings towards bats, and half did not like bats at all. This matches the general lack of knowledge about basic bat natural history. Aside from folklore-inspired fears and misunderstanding due to lack of education, some concerns about bats are tied to reality. The most notable examples are among fruit farmers in the Old World, who continually face problems with fruit bats feeding on their fruit crops and aggregating in human-built structures, and the even more widespread fear of bats as disease vectors. Although these concerns are based in truth, fear and lack of education often lead to an exaggerated public response. In addition, people often fail to recognize the role that they themselves play in inviting conflict with bats. For example, in the Philippines, some fruit bat species forage on agricultural crops, but this may be because agricultural development has displaced their natural habitat. Studies have shown that bats prefer to forage in undisturbed natural forest, even when agricultural areas are available nearby (Mildenstein *et al*., 2005). With an ever-increasing human population, people have fractured natural landscapes and moved into and around bat habitats, creating more opportunities for negative interactions. It follows that human-bat conflicts have become far more pronounced in recent times (Daszak, *et al*.2000).

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Bats consumption in Bamenda is a tradition that cuts across the entire nation. To some tribes in Cameroon like Bakossi, its meat is a traditional delicacy, for this reason bats are seen killed in large numbers for consumption even those advocating for their conservation also eat them. An obvious direct benefit of bats to humans is as a food source. Although bat hunting is illegal throughout most of the Old World, people hunt bats for meat.The hunted species are predominantly megachiropterans, but a few species of insectivorous bats are also hunted in Asia and Africa (Mickleburgh, *et al.*2009). For some cultural groups, the hunting and eating of bats is linked to traditional customs and beliefs, such as indigenous tribes in the Philippines that believe bat meat has special medicinal properties (Mildenstein, 2002); other examples are in Swensson (2005) and Jenkins and Racey (2008). To other people, such as the Chamorros and Carolinians in the Mariana and Carolina Islands of The Federated States of Micronesia, fruit bats are a highly valued delicacy, traditionally eaten at celebrations. In many parts of Asia, however, bats are not a special food, and it is common for them to be hunted opportunistically as a novel supplemental food source (Mildenstein, 2002). Given the known levels of population decline in the Old World, fruit bat harvest is generally assumed to be unsustainable and a threat to the long-term persistence of Old World fruit bats (Mickleburgh, *et al.*2009; IUCN, 2010).

In recent years, bats have gained significant notoriety for being implicated in numerous emerging infectious disease events, and their importance as reservoir hosts for viruses that can cross species barriers to infect humans and other domestic and wild mammals is increasingly recognized (Calisher *et al.,* 2006). Historically, there has been a significant body of work on the role of Microchiroptera (insectivorous bats) as reservoirs of infectious agents, but relatively little available information on members of the suborder Megachiroptera (flying foxes and fruit bats) (Mackenzie, *et al.* 2003). Although the role of bats in harbouring viruses (alphaviruses, flaviviruses, rhabdoviruses and arenaviruses) is well established (Sulkin and Allen, 1974; Mackenzie, *et al.*2003), there is increasing global interest in evaluating the broad range of potential infectious agents that bats harbour, with a particular focus on potential emerging pandemic threats. This concern may be somewhat exaggerated, as bats themselves do not represent the real threat to people as regards potential pathogens leading to large-scale zoonotic disease events. However, it is worth investigating the infectious agents harboured by bats, and integrating this information with an understanding of the risk of transmission from bats to people or livestock, which may serve as intermediate hosts and transmission vectors linking bats and people.

Although bats have been identified as carriers of many highly virulent human pathogens (Chen *et al.* 2014), evidence of pathogen-related clinical signs or disease in bats is scarce, particularly for intracellular pathogens such as viruses (Brook and Dobson 2015). Ebola virus, the most prominent filovirus causing severe haemorrhagic fever in humans, with high mortality and it is fast spreading among African populations. The recent outbreak in 2013 in West Africa has resulted in the most severe epidemy of Ebola so far, with more than 11,000 lethal cases (World Health Organization 2014). It has thus became apparent that spillover from animals to humans occurs through hunting, butchering and consumption of bushmeat (Gonzalez *et al*. 2005; Li and Chen 2014), followed by fast human-to-human transmission (World Health Organization 2014). An outbreak of Ebola in Congo in 2007 that resulted in 260 infected humans of whom 186 died has been traced to a potential direct transmission from a dead fruit bat that the first human victim bought from hunters to eat (Leroy *et al*. 2009). Antibodies against Ebola virus have since been detected in a total of 14 bat species, with seroprevalences of up to 44 % depending on species and location (Olival and Hayman 2014).

The recent outbreak of Ebola in Guinea and neighbouring countries in 2013, countries that are at significant distance to the previous outbreaks in central Africa, has caused speculations about a possible transmission of the virus by migrating fruit bats (Bausch and Schwarz 2014; Vogel 2014). However, as the strain of the west African Ebola virus is a genetic outlier within the known Ebola viruses, it has been argued that the west African variant may have emerged from local wildlife populations rather than from migrating individuals (Gatherer 2014). Furthermore, although speculated (Saéz *et al*. 2015), it is yet not clear whether the spillover of Ebola virus in west Africa originated from bats. Marburg virus is the only filovirus that has so far been directly isolated from bats (Towner *et al.* 2009; Amman *et al.* 2012; Pourrut *et al*. 2005). The first outbreak of the virus was caused by a spillover from laboratory monkeys to humans in Marburg, Germany, in 1967 (Jacob and Solcher 1968). The high divergence of the genome sequence of Marburg in this population suggests a long-term association of the virus with the host, leading to the assumption that bats are the natural reservoir (Towner *et al*. 2009).

V. CONCLUSION

The survey revealed that even though many people consuming bats in Bamenda and other parts of Cameroon know the risk of contracting zoonotic infections like Ebola and similar related diseases but are yet to believe they could suffer any infection from the consumption. Many Cameroonians in remote areas are still doubting if bats consumption could lead to a virulent disease outbreak as claimed by the government public health educators. Others are of the opinion that their ancestors consumed these animals and were neither infected nor killed by these diseases, and that the government public campaigns to discourage the eating of bats on grounds that they carry zoonotic diseases is rather considered as a bat conservation strategy. From this position, so many people are still very much interested and comfortable eating bats as a source of protein. However, the eating of these animals is believed to be more restricted to the remote areas in Cameroon where they are less disturbed and could easily form huge roosting colonies. The poverty situation in some remote places in Cameroon has pushed so many people into illegal hunting of bats and other wildlife including threatened and endangered species, even though outlawed by the government conservation authorities. The bats consumption behaviour of the inhabitants of Bamenda and many other parts of Cameroon might not go so soon so long as poverty remains a food-choice determinant.

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