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Knowledge and Perceptions of, and Attitudes to, Bats by People Living around Arabuko-Sokoke Forest, Malindi-Kenya

Simon Musila[*], Pavol Prokop[†], and Nathan Gichuki[‡]
[*]Mammalogy Section–Zoology Department, National Museums of Kenya, Nairobi, Kenya
[†]Department of Biology, Faculty of Education, Trnava University, Trnava, Slovakia
[‡]School of Biological Sciences, University of Nairobi, Chiromo-Nairobi, Kenya.

Address for correspondence: Simon Musila, Mammalogy Section–Zoology Department, National Museums of Kenya, P.O. Box 40658-00100, GPO Nairobi, Kenya. E-mail- sumbirds@gmail.com

ABSTRACT Bat populations continue to decline worldwide because of myriad human activities. To enhance bat conservation, human behavior needs to change. Such change can occur, in part, through an understanding of what motivates human actions toward bats. We used a Bat Attitude Questionnaire (BAQ) to investigate attitudes toward bats in people (n = 394) living around Arabuko-Sokoke Forest (ASF), Kenya. Belief in myths seemed to prevail among those surveyed and that these myths were significantly associated with low tolerance of bats (ordinal regression, $p < 0.05$). Older and more educated people reported more positive attitudes toward bats than others. Multiple linear regression revealed that females showed more negative attitudes toward, and more belief in, myths about bats than males (both $p < 0.01$). Ordinal regression showed that hostile behavior toward bats was more common among males ($p < 0.001$). Nearly one-third of the respondents reported actively killing bats or destroying bat roosts. A similar proportion did not see any benefits of bats to humans, while the majority of respondents associated bats with the destruction of farmers' fruits. To address prevailing negative attitudes about bats, we recommend conducting evening school-based bat study tours, specifically targeting youths in schools around the forest, to examine whether physical contacts with bats would help positively influence human attitudes toward bats. Additionally, since mango (*Mangifera indica*) farming is an important source of income to people around ASF, an assessment of the quantity of mangoes destroyed by bats would be important to determine whether there is a need for controlling bat access to crops through appropriate schemes.

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Anthropogenic activities pose the greatest threats to bat populations worldwide (Aguiar, Britom, & Machado, 2010; Mayen, 2003; Mickleburg, Hutson, & Racey, 2002; Reid, 2013; Rodhouse et al., 2015; Voigt & Kingston, 2016). There is an urgent need to understand what motivates peoples' actions toward bats and their habitats, and to use knowledge of people's values, attitudes, and social norms in the design of messages aimed at influencing behavior (Kingston, 2016). The theory of planned behavior hypothesizes that attitudes, subjective norms, and perceived behavior control determines people's behavioral intentions (Ajzen, 1991; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). An attitude is the way one thinks or acts toward something (Eagly & Chaiken, 1993). Subjective norms are societal pressures which influence one's decision to act in a certain way (Ajzen, 1991). Perceived behavior control refers to people's perception of the ease or difficulty of performing a certain behavior (Azjen, 1991). These factors interact in a complex way and influence an individual's choice of actions, which in turn affect the survival of species or habitats. Although bat species play an important role in the regulation of insect herbivory (Kalka, Smith, & Kalko, 2008), seed dispersal, and pollination (Fleming & Sosa, 1994; Galindo-Gonzalez, Guevara, & Sosa, 2000; Kelm, Wiesner, & Helversen, 2008; Kunz et al., 2011), they are still perceived and conceptualized as "bad" animals even among pre-schoolers (Kubiatko, 2012), as well as adults. Additionally, bats together with bugs, mice, spiders and snakes, are the most frequently cited category of phobic fears (Arrindell, 2000; Davey, 1994a, b; Robins & Regier, 1991). Myths commonly propagate a fear of poorly-known animals, and can result in direct persecution, with attendant consequences for the ecosystem services they provide (Brito, Rebelo, & Crespo, 2001; Ceríaco, Marques, Madeira, Vila-Viçosa, & Mendes, 2011; Ceriaco, 2012; Fita, Neto, & Schiavetti, 2010; Prokop & Fančovičová, 2012). Considering the lack of understanding of these animals, it is not surprising that bats evoke little sympathy (Bjerke & Østdahl, 2004; Davey et al., 1998). Therefore, there is a need to document bat–human interactions and the attitudes that underlie them, in order to understand why people act the way they do toward bats, and design appropriate interventions to engage people in conserving bats species and their habitats.

More than 108 bat species live in Kenya (Patterson & Webala, 2012), but ecological studies are few. Although some studies have focused on attitudes toward animals and protected areas in Kenya (de Pinho, Grilo, Boone, Galvin, & Snodgrass, 2014; Gadd, 2005; Low, Sundaresan, Fischhoff, & Rubenstein, 2009), there have been no studies of attitudes toward bats. We investigated knowledge and perceptions of, and attitudes toward, bats by Mijikenda people living around ASF. This area is of particular interest because the farmlands in the eastern part of ASF have a number of limestone coral caves that provide suitable roosting habitat for bats. In addition, many bat species and their roosts in Kenya occur within human habitations outside legally protected areas, where they are highly prone to direct persecution and roost destruction. The Mijikenda tribe, restricted to the Kenyan coast, consists of nine subtribes (Digo, Giriama, Duruma, Rabai, Chonyi, Kauma, Kambe, & Jibana), believed to have a common historical origin (Spear, 1978). Specifically, we investigated whether age, gender, education level and distance from roosts affected attitudes toward bats. Because more knowledge and higher levels of education seem to have a positive influence on human attitudes toward animals (Bjerke, Ostdahl, & Kleiven, 2003; Kleiven, Bjerke, & Kaltenborn, 2004), we predicted that more educated people would have a more positive attitude toward bats. Studies

have also found that females manifest more negative attitudes toward animals considered to be a threat and harm than males (Ceríaco, 2012; Curtis, Aunger, & Rabie, 2004; Curtis, de Barra, & Aunger, 2011; Oaten, Stevenson, & Case, 2009), thus we predicted females would hold more negative beliefs about bats than males.

Methods

Study Area

This study was conducted in villages in Gede town, on the eastern part of Arabuko-Sokoke Forest (ASF), in Kilifi County, Kenya from December 2014 until July 2015. ASF is the largest single block of indigenous coastal forest remaining in East Africa, situated in Gede town, about 100 km north of Mombasa, 3° 20' S, 39° 50' E (Bennun & Njoroge, 1999). The main fruit trees found in the farmlands in Gede are mango, cashew nut (*Anacardium occidentale*), coconut (*Cocos nucifera*), neem (*Azadirachta indica*), and casuarina (*Casaurina equesitifolia*). Most of these trees remain evergreen throughout the year and may provide suitable roosting habitats for bats. Some of the common fruit bat species found in the farmlands are Wahlberg's Epauletted Fruit Bat (*Epomophorus wahlbergi*) and Egyptian Rousette (*Rousettus aegyptiacus*), while the insectivorous bats are Heart-nosed Bat (*Cardioderma cor*), Egyptian Slit-Faced Bat (*Nycteris thebaica*), Striped Leaf-nosed Bat (*Macronycteris vittata*) and Green House Bat (*Scotophilus viridis*). All of these bat species roost in natural and man-made structures (Happold & Happold, 2013).

Participants and Procedure

A semi-structured questionnaire was prepared in English and then translated into Swahili, the official language spoken by many people in Gede. The questionnaire was pre-tested by interviewing 50 people and consequently refined based on responses before data collection began. Because we were not natives of Gede, we visited local government officials (chiefs and subchiefs) and explained our methods of research before data collection began. Nearly an equal number of adults (> 21 years of age) and youths (8–20 years) of both sexes were interviewed. Interviews were conducted in villages around three caves that were actively used by bats for roosting, up to a maximum radius of 1 km around each cave. The caves were Ali Baba /Makuruhu (S03.32268; E040.04147 (>300,000 individuals of bats), Panga Yambo (S03.32270; E040.02346 (>100 individuals of bats) and Kaboga (S03.33439; E040.03086 (> 5,000 individuals of bats). The GPS coordinates of each cave were recorded and used to estimate the distance from each household visited. Within 100 m to1 km of the caves, 190 people (93 females [47 adults, 46 youths]; 97 males [49 adults, 48 youths]), aged 8–87 years were interviewed in Jimba village. To determine whether the distance from the caves influenced people's knowledge of and attitudes toward bats, we also interviewed 204 respondents aged 10–75 years, comprising 102 females (51 adults, 51 youths) and 102 males (51 adults, 51youths), about 3 km from caves in Mabuani and Mkenge villages near Gede town.

A team of four people, accompanied by a local guide, visited the households. The guide introduced the interview team to the household members, explained the purpose of the visit, and then requested individuals of the households to participate in the interview. If they agreed, two people of different sexes or age group were interviewed separately, at least 10 m from each other in each household. Individual responses to questions during the interview were used to complete the form. It took a maximum of 15 minutes to complete one questionnaire with one respondent. We recorded the tribe, number of people in the household, and the education level

of the respondent. To document knowledge of bats and human–bat interactions, we asked the word for bat in the respondent's mother tongue, when a bat was last seen, known place/s where bats occurred in large numbers, traditional beliefs about bats, benefits of bats to people, and how bats affected people. To understand people's reaction to bats found on their farms, we asked respondents to choose one of the following five different options; 1 = I killed many of them, 2 = I killed at least one, 3 = I destroyed their roosting place to chase the bats away, 4 = I did nothing, 5 = I contacted a government officer.

Measuring Attitudes toward Bats

Local human attitudes toward, belief in myths about, and knowledge of bats were measured using 5-point Likert-type items in semi-structured questionnaires, developed in a fashion similar to Kellert's (1996) research on attitudes toward animals. Attitudes toward bats were examined with a modified Bat Attitude Questionnaire (BAQ) (Prokop, Fančovičová, & Kubiatko, 2009, Appendix 1) consisting of five domains: myths, negativistic, scientistic, ecologistic, and knowledge. Each domain was assessed with a number of items. Nine negativistic items measured an active avoidance of bats because of dislike or fear. Four scientistic items measured interest in the biology of bats. Eight knowledge items measured basic facts about bat biology, using items which were easy to understand by people who are not bat experts. Nine ecologistic items investigated respondents' concern for the role of bats in nature and relationships between bats and humans (Prokop et al., 2009). Seven myth items tested the levels of respondents' acceptance of traditional folklores about bats. Each item was represented by a set of choices rated on the Likert type scale from 1 (absolutely disagree) to 5 (absolutely agree). Negatively worded items in the ecologistic and scientistic domains were reverse scored, so high scores represent highly positive ecologistic and scientistic attitudes. In contrast, the negativistic and myths domains were scored such that the high scores represented highly negative attitudes and strong beliefs in myths about bats (Appendix 1). The questionnaire and methods used to collect data in this study were presented to Graduate School, University of Nairobi-Kenya, as part of the lead author's PhD proposal defense, and were approved before fieldwork was conducted.

Respondents' Demographic Details

Respondents ranged in age from 8 to 87 years (M = 27.4 yrs, SD = 16.2, n = 394). Those interviewed near caves had a mean age of 28.4 (SD = 16.9, n = 190), while those living 3 km or more away had a mean age of 26.5 (SD = 15.6, n = 204). The household sizes ranged from 1–55 people (M = 8.8, SD = 5.9, n = 394). Of respondents living within 1 km of the caves, the mean distance was 643.5 m (SD = 194.1), while those interviewed away (> 3 km) in Mabuani and Mkenge villages, were an average of 4,188.7 m (SD = 503) away. Five different tribes were represented by the respondents, including six (Giriama, Duruma, Chonyi, Digo, Kauma, and Rabai) sub-tribes of Mijikenda, as well as Bajuni, Swahili, Taita, and Sanya. Of the 394 people interviewed, 94% (371) were Giriama, with other sub-tribes represented by small numbers of individuals. Many (66%) respondents had obtained a primary education, followed by 19% with secondary school, 10% illiterate, and the rest had college or university education.

Data Analysis

Reliability scores for a prioi established domains were generally low (Cronbach's α ranged between 0.36 and 0.7). Knowledge scores showed unacceptably low reliability (α = 0.18; Nunnaly, 1978). In order to increase the reliability, we employed a factor analysis with varimax rotation on the

attitude data. This choice was made due to low correlations between domains (Table 5), following the recommendation of Tabachnick and Fidell (2007). Barlett's test of sphericity ($\chi^2 = 2463.5$) and the Kaiser-Meyer-Olkin measuring of sampling adequacy (0.72) yielded significant results ($p < 0.001$), indicating that the factor analysis was appropriate. Fourteen factors that explained 64.5% of the variance were derived. We removed items with factor loadings lower than 0.3, items that loaded with more than one item, and domains that were represented by less than three items. This procedure yielded a reduced number of items, but the reliabilities of each domain increased (scientistic domain, $\alpha = 0.72$; negativistic domain, $\alpha = 0.5$; ecologistic domain, $\alpha = 0.67$, and myths, $\alpha = 0.68$). The reliability of the knowledge domain was not improved and therefore this domain was not included in further statistical analysis.

Multiple linear regression was applied to test how attitude domains were influenced by independent predictors, following Kalteborn, Bjerke, Nyahongo, and Williams (2006). The independent variables were: gender, age, number of people in the household, presence of bats on a farm, educational level, time to last bat sighting, and distance to cave. We pooled data on sighting of bats into recent observation (bats seen within 7 days), and older sightings (bats seen > 7 days). The dependent variable was always one domain of attitudes, as in Kaltenborn et al. (2006). This yielded several multiple regression models. Dependent variables were Box-Cox transformed to achieve normality. To measure respondents' behavior toward bats, we used data for individuals who reported the presence of bats on their farms ($n = 352$), because this question was not applicable to people who did not have direct contact with bats. In order to test which variables were associated with behavior toward bats (dependent variable), ordinal regression was performed, with the independent variables being gender, age, number of people in household, educational level, last bat sighting, distance to cave, and four domains of attitudes as described above. All statistical tests were made in Statistica (StatSoft, 2007). The stepwise forward procedure was applied in order to derive the most parsimonious models.

Limitations

Although a single reliability standard should not be applied universally (Lance, Butts, & Michels, 2006; Nunnaly, 1978), the negativistic domain had poor reliability (Cronbach's $\alpha = 0.5$). The reliabilities of the other domains were acceptable (George & Mallery, 2003). Thus, some caution needs to be practiced when interpreting data from this study. Lower reliabilities generally suggest that some items were not perceived as unidimensional by participants and/or that the domain was represented by a small number of items (George & Mallery, 2003). We suggest that a greater number of items be applied in future research, despite the inherent complications of obtaining information through interviews.

Results

Knowledge and Traditional Beliefs about Bats

There were five different names given to bats in the native tongue of the respondents including *Ndema, Kanundu, Nundu, Mpopo,* and *Popo*. The majority (71%) of Giriama respondents, called a bat *Ndema*, followed by *Kanundu* (18%), and *Nundu* (10%). *Ndema* was a name referring to large bats, especially members of the plant-visiting family *Pteropodidae*, which were not reported as entering people's houses. *Nundu* was a name given to smaller-sized bats, presumably insectivorous species, which were reported as roosting in houses or occasionally entering houses at night. Trees (54%), followed by caves (24%), were the main bat roosts reported. The majority (61%) of the respondents reported that insectivorous bats were

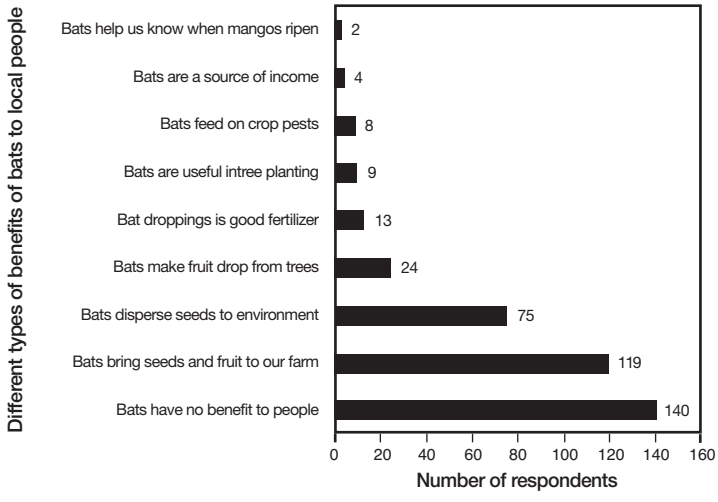

Figure 1. The types of benefits bats provide to local people around Arabuko-Sokoke Forest, Malindi-Kenya.

agents of the devil and could be used by witches to cast spells on people. About 25% of people did not have any kind of traditional myths or beliefs about bats.

Benefits of Bats to People

Thirty-six percent of respondents did not see any benefits of bats to humans. Many people (30%) reported that bats were useful in bringing to their farms fruits, seeds, or fragments of guava (*Psidium guajava*), mango, cashew nut, neem, sugar-apple (*Annona squamosa*), paw-paw (*Carica papaya*), and banana (*Musa* spp. (Figure 1). The majority (57%) of the respondents reported that cashew nuts followed by guava (19%) were the main fruit fragments and seeds brought by bats to their farms. When all the benefits of seed dispersal were combined, they were reported by 58% of respondents. Bats were also reported as a source of fertilizer (3%) and income (1%), when tourists paid to be taken to caves such as Panga Yambo and Ali Baba to see bats, and for cultural and historical significance.

Effects of Bats on Local People

The majority (66%) of the respondents implicated bats in the destruction of farmer's fruits, while 18% of the respondents indicated that bats had no effect on people. Fruit bats destroyed fruits by breaking into their outer cover, sucking juices, and eating some or all of the fruit pulp. This made fruits unsuitable for eating or selling. The most damaged fruits were mango (42%), followed by guava (18%) and cashew nut (18%). Bats were reported to infect people with diseases from their droppings which accumulated in the roost areas inside houses or nearby trees.

Attitudes toward Bats among Local People

Scientistic Domain: The mean value of the scientistic domain was 3.92 (*SD* = 0.55). This means that the respondents showed positive attitudes toward bats in this domain. The multiple regression model was significant ($R^2 = 0.06$, $F_{(5,387)} = 4.89$ $p < 0.001$, Table 1). Three out of five variables that were entered into the model were significantly associated with scientistic attitudes. The number of people in the household and educational level correlated with positive scientistic attitudes. Households with a large number of occupants had a more positive attitude

Table 1. Multiple regression on the scientistic domain. Distance from the cave and the participant's age were removed from the stepwise regression model (n = 394).

	β	*SE* of β	*t*	*p*
Intercept			0.41	0.68
Bat last seen	0.11	0.05	2.18	0.03
Education level	0.12	0.05	2.36	0.02
No. of people in household	0.1	0.05	1.99	0.05
Presence of bat on farm	–0.07	0.05	–1.50	0.13
Gender	0.07	0.05	1.46	0.14

Table 2. Multiple regression on the negativistic domain. Distance from the cave and educational level were removed from the stepwise regression model (n = 394).

	β	*SE* of β	*t*	*p*
Intercept			3.14	0.00
Age	–0.21	0.05	–4.18	0.00
Gender	–0.18	0.05	–3.50	0.00
No. of people in household	0.07	0.05	1.39	0.17
Bat last seen	–0.07	0.05	–1.33	0.18

toward bats. Also, more educated people had a more positive scientistic attitude toward bats. Recent encounters with bat(s) were also associated with more positive scientistic attitudes. Although the presence of bats on farms and gender differences contributed to the model, the contributions were not significant.

Negativistic Domain: The mean value of the negativistic domain was 3.07 (SD = 0.50). This means that the majority of the respondents showed neutral attitudes rather than extremely positive (mean value ≥ 4; 3.8% of the respondents) or extremely negative attitudes (mean value ≤ 2; 1.8 % of the respondents). Multiple regression resulted in a significant model (R^2 = 0.08, $F_{(5,387)}$ = 7.16 p < 0.0001, Table 2). Older people had more positive attitudes toward bats than younger people, and females held more negative attitudes toward bats than males. The number of people in the household, encounters with bats, and their presence on farms showed a non-significant contribution to the model, meaning that these variables did not strongly affect negative attitudes toward bats.

Ecologistic Domain: The mean value of the ecologistic domain was 3.52 (SD = 0.57). This means that the respondents showed slightly positive attitudes toward bats in this domain. The regression model was significant (R^2 = 0.13, $F_{(4,388)}$ = 14.131 p < 0.0001, Table 3); older people and more educated people held more positive ecologistic attitudes toward bats. Gender differences and encounters with bats showed a non-significant association with ecologistic attitudes.

Myths Domain: The mean value of the myths domain was 2.83 (SD = 0.60). This suggests that only a few of the respondents held some belief in myths (mean value ≥ 4; 2.5% of the respondents compared with 10% of respondents with a mean value ≤ 2). The model for the myths domain was significant (R^2 = 0.10, $F_{(5,387)}$ = 9.03, p < 0.0001, Table 4). Females believed

Table 3. Multiple regression on the ecologistic domain. Number of people in the household, presence of bats on farm, and the distance from the cave were removed from the stepwise regression model (n = 394).

	β	*SE* of β	*t*	*p*
Intercept			–1.27	0.21
Age	0.34	0.05	6.86	0.00
Education level	0.15	0.05	3.07	0.00
Bat last seen	0.07	0.05	1.47	0.14
Gender	0.06	0.05	1.25	0.21

Table 4. Multiple regression on the myths domain. Number of people in the household, presence of bats on farm, and bat last seen were removed from the stepwise regression model (n = 394).

	β	*SE* of β	*t*	*p*
Intercept			3.86	0.00
Gender	–0.24	0.07	–3.48	0.00
Education level	–0.31	0.07	–4.37	0.00
Age	–0.14	0.07	–2.04	0.04
Cave distance	0.12	0.07	1.78	0.08

Table 5. Correlations between the attitude domains (n = 394).

	Negativistic	Myths	Ecologistic
Scientistic	–0.05	–0.14**	0.32***
Negativistic	—	0.18***	–0.22***
Myths		—	–0.17**

**$p < 0.01$; ***$p < 0.001$.

more in myths about bats than males. Better educated people and older people had fewer incorrect beliefs about bats. The closer the cave to the participant's household, the more the myths about bats, although this association was only marginally significant.

Correlations between Domains

Correlations between domains were small or modest (Table 5). People with high ecologistic attitudes showed positive scientistic and low negativistic attitudes toward bats. The correlation in the latter case is negative, because negative attitudes are represented with a high score in the negativistic domain. Myths showed very clear patterns: a negative association with the scientistic and ecologistic domain, but a positive association with negativistic attitudes. This means that beliefs about myths is associated with negative attitudes toward bats. Negativistic and scientistic attitudes did not correlate with each other.

Behavior of Individuals toward Bats on Their Farms

Most (74%) of the respondents had seen bats within the previous two days. The mean score was 3.58 (SD = 0.45), suggesting that bats were very common in the study area. A total of 16 and 21 respondents (11%) reported that they killed a number of bats or at least one, respectively. Sixty-three respondents (18%) reported that they destroyed bat roosting areas in order

to chase them away. The majority of the respondents (70%) did nothing to bats on their farms, while the remaining four respondents (1%) reported that they contacted the responsible government officer to report about bats found on their farms. The model for behavior of individuals toward bats found on their farms was significant ($\chi^2 = 75.9$, $df = 14$, $p < 0.0001$) and explained 23% of the total variance of results (Nagalkerke R^2). Negativistic attitudes (estimate = –0.57, $p < 0.0001$) and belief in myths (estimate = –0.33, $p = 0.02$) were significantly associated with a negative behavior toward bats. In contrast, positive ecologistic attitudes (estimate = 0.29, $p = 0.009$) and a closer distance to a cave (estimate = 0.000, $p = 0.001$) were associated with a positive behavior toward bats. Males showed more hostile behavior toward bats than females (estimate = 1.21, $p < 0.0001$). Recent contact with bats was associated with positive behavior (estimate = –0.75, $p = 0.02$). Associations between the age of respondents, the number of people in households, scientistic attitudes, the level of education, and behavior toward bats were not significant (all $p > 0.05$).

Discussion

Bat–human interactions among the 44 tribes in Kenya have not been previously documented. This information provides crucial insights into designing an effective bat conservation strategy for the country. This study investigated knowledge, perceptions, and experiences of, and attitudes toward, bats of the Mijikenda tribe living around ASF. Fear of strange animals, such as bats, commonly generate various myths that are more or less believed by humans (Isbister, 2002; Prokop & Tunnicliffe, 2008; Prokop & Kubiatko, 2014). The results of this study reinforced this idea, since the majority (61%) of the respondents reported that bats were agents of the devil, which could be sent by witch doctors to harm local people. As nocturnal volant animals, people do not experience bats in the way that they might birds or diurnal non-volant animals, and this has consequences for attitudes (Kingston, 2016) or development of fear, myths, and misinformation. Encounters are often brief and rarely at close range (Sexton & Stewart, 2007). Such a brief encounter, combined with a limited understanding of bats, may be the reason they are viewed negatively and less appreciated by people in the study area. Belief in myths is particularly dangerous because it is associated with negative attitudes (Álves et al., 2014b; Ceríaco, 2012), deliberate killing of animals (Ceríaco et al., 2011; Dickman, 2010), killing of animals for medical or religious purposes (Álves et al. 2014a), or cutting down bat roost trees (Webala, Musila, & Makau, 2014). Indeed, belief in myths in this study was significantly associated with the killing of bats.

More knowledge (Thompson & Mintzes, 2002) and higher levels of education seem to have a positive influence on attitudes toward animals (Kellert, 1980; 1993; Røskaft, Bjerke, Kaltenborn, Linnell, & Andersen, 2003) as well as conservation efforts (Kidegesho, Røskaft, & Kaltenborn, 2007; Kaltenborn, Bjerke, & Vittersø, 1999). Our findings concur: a better education was associated with positive scientistic and ecologistic attitudes toward bats, probably due to plant and animal interrelationships taught to children in schools. Compulsory science and biology lessons are taught, for example, to children for 12 years in Kenya; eight and four years in primary and secondary schools, respectively. It is possible that a respondent's age is associated with greater knowledge (Jimenez & Lindemann-Matthies, 2015; Randler, Höllwarth, & Schaal, 2007), and that's why older people in this study held more positive attitudes toward bats. This was evident not only when examining myths, but also in the negativistic and ecologistic domain. Perhaps a positive association between the number of people in a household and scientistic attitudes in this study could be influenced by the impact of older and, thus,

more experienced people on the opinions of younger people. The elderly people have interacted with the environment for longer than youths, and some of the myths or misinformation about bats formed in youth may have been found to be incorrect after long-term exposure to bats. Therefore, the initial negative attitudes could have been changed to positive appreciation. Ceríaco (2012) found, for example in Portugal, that older people had fewer negative attitudes about frogs and reptiles compared with younger people.

Myths about bats tended to be more prevalent in respondents who lived close to caves where bats were present. In Australia, Larsen, Beck, Hartnell, and Creenaune (2002) found that people who lived near flying fox roosts (< 100 m) tended to have more negative attitudes about coexisting with bats. Kellert, Black, Rush, and Bath (1996), Kleiven et al. (2004), and Røskaft, Händel, Bjerke, and Kaltenborn (2007) similarly showed that people who thought that carnivores lived in their area expressed more negative attitudes toward them. Understanding the influence of the vicinity of bats seems to be more complicated because respondents living closer to a cave reported more positive behavior toward bats. Røskaft et al. (2003) found the opposite pattern: people living close to areas where large carnivore predators were present had a lower fear of them. We suggest that these mixed results can be influenced by the method used to measure distance from predators or bats. People may perceive the nearest distance from a cave subjectively and this subjective perception is the most important predictor for self-reported fear (Røskaft et al., 2007). In the current study, objective measures were used and so this may be why the results are different from those based on subjective responses. Further research is needed to control both subjective and objective measurements of distance to areas where animals live, in order to obtain the most objective results.

Female respondents in this study showed more negative attitudes and more belief in myths about bats than males. In contrast, hostile behavior toward bats was more common among males. Females commonly hold more negative attitudes toward wild, unpopular animals and predators than males (Almeida, Vasconcelos, & Strecht-Ribeiro, 2014; Alves et al., 2014b; Bjerke et al., 2003; Ceriaco, 2012; Lindemann-Matthies, 2005; Røskaft et al., 2003). Ultimately, these gender differences may stem from stronger avoidance of both predators (Røskaft et al., 2003) and disease cues (Prokop, Tolarovičová, Camerik, & Peterková, 2010), because females are more vulnerable to predation (Treves & Naughon-Treves, 1999) and need to protect their children from pathogens (Prokop & Fančovičová, 2016). Males are more frequently the perpetrators of animal abuse than females (Flynn, 1999; Pagani, Robustelli, & Ascione, 2007) which can explain why males showed more negative behavior toward bats than females. Male farmers in Puebla, Mexico considered it bad to have bats living on their farms, and 16% (n = 36) of those interviewed reported killing bats when found inside their houses (López-del-Toro, Andresen, Barraza, & Estrada, 2009). Males in Gede could also be attacking bats more than females because of the destructive nature of bats to fruit on the farms, the view of bats as agents of evil, or because of the perceived fear associated with bats.

Just over a third of the respondents (36%) did not see any benefits of bats to humans. Furthermore, 66% of respondents linked bats with the destruction of farmers' fruits. Mango farming is one of the most important sources of income to local people. Previous research has shown that self-reported financial loss is associated with negative attitudes toward animals (Hazzah et al., 2014; Li et al., 2015; Naughton-Treves, Grossberg, & Treves, 2003; Røskaft et al., 2007). Although it was reported that mangoes were the most frequently destroyed fruits in Gede, the quantity destroyed by bats relative to the total harvest may be overestimated. *R. aegyptiacus* is a common fruit bat in the study area. It feeds on many cultivated fruits and is

considered a pest in some areas, but its impact on crops has been largely overestimated (Korine, Izhaki, & Arad, 1999), because they avoid unripe fruits and commercial fruits are harvested several days before they become attractive to bats (Hadjisterkotis, 2006; Makin & Mendelssohn, 1986; Tuttle, 1986). It would therefore be important to quantify the fruit losses from bats and determine the need for controlling these losses in Gede using appropriate approaches.

The loss of cultivated fruits to farmers by fruit bats in Gede, may cause local people to develop more negative attitudes toward bats. Local people in Peshawar and Charsadda districts, Pakistan, disliked, for example, bats because they destroy cultivated fruits (Mahmood-ul-Hassan, Faiz-ur-Rehman, & Salim, 2011). On Tioman Island in Malaysia, (79%) of respondents (n = 119), disliked flying foxes because they raided fruit trees, as well as for their noise, and the smell from their faeces (Azizi, Olival, Bumrungsri, Richards, & Racey, 2016). Cousins and Compton (2005) found that fruit-crop raiding was the most common reason for negative local attitudes toward flying foxes on the Cook Islands. Furthermore, the loss of fruit crops because of bats can lead to their killing by people, as reported in Mauritius (Florens, 2016), as well as limited support for fruit bat conservation (Aziz et al., 2016). On a positive note, many (58%) respondents in Gede also reported that bats were beneficial to them because they dispersed cashew nut and guava seeds to their farms. The resulting cashew nut seeds are a source of income and food for local people in Gede. Consequently, to provide a foundation for effective bat conservation awareness in Gede, future research should also quantify cashew nut seeds dispersal by bats, and assess the economic contribution of the fruit bats to the livelihoods of local people.

Conclusion

Most of the respondents living around ASF showed neutral or slightly positive attitudes toward bats. Nonetheless, a significant number of people killed bats or destroyed their roosting places. Belief in myths was prevalent among females, and these myths were significantly associated with a low tolerance of bats. To address threats faced by biodiversity, bats included, it is imperative to change human behavior toward these species (Clayton & Myers, 2015; Ehrlich & Kennedy, 2005; Schultz, 2011; Stern 2000; St John, Keane, & Milner-Gulland, 2013; Veríssimo, 2013). The local people in Gede interact with bats daily, since bats roost in houses, trees in households, or nearby caves, or feed on farmers' fruits. Thus, people's actions contributing to the killing of individual bats or destruction of roosts would have a serious negative impact on species survival. Since older people had more positive attitudes toward bats than youths, bat education awareness which targets young people, dispelling myths recorded, and capitalizing on the positive roles of bats in bringing valuable cashew nut seeds to households would enhance bat appreciation and tolerance in Gede.

When adult environmentalists were asked about the origin of their commitment to protect the environment, most mentioned positive experience with nature during childhood (Chawla, 1999; Chawla & Cushing, 2007; Wells & Lekies, 2006). Environmental educators have consequently stressed activities that increase children's contact with nature (Bogner, 1998; Farmer, Knapp, & Benton, 2007; Yardimci & Leblebicioglu, 2012). In an area around ASF, evening school-based bat study tours may be an effective approach because they would involve catching bats using mist-nets, showing features of bats to learners, answering questions from students, and explaining details about bats using hand-held live bats. Encounters with live bats in a learning environment may positively influence human attitudes toward bats (Ballouard, Provost, Barre, & Bonnet, 2002; Tomažič, 2008).

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Conflicts of Interest

The authors state there are no conflicts of interest.

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Appendix 1. Final version of the Bat Attitude Questionnaire (BAQ) used in this study. Eigen values from factor analysis are shown for each item. Items removed after factor analyses are not shown.

Scientistic (1 = Strongly disagree, 5 = Strongly agree)	
1. I would like to know more about bats	0.80
2. We should learn more about bats in school	0.76
3. I would like to join a bat trip/expedition and learn about bats	0.70
4. Bats should be protected by law	0.58
Explained variance: 11%	
Negativistic	
1. Are you afraid that bats can infect you with dangerous diseases? (1 = Not at all, 5 = Extremely)	0.51
2. How attractive are bats in your view? (Absolutely unattractive, 5 = Extremely attractive) *	0.71
3. I like holding a bat in my hand (1 = Absolutely not disgusting, 5 = Extremely disgusting)	0.61
4. How disgusting are bats in your view? (1 = Absolutely not disgusting, 5 = Extremely disgusting)	0.45
Explained variance: 8%	
Myths (1 = Strongly disagree, 5 = Strongly agree)	
1. Bats are ghosts	0.51
2. When you see a bat in your house, it is sent by your enemy to harm you	0.78
3. If a bat urinates on someone he/she becomes impotent	0.34
4. It is a bad omen if bats start living in your new house before you move in	0.66
5. Body parts of bats are used by witchdoctors to cast spells on people	0.67
Explained variance: 6%	
Ecologistic (1 = Strongly disagree, 5 = Strongly agree)	
1. Bats play a very important role in the environment	0.59
2. Bats help in pollination of flowers	0.58
3. Bats help in insect pest control	0.44
4. Bat droppings are a source of good fertilizer	0.66
5. Planting trees helps conserve bats species	0.60
6. Caves are very important for survival of bats	0.57
Explained variance: 5%	

*Reverse-scored item.