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Research

Keywords: Myth, Popular knowledge, Urban areas, Interviews, Caxias-MA

Posted Date: December 10th, 2019

DOI: <https://doi.org/10.21203/rs.2.18431/v1>

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**POPULAR PERCEPTIONS OF BATS HINDER CONSERVATION ACTIONS IN
MARANHÃO, NORTHERN BRAZIL**

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Abstract

Background: Bats play an important role in the ecology of many environments, although the general lack of knowledge on the relevance of these animals hinders initiatives that contribute to the development of favorable attitudes and participative measures that promote the conservation of these animals and the ecosystems they inhabit. In the present study, 398 residents of eight neighborhoods of the town of Caxias in Maranhão, Brazil, were interviewed to verify their perceptions of bats.

Methods: A total of 398 individuals were interviewed during the present study. The interviewees were between 17 and 91 years old, and two-thirds (263; 66%) were women, while the other 135 were men (34%).

Results: Most of the interviewees described bats as ugly and disgusting animals that look like rats, feed primarily on fruit, and frighten people. These individuals also confirmed that bats are important for Nature and should be protected simply because they are living creatures. The analyses indicate a significant association between a fear of bats and the belief that all these animals are vampires, and also that women are more likely to have a fear of bats than men. There was also an association between a low education level and the belief that all bats are vampires.

Conclusions: The present study provides important insights into the perception of bats by the local population, highlighting the prevalence of mythical beliefs, which hinder the implementation of effective conservation measures. The results of this study reinforce the need for initiatives in environmental education that provide more reliable information on the biology

of bats and their ecological importance, thereby contributing to the conservation of bat diversity.

Key words: Myth. Popular knowledge. Urban areas. Interviews. Caxias-MA

Background

Bats (the order Chiroptera) are one of the world's most diverse mammalian groups, with 18 families, 202 genera, and 1120 species described to date (Simmons 2005). The Chiroptera has a worldwide distribution, being absent only from the polar regions and some oceanic islands (Reis 2007). The only true flying mammals (Nowak 1991), bats are nocturnal and roost upside down. They can be found roosting in caves, tree-holes, and the roofs of buildings (Allen 1967). Bats normally leave their roosts in the early evening, communicating and flying with the aid of high-frequency sounds emitted through the mouth or nostrils, which enable them to detect obstacles by echolocation. The interpretation of the echoes created by the features around them allows bats to orientate themselves and maneuver in complex environments, although they also rely on their vision and sense of smell (Laurindo and Novaes 2015; Gomes and Neto 2016).

Bats play an important role in the ecology of many environments (Nowak 1994), and exploit an ample variety of diets (Reis 2007). Many bats are frugivores, and are important seed dispersers (Garcia 2000), while others are insectivorous, and may help to control insect populations (Goodwin and Greenhall 1961), and some are nectarivores, playing an essential role as pollinators (Sipinski and Reis 1995). Some bats are considered to be important bioindicators (Bianconi 2004), while others are hematophagous (Brass 1994). Despite the considerable ecological diversity of these animals, then, popular perceptions are influenced heavily by the hematophagous habits of some species, which has led to the establishment of numerous myths and legends, and a widespread association of bats with evil spirits (Allen 1967).

Ancient superstitions have persisted up to the present day, with negative perspectives influencing the perceptions of most people, who tend to see these animals as evil or bad, and almost never as charismatic (Marinho-Filho and Sazima 1998). The Central American Mayan civilization associated bats with cruel characters, linked to death (Yalden and Morris 1975; Hill and Smith 1988). The Mayan god of the dead is represented by a human body, but with the head of a vampire bat (Villa and Canela 1998). In Africa, the crepuscular habits of bats were associated with negative sensations, such as fear (Hill and Smith 1988).

In the fables that involve these animals, the hematophagous habits of some bats have taken on fantastic proportions. In particular, the legend of Dracula has done much to reinforce the negative image of these mammals, resulting in the widespread belief that bats are aggressive, savage, and feed only on blood (Scravoni et al. 2008). These myths and legends consolidate beliefs such as the idea that bats are old blind mice with wings, worms or even insects, that serve only to transmit diseases (Arandas et al. 2011). In Portuguese, the word for bat, “morcego”, is derived from the Latin *muris* (mouse) and *coecus* (blind), while in French, bats are known as *chauve-souris* (bald mice), in Spanish, they are *murciélagos*, or old mice, and in German, *fledermäusen*, or flying mice (Reis et al. 2007). Despite this negative imagery, some cultures regard bats as positive symbols, associated with happiness or fertility (Allen 1967; Fenton 1992). In the Far East, bats are symbols of good luck and longevity, while in Egypt and India, they are considered to be sacred (Esberard et al. 1996).

Negative attitudes toward bats hinder initiatives for the preservation of their populations, given that the prevailing myths tend to obscure their ecological value and diminish their importance as an integral component of the ecosystem (Scravoni et al. 2008). The persistence of biased and unrepresentative interpretations of bat behavior means that a large proportion of present-day human populations tend to perceive bats as aggressive and dangerous, and the embodiment of evil (Wilson 1997). This is reinforced in urban environments, where bats often roost in the eaves of houses, disturbing the residents with their movements and

vocalizations, and the accumulation of feces and other waste. This results in the persistence of negative perceptions, and an increasing fear of bats (Bredt et al. 1996; Bredt 2003; Pacheco et al. 2010). Given this, and the general lack of reliable knowledge on the importance of these animals for the environment, many bat populations are being decimated, primarily through the application of insecticides and other substances, which tend to impact insectivorous chiropterans, in particular (Gomes and Neto 2016)

The general lack of information on the ecological importance of bat species tends to undermine conservation initiatives, primarily by reinforcing negative attitudes in the general population (Uieda 2008). This emphasizes the need for the improvement of environmental perceptiveness of the population through initiatives in Environmental Education (Andriguetto and Cunha 2004). This can be achieved through an integrated approach that involves the participation of local residents (Deikumah et al. 2015). In this context, the present study investigated the perceptions of bats of the population of the town of Caxias in Maranhão, Brazil, with the aim of verifying the principal factors that hinder community-level initiatives for the conservation of this important vertebrate group.

Methods

Study Area

The present study focused on the municipality of Caxias in Maranhão, Brazil. Caxias is part of the mesoregion of eastern Maranhão, and has an area of 5,196.77 km². It is neighbored to the north by the municipalities of Codó, Aldeias Altas, and Coelho Neto, to the west, by São João do Sóter and to the south, by Parnarama and Matões. The eastern limit of the municipality of Caxias coincides with the western border of the state of Piauí (Figure 1). Caxias has a population of approximately 155,000 inhabitants, with a density of 30.1 inhabitants per km² (IBGE, 2010).

Figure 1. Municipality of Caxias in Maranhão, Brazil, and the neighboring municipalities in eastern Maranhão.

Source: Prepared by the authors

Collection and analysis of data

Data were collected using interviews, which were conducted during visits to households in eight neighborhoods of the town of Caxias. These neighborhoods were Baixinha, Cangalheiro, Cohab, Centro, Campo de Belém, Dinir Silva, Seriema, and Volta Redonda. All the interviews were conducted in 2014, and a total of 398 local residents were interviewed. This project was approved by the Ethics Committee of Maranhão State University (UEMA) through protocol number 1.837.255 and CAAE: 60681916.0.0000.5554.

The questionnaire had three sections. The first section included questions on personal details (name, age, and sex of the interviewee, and neighborhood), as well as their education level. The second section of the interview included questions on the individual's perceptions of bats, and the third section, questions on the importance of these mammal for the population and Nature, that is, their conservation potential (Appendix A). The data were fed into Excel

spreadsheets for processing and quantitative and qualitative analyses. Statistical analyses were run in STATA, version 13 (STACORP, 2013), with a $p < 0.05$ significance level.

Results

Profile of the interviewees

A total of 398 individuals were interviewed during the present study. The interviewees were between 17 and 91 years old, and two-thirds (263; 66%) were women, while the other 135 were men (34%). Overall, 5.28% of the interviewees were illiterate, 2.51% were literate (basic reading and writing skills, but had not graduated elementary school), 29.90% had graduated elementary school, 45.98% had graduated high school, and 16.33% had a college degree. No correlation was found between sex and education level ($p = 0.521$).

Descriptions of bats and the imagined perceptions of the individuals interviewed

Fifteen interviewees (3.77% of the total) claimed not to know bats personally, although they described them as ugly animals with wings, black in color, that are nocturnal, malodorous, like caves and blood, and transmit rabies. These individuals stated that bats are similar to rats and birds.

The other 383 interviewees (96.23% of the total) reported that they knew bats. The characteristic most cited by these individuals was the ugliness of the bats, as well as being small in size, hairy, with wings, and either black, brown or gray in color, that hang by their legs. Irrespective of their age, sex or education level ($p > 0.46$), these interviewees reported negative aspects of bats, such as the fact that they were frightening or disgusting, associated them with other animals (Table 1), in particular rodents, with “rats with wings” being one of the most frequent descriptions. Only two of the 383 interviewees that confirmed knowing bats referred to them as attractive animals. One of these interviewees was male and had a college degree, while the other was a female elementary school graduate. Almost half (49.25%) of the interviewees reported being afraid of bats, although experience did not influence their fear ($p =$

0.396), that is, individuals were afraid of bats whether they had seen one or not. Similarly, no correlation was found between a fear of bats and the level of education of the interviewee ($p = 0.796$).

Table 1. Perceptions of the interviewees about bats.

Characteristics cited	Response of the interviewee
	“They look like rats with wings”.
	“They look like capuchin monkeys”.
	“They look like owls”.
	“They’re like butterflies, only larger”.
	“They look like vampires”.
	“They look like rats”.
	“They look like birds with monkeys’ faces”.

Source: Prepared by the authors

Perceptions of the interviewees on bat diets

In response to the question “What do bats eat?”, most interviewees referred to fruit, and mentioned specifically cashew, custard apple, papaya, mango, and acerola cherry. These fruits were mentioned either on their own or in combination with other foods. Typically, the interviewees reported having seen the bats either feeding on fruit or dropping seeds and pieces of fruit onto the ground. Other foods cited included insects, nectar, seeds, monkey pepper (*Xylopia aromatica* and *Piper aduncum*), blood, butterflies, other animals, rice, beans, termites, and leftovers. A total of 19 interviewees (18 of whom were female) were unable to provide an answer to this question. The 18 females included seven elementary school graduates, seven

high school graduates, and three with college degrees, while the male was a high school graduate.

Are all bats vampires? Are you scared of them?

In response to the question “Are all bats vampires?”, 22.03% (87) of the interviewees responded affirmatively (Figure 2), although 20 of these individuals were unable to justify their response. These 20 interviewees included two illiterate males, nine high school graduates (all female), six elementary school graduate (four female and two male), and three (two female, one males) college graduates. Most of the respondents justified their response based on the hematophagous diet of the bats, their teeth, body shape, images observed in films, and popular beliefs, which all indicate that bats drink blood and prefer this type of nutrient. In this case, a significant relationship ($p < 0.001$) was found between the belief that bats are vampires and the level of education of the interviewee, with a majority (42.52%) of the positive respondents being elementary school graduates, followed by high school graduates (35.63%).

The other 308 interviewees affirmed that not all bats are vampires, although 105 were unable to justify their response. These individuals included interviewees of different education levels, although the majority were female high school graduates, while the males had no formal qualifications. The other 203 interviewees justified their response, replying that bats “eat fruit”, “are mammals”, “don’t just eat blood”, “are different from vampires”, “belong to a number of different species”, “eat insects”, and “are frugivorous”. Other responses included “I have never heard of anyone being bitten”, “they don’t attack human beings”, “different bats eat different things”, “the vampire is from the United States”, “only the hematophagous bats are vampires”, and “there are no vampires in Brazil”.

213 **Figure 2.** Are all bats vampires? Responses of the interviewees in Caxias, Maranhão, Brazil.

Source: Prepared by the authors

217 Two thirds (66%) of the 308 interviewees that confirmed that not all bats are vampires
 218 were female, while the other 34% were male. As this is directly proportional to the number of
 219 male and female participants, there was no significant variation ($p = 0.635$) in the response to
 220 this question related to the sex of the interviewee.

221 In response to the question “Are you afraid of bats?”, 199 interviewees responded
 222 “no”(Figure 3), although three of these individuals responded that they feel disgust, rather than
 223 fear. A total of 196interviewees responded positively, including eight individuals who
 224 confirmed feeling both fear and disgust. All these individuals were female. Three interviewees
 225 did not provide a response to this question. There is a clear correlation ($p < 0.0001$) between
 226 the sex of the individual and a fear of bats, with women being significantly more likely to feel
 227 fear than men. A fear of bats was also associated significantly ($p < 0.001$) with the belief that
 228 they are all vampires.

Figure 3. Are you afraid of bats? Responses of the interviewees in Caxias, Maranhão, Brazil.

Source: Prepared by the authors

Perceptions on the conservation of bats

In the case of the question “If you found a live bat, what would you do?”, the most frequent response was to “kill” it (Figure 4). This was the response of 84 women (nine illiterate, five with an elementary education, 28 elementary school graduates, 33 high school graduates, and nine college graduates) and 51 men (four illiterate, 42 elementary school graduates, three high school graduates, and two college graduates). Sixty-seven interviewees responded that they would “do nothing”, including 36 women (11 elementary school graduates, one with an elementary education, 15 high school graduates, three who were illiterate, and six college graduates) and 31 men (13 elementary school graduates, one with an elementary education, nine high school graduates, two who were illiterate, and six college graduates). All the 39 individuals who replied that they would “run away” were female, including six elementary school graduates, 20 high school graduates, and 13 with a college degree.

The other 157 interviewees responded in different ways, including “I would leave it where it is” and “I would keep my distance and scream”, while others confirmed that their response would depend on where the bat was, and in particular, that they would kill it if it were

“inside their home”. Only one person, a male college graduate, responded that, if he saw a live bat, he would “admire it and take a photograph”.

Figure 4. If you found a live bat, what would you do? Principal responses. The other interviewees offered a number of different responses, which are covered in the text.

Source: Prepared by the authors

In response to the question “Do you think that bats are useful for Nature or human beings?”, 254 answered positively (Figure 5). Most (164) of these individuals were female, including nine illiterate persons, two with an elementary education, 27 elementary school graduates, 92 high school graduates, and 34 college graduates. The other 90 were male, including four illiterates, one with an elementary education, 25 elementary school graduates, 41 high school graduates, and 19 college graduates. A total of 102 interviewees responded negatively, including 68 women (eight illiterate individuals, one with an elementary education, 23 elementary school graduates, 30 high school graduates, and six college graduates) and 34 men (three illiterate, one with an elementary education, 15 elementary school graduates, 12 high school graduates, and three college graduates). The other 42 interviewees (24 women and 18 men) either did not provide a response or did not know what to say.

Figure 5. Do you think that bats are useful for Nature or human beings? Responses of the interviewees in Caxias, Maranhão, Brazil.

Source: Prepared by the authors

Of the interviewees that responded positively to the question on the usefulness of bats, 21 provided no justification, while 233 referred to ecological roles, such as seed dispersal, pollination, the control of insect pests, and their position in the trophic web. However, some individuals identified bats as vectors of diseases, in particular rabies. The sex of the interviewee did not influence significantly ($p = 0.656$) their response to this question, given that men and women provided similar responses to the question of the importance of bats for Nature.

In relation to the question “Do you think that bats deserve to live and should be protected, like other animals?”, 310 of the interviewees responded positively, 82 negatively, and six provided no answer. The principal responses are shown in Table 2. The sex of the interviewee did not influence the response to either question, i.e., whether bats deserve to live ($p = 0.518$) or should be protected ($p < 0.707$). A fear of bats (question 8) did not influence the response to this question ($p = 0.674$), nor whether the respondent felt that these animals should be protected ($p = 0.135$). Similarly, no systematic relationship ($p = 0.135$) was found between a fear of bats and the response to question 11 (whether bats should be allowed to live).

291 **Table 2.** Do you think that bats deserve to live and should be protected, like other animals?

292 Most frequent responses.

Response of the interviewee	Justification
Yes	<p>“Because they are living organisms”.</p> <p>“Because all living things have the right to life”.</p> <p>“Because they are useful to Nature”.</p> <p>“They deserve to live, but they shouldn’t be protected because they are of no use to anyone”.</p>
No	<p>“Because they are of no use to anyone”</p> <p>“Because they harm other animals, kill them, and suck their blood”</p> <p>“Because they transmit diseases”</p> <p>“Because they are ugly, disgusting, and frightening”</p>

293 Source: Prepared by the authors

294

295 Discussion

296 Few ethnozoological studies are available on the perceptions of human populations with
 297 regard to bats, and the studies that are available tend to be restricted to specific bat groups or
 298 localities (Gomes and Neto 2016). In Brazil, the available data indicate that most populations
 299 regard bats in a negative light (Bredt et al. 1996). In this context, the present study revealed that
 300 attitudes are derived from a mixtures of traditional beliefs and empirical knowledge on the
 301 characteristics of bats, as well as many misconceptions.

Comparisons between bats and birds tend to be related to the fact that these two groups of vertebrates are capable of flight, even though this is merely an evolutionary convergence, and the basic morphology of the two groups is quite distinct (Hildebrand 1995). Contrary to popular belief, the pelage of some bats is white (*Diclidurus*), red or yellowish, but as these animals are nocturnal, these difference are difficult to perceive, especially as the pelage of the vast majority of bat species is predominantly brown or black (Reis et al. 2007). Most of the interviewees referred to this type of coloration.

The legends and myths surrounding bats are related to their nocturnal habits, the fact that they roost “upside down”, and their lack of similarity with other mammals (Andriguetto and Cunha 2004). These attitudes were confirmed in the present study, which found that the vast majority of the individuals interviewed (383 of 398) responded negatively to the questions, considering these animals ugly, frightening (Batman) or disgusting, and in some cases, venomous. These negative attitudes were not influenced by the age or sex of the interviewees, nor were they affected significantly by the education level of the respondent.

One other characteristic that contributes to popular beliefs is the hematophagous behavior of some species, which is the most widely-known, but also the most misrepresented bat behavior, reinforcing the general idea that these animals are associated with vampirism (Zinn et al. 1998). In the present study, however, 78% of the interviewees were aware that not all bats are vampires, which is one positive aspect of the popular knowledge on the biology of these animals. In particular, many interviewees reported having seen bats feeding on fruit or dropping seeds and pieces of fruit to the ground. This influenced the responses on the bat diet, with 64.32% of the interviewees referring to frugivory, either exclusively or in combination with other types of food, followed by hematophagous behavior (39.94%) and insectivory (26.63%). Overall, then, fruit was seen as the principal bat food by most interviewees. Other feeding habits include nectarivory (pollination), carnivory, piscivory, and omnivory (Reis et al. 2011).

The general lack of information on the ecological importance of bats, which exploit an ample variety of feeding niches, contributes to unfavorable attitudes toward bats in general and a lack of support for conservation initiatives (Scravoni et al. 2008). This was clear from the results of the present study, given that, while 64% of the respondents confirmed that bats are useful to Nature, they were unable to define their importance. The individuals who did explain their response referred to seed dispersal, the control of insect pests, and pollination, as well as their importance for the equilibrium of trophic webs. Even so, some respondents did refer to the role of bats as vectors of diseases such as rabies.

Overall, then, a significant proportion of the interviewees did not view bats positively, confirming that they would avoid, scream at or even kill these animals if they encountered them. In a similar study in Japurá, in the Brazilian state of Paraná, Marques et al. (2011) found that approximately half of the interviewees (who were farmers) would be indifferent toward bats, should they encounter an animal. In other studies, alternative approaches have been recorded, such capturing the animal to release it somewhere else (Novaes et al. 2008).

The vast majority (78%) of the interviewees agreed that the bats deserve to live, simply because they are living organisms. Bats also deserve to live because they play important ecological roles in the ecosystem, where their activities are essential for the natural regeneration of the forest in impacted areas, and the control of some species of agricultural pest (Kasso and Balakrishnan 2013). Given this, it will be important to revert traditional beliefs on bats so that the population can understand the ecological importance of the different species and the real sanitary and medical dangers they may pose, in particular the hematophagous species. Environmental education is an important approach to the transmission of information on bats, and especially the risks of extinction faced by many species, and should be applied systematically to guarantee a more favorable environmental perspective on the coexistence of humans and bats in the urban environment (Gomes and Neto 2016). This should provide local populations with reliable and detailed information on the different ecological roles of bats, and

will hopefully arouse their curiosity on the ecological diversity and conservation of these unique mammals (Barreiro and Filho 2016).

Conclusions

The results of the present study provide important insights into the perceptions of bats by the urban residents of northern Brazil, which emphasize the widespread misconceptions of certain aspects of the biology and ecology of these mammals. These findings reinforce the need for systematic initiatives in environmental education in local schools and other public entities and associations, to promote the better understanding of the characteristics of these animals, their ecological importance, and, in particular, their role in the transmission of disease. It is hoped that initiatives of this type will lead to changes in attitudes that benefit the conservation of bats.

Declarations

Ethics approval and consent to participate

This project was approved by the Ethics Committee of Maranhão State University (UEMA) through protocol number 1.837.255 and CAAE: 60681916.0.0000.5554. It is available on the link: <http://plataformabrasil.saude.gov.br/login.jsf>

Consent for publication

The Consent for publication are available from the corresponding author on reasonable request.

375 **Availability of data and materials**

376 The datasets used and/or analysed during the current study are available from the
377 corresponding author on reasonable request.

378 **Competing interests**

379 The authors declare that they have no competing interests.

380 **Funding**

381 Maranhão State Research and Scientific Development Foundation (FAPEMA) for financial
382 support.

383

384 **Authors' contributions**

385 JSS conducted the interviews with the people and tabulated the data in excel spreadsheet. NPS
386 conducted the interviews with the people and tabulated the data in excel spreadsheet. EECS
387 performed the statistical analyzes and tabulated the data in excel spreadsheet. FAGA wrote and
388 revised the manuscript. ECF wrote and revised the manuscript. MCB wrote and revised the
389 manuscript. APMO conducted the interviews with the people, wrote and revised the manuscript.
390 All authors read and approved the final manuscript.

391

392 **Acknowledgments**

393 We would grateful to Dr. Wilson Uieda for his valuable advice on the development of
394 this study. We would also like to thank all the residents of Caxias that allowed us to interview
395 them, and without whom this study would not have been possible.

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Appendix A

UNDERGRADUATE COURSE IN BIOLOGICAL SCIENCES - TEACHING DEGREE

DEPARTMENT OF CHEMISTRY AND BIOLOGY

Questionnaire on bats in Caxias (Maranhão)

- 518 Name of the interviewer: _____
 519 Street: _____ N° _____ Neighborhood: _____ Date: ____/____/2015
 520 Name of the interviewee: _____
 521 Sex: () Male () Female Age: _____
 522 Education: () Elementary school () High school () College degree () Other
 523 (Describe) _____
 524 1. Do you know or have you ever seen a bat? () yes () no

- 525 2. If you answered “yes”, how would you describe the bat that you saw?
526
527 3. If you answered “no”, what do you think a bat is like? Describe it:
528
529 4. If you have seen a bat, where was it/what was it doing? () Flying () Roosting ()
530 Feeding () Fallen to the ground
531 5. At what time did you see the bat? () Morning () Afternoon () Night
532 6. What do bats eat? Name some of their foods:.....
533 7. Are all bats vampires? () yes () no Why?.....
534 8. Are you afraid of bats? () yes () no
535 Describe any other sentiments you may have toward bats:.....
536 9. If you found a live bat, what would you do? Describe your feelings and actions:
537
538 10. Do you think that bats are useful for () Nature or () human beings? If so, in what
539 way?.....
540 11. Do you think that bats deserve to live and should be protected, like other animals? () yes
541 () no. Why?

Figures

Figure 1

Municipality of Caxias in Maranhão, Brazil, and the neighboring municipalities in eastern Maranhão.

Figure 2

Are all bats vampires? Responses of the interviewees in Caxias, Maranhão, Brazil.

Figure 3

Are you afraid of bats? Responses of the interviewees in Caxias, Maranhão, Brazil.

Figure 4

If you found a live bat, what would you do? Principal responses. The other interviewees offered a number of different responses, which are covered in the text.

Figure 5

Do you think that bats are useful for Nature or human beings? Responses of the interviewees in Caxias, Maranhão, Brazil.