Attitudes Towards Scorpions and Frogs: A Survey Among Teachers and Students from Schools in the Vicinity of an Amazonian Protected Area

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ATTITUDES TOWARDS SCORPIONS AND FROGS: A SURVEY AMONG TEACHERS AND STUDENTS FROM SCHOOLS IN THE VICINITY OF AN AMAZONIAN PROTECTED AREA

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Many conservation and management policies adopted in countries with megadiverse forest remnants largely neglect local human communities living in areas surrounding preserves. We investigated the attitudes and knowledge of teachers and students towards scorpions and frogs in the limits between a tropical rainforest reserve and a large Amazonian city. We aimed to identify possible deficiencies in environmental education and the level of knowledge about these animals. Data were collected from 110 students of both genders, aging between eight and 16 years old, representing four different schools located at the periphery of Manaus City, Amazonas State, Brazil. Written responses concerning personal experiences, knowledge, and background about the animals were collected from students and teachers through open- and closed-ended questions. Hand drawn responses were also gathered from the students. Members of the studied population showed more negative than positive attitudes towards scorpions and frogs. We found that gender and sex held similar attitudes in relation to these animals. However, boys tended to be more interested than girls were in the biology of scorpions. In addition, attitudes towards scorpions became more negative as age increased. Most students pictured scorpions and frogs as dangerous, lethal, or aggressive. Such conceptions were also recorded among teachers. We detected a huge lacuna in the knowledge on the importance and about biological and ecological aspects of both groups. Educational activities focused on emotional affinity of students with animals should be associated with traditional lessons, which can enhance conservation strategies.

Keywords: *Amazonia, Anura, ecological reserve, environmental education, Scorpiones*

Introduction

Humans are extremely sensitive to biologically threatening stimuli (Seligman 1971). Data on populations from America and Africa support the hypothesis that humans display preference for living in dry and open areas (i.e., savanna) and avoid dense forests, as a remnant of our evolutionary history in natural biomes (Falk and Balling 2009). In contrast to the more closed and complex environment of dense forests, the openness of the savanna facilitates the anticipation and detection of predators (Orians 1980). Studies have demonstrated fear attitudes of humans and other primates towards snakes, spiders, lions, and other animals considered of relevant threat (Hayakawa et al. 2011; Isbell 2006; Masataka and Shibasaki 2012; Masataka et al. 2010; Öhman and Mineka 2001; Penkunas and

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Coss 2013; Rakison and Derringer 2008). The innate aversion that humans have in relation to these animals can be a result of a powerful selective pressure that provided humans a set of psychological adaptations to avoid threatening situations in order to ensure survival (LoBue and Rakison 2013).

Sociocultural pressures and personal factors can also exert influence on human attitudes towards animals. Such pressures and attitudes include economic values (Serpell 2004), traditional religious practices (Ceríaco et al. 2011), and cultural beliefs, especially those derived from popular culture (Ceríaco 2012). Studies have shown that human females manifest more negative attitudes towards animals considered to be a threat and harm than males (Ceríaco 2012; Curtis et al. 2004; Curtis et al. 2011; Oaten et al. 2009; Prokop and Fancovicova 2012, 2013). It has also been shown that humans become more scared of animals as they get older (Ericsson and Heberlein 2003; Kleiven et al. 2004). Thus, human aversion to animals derives from a combination of sociocultural and evolutionary factors, which, along with many current environmental problems (Blaustein and Kiesecker 2002), have a great impact on animal populations, causing death and/or population declines of species.

In Brazil, one of the richest reserves of biodiversity in the world, amphibians and scorpions are represented by 1026 and 160 species, respectively (Brasil 2009; SBH 2014). Scorpions and anuran amphibians (frogs and toads, hereafter referred to as frogs) are objects of innumerable stories, legends, and beliefs that are deeply rooted in popular culture in Brazil (Cascudo 2004; Leite 2004). However, beyond the common aversion and lack of interest of people for these animals (Ceríaco 2012; Kellert 1993; Prokop and Fancovicova 2013), habitat loss, degradation, and fragmentation are the most significant threats to these animals (Primack and Rodrigues 2001; Wake 1991).

Urbanization is one of the leading causes of decreases in animal populations (McKinney 2006). Protected areas represent powerful tools for biodiversity conservation, but many conservation and management policies adopted in Brazil ignore the social and biological universe of human populations living in protected areas or in their vicinity (Diegues 2000). The Amazon biome covers about 60% of the Brazilian territory (IBGE 2010) and is recognized for its exuberant continental landscapes in which humans are configured as an integral part. Numerous social groups that inhabit the Amazon (i.e., mestizos, riparian, indigenous, and urban people) have developed unique lifestyles, transmitting their customs and cultural practices to subsequent generations (Fraxe 2004). Despite its geographical and sociocultural dimensions, this biome is one of the least studied in ethnoconservation research (Alves and Souto 2011). In the Amazon, studies have generally focused on indigenous people and riparian populations (Alves and Souto 2011), but urban human populations inhabiting and establishing relations with resources near protected areas have been little studied. Thus, the popular knowledge and attitudes that these populations have towards the natural world is disregarded, rather than being integrated into management efforts of these areas (Bensusan 2006). The comprehension of these phenomena is essential for understanding the relations between humans and environment, which is significant for biodiversity conservation, sustainable development, and formal education (Begossi 1998; Clement 1998).

The Environmental Protection Area Adolpho Ducke is a 10,000 ha forest fragment with high biological potential for maintaining native biodiversity. Despite a considerable amount of studies and field guides carried out since the 1960s, the area has suffered an intense transformation due to uncontrolled human settlement in its surroundings (Oliveira et al. 2008). The fragment has only recently been transformed into an environmental conservation area by the Municipal Decree 1502 of March 27, 2012 (SEMMAS 2012) and there is a period of five years for the development of an ecosystem-based management plan considering the local human communities living nearby. We are not aware of any study with an ethnozoological focus in this protection area.

We investigated the attitudes and knowledge of teachers and students living near a tropical rainforest protection area towards scorpions and frogs. These taxa were chosen as indicators of environmental awareness because they represent threatened and impaired animal groups that can be found in both pristine and human-altered environments. First, we aimed to identify possible deficiencies in environmental education and the level of knowledge of individuals about biological and ecological aspects of these animals. We anticipated that humans in general would have more negative attitudes (i.e., aversion, fear) than positive ones (i.e., sympathy, fearlessness) towards scorpions and frogs. Second, we included gender and age as independent variables to assess their influence on human attitudes in relation to these animals. Based on aforementioned studies, we expected that boys would be less likely to show negative attitudes than girls and that attitudes would become more negative with increasing age. Third, we investigated the impact of the family, teacher/school, or media as sources of information influencing individuals. Given that the family is recognized as the primary arena for learning (Fagundes 2001), we expected the family to play a central role in the construction of perceptions about nature, followed by further experiences at school and in people's social lives.

Methods

Study Site

The study was conducted in the region surrounding the Environmental Protection Area Adolpho Ducke (02°55′ and 03°01′ S, 59°53′ and 59°59′ W), located north of Manaus City (Figure 1, left). Fifty anuran and 11 scorpion species are recorded for the area (Araújo 2007; Lima et al. 2008). Human occupation in the limits of the reserve is represented by two districts (Cidade de Deus and Nova Cidade), including various communities living in non-traditional (modernized) ways. About 130,000 inhabitants, including immigrants from other local villages and from other regions are living in the area (IBGE 2010). Both districts are characterized by a large number of non-regulated occupations (Figure 1, upper right and lower right), sanitation problems, and lack of basic infrastructure such as sewage treatment. Because of the deforestation along the border of the rainforest, many animals take refuge in the vicinity of or inside the homes of the residents, which sometimes leads to injury or death of animals. People that

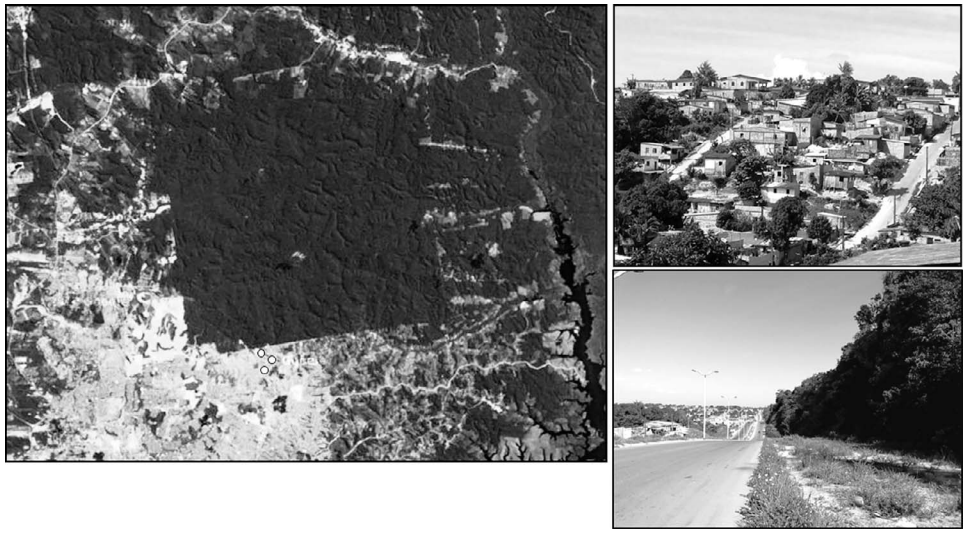

Figure 1. Neighborhoods covered by the study. Left: Environmental Protection Area Adolpho Ducke in square form and circles indicate the locations of the schools involved in the research; Upper right: Residencies of the "Alfredo Nascimento" District which neighbor the protection area; Lower right: Limit between the protection area and the "Cidade de Deus" District (Image Credit: left) www.mapsgoogle.com.br; upper right) and lower right) Vanessa Gama).

neighbor the protection area are unaware of the importance of conserving the existing biodiversity, claiming not to know the purpose for which the reserve was created (Azevedo 2007).

Participants

The study was conducted between February and April 2013. The sample of participants comprised children and teenagers (53 boys and 57 girls) aged between eight and 16 years, attending one of the four primary classes of selected municipal schools. The legal representatives of the students were asked for permission to perform the research with their children one month prior to the beginning of the study. Another group was comprised of four teachers of the selected classes. The research project was submitted to the Human Research Ethics Committee (CEP) of Instituto Nacional de Pesquisas da Amazônia (INPA) and approved on February 27, 2013, under project identification (ID) number 12151013.8.0000.0006.

Written Responses and Drawings

Written and hand drawn responses were collected from the students in the classroom in the presence of the teacher and a researcher. The questionnaire included six open-ended and three closed-ended questions and took 30 minutes to complete. Drawing sets and paper of 30 $\times$ 23 cm were given to the students to draw pictures related to their attitudes towards scorpions and frogs and took another 30 minutes to complete. The act of drawing allows the participant to focus

attention on particular features and to organize information processed through lived experiences, which allows them to develop a unique style of representing the world (Goldberg et al. 2005), reflecting the unique social, educational, and cultural experiences of the students. This method has as a theoretical basis in studies of childhood development carried out by Luquet (1984) and Piaget (1966), and represents a reliable tool for assessing attitudes related to the environment (Alerby 2000; Dove 1999; McNair and Stein 2001). The purpose of the drawings was explained to the students in a general way. The phrase, "The first thing you remember when you think of scorpions and frogs," was written in Portuguese on the class board as a thematic direction for the illustration. In addition, the researcher requested a written explanation about the drawing.

Written responses were collected from the teachers in a dedicated room to avoid distractions. The questionnaire included six open-ended questions and took 30 minutes to complete.

Data Analysis

Four sets of data were analyzed: open-ended questions, closed-ended questions, students' drawings, and teachers' open-ended questions. All interviews were conducted in Portuguese. For the students, age and gender were considered. Two questionnaires were designed, one for scorpions and another for frogs, placed side-by-side on the same page. Items from the questionnaire were modified by simply changing the term "scorpion" to "frog." The questions were as follows:

1. What is a scorpion (frog)?
2. Is it important? (Yes or No) and Why is it important?
3. Do you like scorpions (frogs)? (Yes or No)
4. Have you heard about scorpions (frogs)?
5. Who told you about scorpions (frogs)?
6. Did you learn about frogs (scorpions) in school? (Yes or No) and What did you learn?

For the teachers, we considered age, gender, area of expertise, how long they have been teaching, how long they have been working at the school, and type of employment at the school. One questionnaire was designed with six questions. These were:

1. What do you know about the biodiversity of the Environmental Protection Area Adolpho Ducke?
2. What is a scorpion? What do you know about scorpions?
3. What is a frog? What do you know about frogs?
4. Have you been giving classes about scorpions or frogs? If yes, what have you been teaching? If not, why?
5. In your opinion, what is environmental education?
6. Have you been giving classes in a natural environment? If yes, where and with what frequency? If not, why?

Content analysis was used for open-ended questions and the central idea of each answer was categorized (Bardin 1977; Bauer and Gaskell 2002). Three human attitudes and behaviors towards scorpions and frogs were used for the interpretation of the answers: 1) distance, when showing aversion, fear, or life threatening potential; 2) proximity, when showing sympathy and fearlessness; 3) biology, when showing knowledge about aspects of life and ecology of the animal.

The terms (words) and their frequency in the answers were recorded. Terms with similar ideas were grouped in the three established categories, considering the total frequency of use of each term. Thus, the number of words in each category was used as a dependent variable to reflect underlying domain or environmental knowledge related to scorpions and frogs.

To test gender and age effects on the drawings and answers to the closed questions, the students were split in two groups of eight to 11 years old ($n = 57$) and 12 to 16 years old ($n = 53$). Lastly, to test for a difference between the impacts of different sources (teacher/school, media, or family/friends) on the attitudes of students towards animals, the frequencies at which they were indicated were compared. All statistical tests were calculated using the R Programming Language (R Core Team 2012).

Teachers' answers were used mainly for the discussion of the data collected from the students. A full reference collection of material (written responses and drawings) was deposited in the Laboratory of Systematic and Ecology of Soil Invertebrates at INPA.

Results

Students Attitudes and Knowledge Towards Scorpions (Open-Ended Questions)

The students demonstrated more negative than positive attitudes towards scorpions (Figures 2A and 2B). The use (frequency) of terms related to distance ($p = 0.037$, Student's $t = 2.109$) and biology ($p = 0.025$, Student's $t = -2.30$) varied with gender. Girls (mean = 3.509) used one more word on average to express distance than boys (mean = 2.660). Boys tended to be more interested in the scorpion's biology than girls were. They (mean = 0.811) expressed twice as many terms related to biology than girls (mean = 0.439). There was no significant effect of gender in expressing proximity towards scorpions ($p = 0.677$, Student's $t = 0.416$) (Figure 2A).

Because very few responses were categorized as attitudes of proximity and biological knowledge (biology), the effect of age was tested for terms expressing distance towards scorpions only. The use of terms expressing distance increased with the age of the individuals ($p = 0.002$, linear regression's $F = 10.34$, $r^2 = 0.087$) (Figure 2B). When combining the effect of age and gender, the attitudes of distance were also significant. The use of terms of distance increased among girls ($p = 0.0004$, linear regression's $F = 9.04$, $r^2 = 0.250$) until they were 13 years old, but decreased thereafter. In contrast, among boys the use of this term

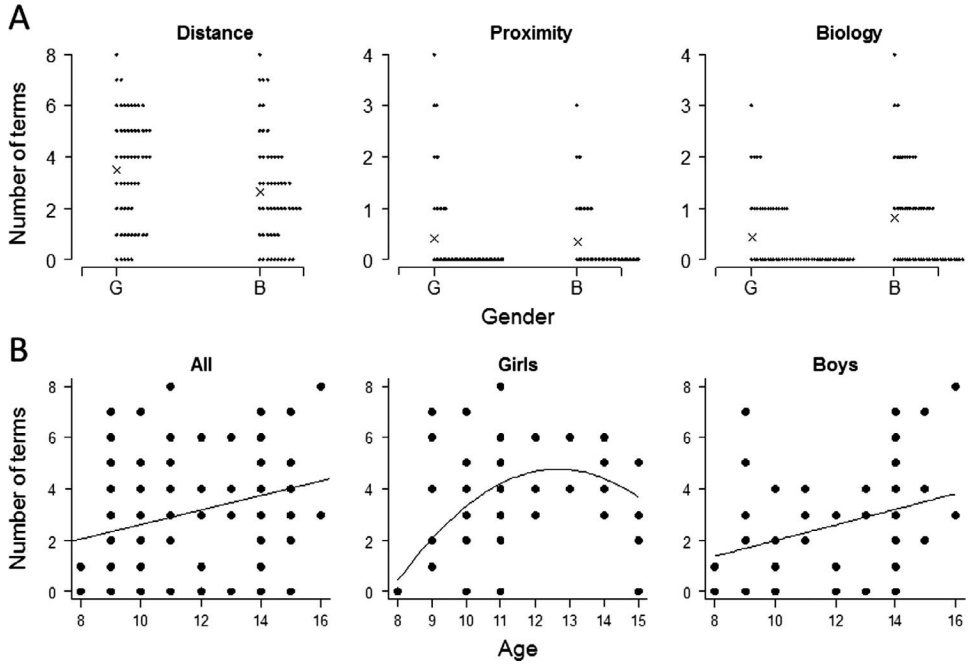

Figure 2. Frequency of the terms used by the students towards scorpions. A) Frequency of the terms used by girls (G) and boys (B) in relation to the attitudes of distance, proximity, and biology towards scorpions. B) Number of terms used according to age and gender of the student in relation to distance towards scorpions. Total = total of individuals; X = mean of each treatment.

increased progressively with age ($p = 0.019$, linear regression's $F = 5.893$, $r^2 = 0.103$) (Figure 2B).

Student's Attitudes and Knowledge Towards Scorpions (Closed-Ended Questions)

Boys and girls did not differ in relation to the knowledge (response type frequency) about 1) what a scorpion is (Student's t, $p = 0.159$); 2) if scorpions are important (Student's t, $p = 0.097$); and 3) if the individual liked scorpions (Student's t, $p = 0.274$). Younger and older students held similar attitudes in responding to the questions (Student's t, $p = 0.164$, $p = 0.250$, and $p = 0.220$, respectively).

Student's Attitudes and Knowledge Towards Scorpions (Drawings)

We found a significant difference between genders ($p = 0.029$, chi-square = 4.709), because more drawings expressing distance were recorded for girls ($n = 19$) than for boys ($n = 8$). Boys showed a higher frequency of drawings expressing biology ($n = 35$) in relation to girls ($n = 26$) (Figure 3).

The drawings of 15 older and 12 younger individuals were categorized as attitudes of distance and the difference was not significant for the effect of age (chi-square, $p = 0.445$). The drawings of 27 older and 34 younger individuals expressed biological knowledge, but the difference was not significant either (chi-square, $p = 0.557$).

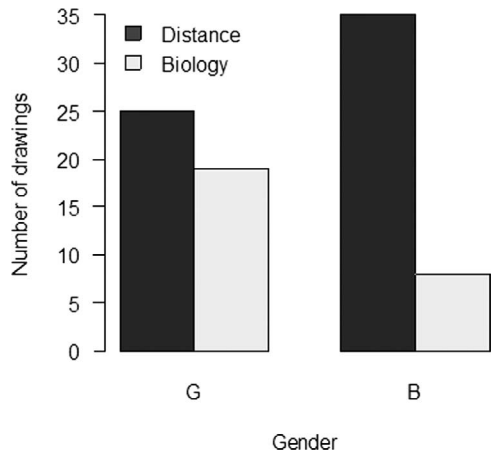

Figure 3. Number and categorization of student's drawings in relation to scorpions. Dark grey bars show the number of drawings grouped in the attitudes of biology and light grey bars show the number of drawings grouped in the attitudes of distance. G = Girls and B = Boys.

Student's Attitudes and Knowledge Towards Frogs (Open-Ended Questions)

Students more often have negative rather than positive attitudes towards frogs (Figures 4A and 4B). Boys and girls held similar attitudes of distance (Student's t, $p = 0.217$), proximity (Student's t, $p = 0.897$), and biological knowledge (Student's t, $p = 0.799$) towards frogs. The effect of age was tested only for terms expressing distance towards frogs only, because few responses were categorized as attitudes of proximity and biology. No difference was found for the effect of age considering all individuals (Student's t, $p = 0.209$, $n = 110$), only boys (Student's t, $p = 0.280$, $n = 53$), or only girls (Student's t, $p = 0.290$, $n = 57$). In relation to frogs, boys and girls of all ages held similar attitudes.

Student's Attitudes and Knowledge Towards Frogs (Closed-Ended Questions)

Genders did not differ in relation to the knowledge (response type frequency) about what a scorpion is (Student's t, $p = 0.863$), if frogs are important (Student's t, $p = 0.438$), and if the individual liked frogs (Student's t, $p = 0.259$). The same way, younger and older students held similar attitudes in responding such questions (Student's t, $p = 0.257$, $p = 0.206$, and $p = 1.000$, respectively).

Student's Attitudes and Knowledge Towards Frogs (Drawings)

Considering the number of drawings representing distance made by boys ($n = 3$) and girls ($n = 10$), the gender of the participant had no effect on the representation of frogs in the drawings (chi-square, $p = 0.157$). The same result was found for the number of drawings representing biology made by boys ($n = 37$) and girls ($n = 39$).

Considering the number of drawings made by younger ($n = 4$) and older individuals ($n = 9$), the age of the participants had no effect on the drawing's

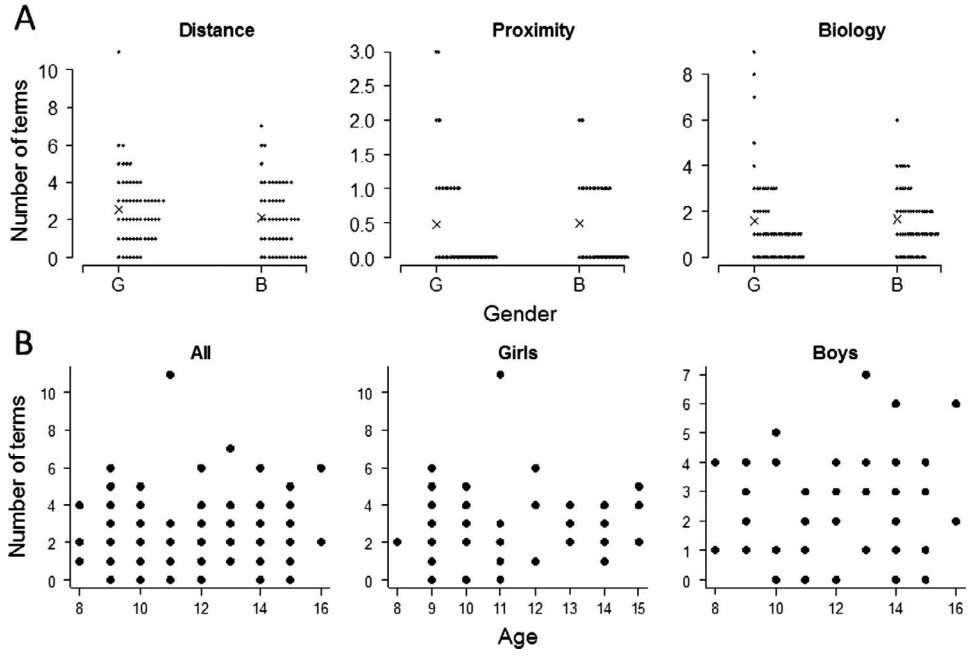

Figure 4. Frequency of the terms used by the students in relation to frogs. A) Frequency of the terms used by girls (G) and boys (B) in relation to the attitudes of distance, proximity, and biology towards frogs. B) Number of terms used according to age and gender in relation to distance from the frogs. Total = total of individuals; X = mean of each treatment.

representation of frogs (chi-square, $p = 0.213$). The same result was found for the number of drawings representing biology made by younger ($n = 41$) and older ($n = 35$) students.

Narrative of Students and Teachers about Scorpions and Frogs

Students' narratives (Table 1) showed attitudes towards animals, like: 1) the animals exhibit intentionality for evil practices, e.g., "…do not like them [frogs] because they are the devil's things"; "I do not even come close to them [scorpions] because they are evil and all that they want to do is to hurt us"; 2) popular beliefs, e.g., "I do not like frogs because it spits that milk; if the milk catches the eye, it can make us blind"; 3) familiar background, e.g., "My father said that the scorpions help to make compost because they live in trunk of fallen tree"); 4) aspects of biology and ecology, e.g., "They [frogs] are green and full of flecks across the skin"; "Scorpions help in plantation, with the growth of plants."

Teachers' narratives (Table 2) described several aspects of: 1) ecology, e.g., "A person who has been stung by a scorpion feels a lot of pain, but the poison can be lethal or not, all depends on the species and the smallest are the most dangerous"; 2) misconceptions, e.g., "Frog is an amphibian animal that squirts blood from its eyes as a defensive strategy"; and 3) showed ignorance about the animals,

Table 1. Attitudes and knowledge towards scorpions and frogs manifested by students from four schools near a tropical rainforest reserve. Information from the literature is showed at the right column.

Phrases	Information from the literature
"My father said that the scorpions help to make compost because they live in trunk of fallen tree" (boy, 12 years old) "Scorpions help in plantation, with the growth of plants" (boy, 10 years old).	Scorpions are usually discrete and nocturnal animals. During the day, they are hidden under logs, bark, and stone, and in rock crevices or holes in the ground. Its representation as an animal that helps the production of fertilizer or plant growth can be associated with its habit, which is close to decaying organic matter (Ruppert et al. 2005).
"The mucus of the frog helps people to get rid of warts" (girl, 12 years old).	The mucus of the frogs helps their skin retain moisture, which the frog needs to breathe and stay hydrated (Duellman and Trueb 1994). Frogs and warts are associated with mystical beliefs. However, warts have nothing at all to do with the frogs themselves (Burke Museum of Natural History and Culture 2015).
"…do not like them [frogs] because they are the devil's things" (girl, 13 years old). "I do not even come close to them [scorpions] because they are evil and all that they make is to hurt us" (girl, 12 years old).	The representation of frogs in tales and narratives associated with witches and evil things refers to the Middle Ages. Even today, many rituals and magic cults use animals like frogs, scorpions, snakes, and spiders (Barros 2005; Leite 2004).
"If you get close to the frog, it splashes a stinky piss that burns the skin and makes the person blind" (girl, 12 years old). "The frog's piss causes burns and wounds when it touches the skin" (boy, 11 years old).	Frogs eliminate urine when they feel threatened, emptying the bladder as a strategy to facilitate escape (Wells 2007). There is no scientific evidence to prove that the frog's urine can blind a human being, although it can generate irritation when it is exposed to the eyes (Pough et al. 2003).
"I do not like frogs because it spits that milk; if the milk catches the eye, can make us blind" (boy, 14 years old). "When the frogs sees us, he spits milk outside of his mouth" (boy, 14 years old).	Anurans have mucous glands scattered all over the body. They squirt jets of a transparent and milky mucus when pressed, as a defense against predators (Pough et al. 2003). The defense mechanism of the Amazonian toad *Rhaebo guttatus* is unique because it can voluntarily squirt jets of poison from its parotoids (Jared et al. 2011).
"Frog squirts blood from its eyes" (girl, 9 years old).	Information not found in the literature.
"Frogs have the body covered with moss" (girl, 13 years old).	Many species of frogs can carry a layer of algae attached to the integument, when they leave the water to the land, and may look similar to a concentration of mosses (Duellman and Trueb 1994).
"Frog is not important because it only stays in the lake" (boy, 9 years old). "Frogs live in ponds" (boy, 9 years old) "They [frogs] are green and full of flecks across the skin" (girl, 10 years old)." "Scorpions live in the desert of Africa" " (boy, 13 years old).	In textbooks of elementary education, amphibians are generally represented by green frogs that live on aquatic plants in lakes or ponds. Scorpions are represented living in the sand of arid environments. This way, their ecological role in the ecosystem can be diminished. Some textbooks are marked by landscapes and species that are not found in Brazil (Pinheiro da Silva and Cavassan 2003). This also suggests that great care must be taken in textbook writing, bringing the students closer to their reality.
"Frog is a reptile animal" (girl, 13 years old). "The scorpion is an insect that stings and hurts us" (boy, 11 years old).	Frogs belong to the Class Amphibia instead of the Class Reptilia, but the term "reptile" usually refers to ectodermic or "cold-blooded" animals, a characteristic shared by the two classes (Pough et al. 2003). The scorpions are animals belonging to the Class Arachnida and not to the Class Insecta, which is also a very common and popular identification (Ruppert et al. 2005).

Table 2. Attitudes and knowledge towards scorpions and frogs manifested by teachers from four schools near a tropical rainforest. Information from the literature is showed at the right column.

Phrases	Information from the literature
"Frog is an amphibian animal that squirts blood from its eyes as a defensive strategy" (Teacher, CSA, 36 years old).	Amphibians have several defensive strategies, but the elimination of blood through the eyes was not found on the literature (Pough et al. 2003).
"Scorpions are arachnids animals and there are people that can eat them, taking his tail, they can be eaten!" (Teacher, CSA, 36 years old)	In Asia and Eastern European countries, the consumption of scorpions is a common practice, but the stingers and venom glands from the tips of the scorpions' tails must be discharged (Brazil and Porto 2010).
"A person who has been stung by a scorpion feels a lot of pain, but the poison can be lethal or not, all depends on the species and the smallest are the most dangerous" (Teacher, CSA, 36 years old).	Lethal potency of scorpion's venom varies according to the species. The most poisonous scorpions, although they are toxic enough to kill many invertebrates, are generally unable to deliver enough venom to kill healthy adults. However, it can be painful when venom is injected into the victim (Ruppert et al. 2005).
"The frogs are poisonous animals, but I know they are not aggressive. They only expel poison when they feel threatened" (Teacher, MSFS, 34 years old).	The release of toxic substances through the frog's skin only occurs when the individual feels threatened by a predator. Most species expel the poison only when the secretion glands are pressed (Jared et al. 2011).
"Scorpion is a poisonous animal that lives in humid places and is resistant because it has a hard shell" (Teacher, MSFS, 34 years old).	Scorpions inhabit forests and pastures, but its occurrence is not restricted to moist environments. They can inhabit arid regions such as Baja California, the region with the greatest diversity of scorpions in the world. The exoskeleton of scorpions is waterproof and very resistant to mechanical shocks (Ruppert et al. 2005).
"Amphibians are poisonous animals, which have several classes such as frogs, toads and salamanders" (Teacher, EVB, 40 years old)	Erroneous classification of frogs is quite common. These animals belong to the Class Amphibia that consists of three orders: Anura (toads and frogs), Urodela (salamanders), and Gymnophiona (caecilians) (Pough et al. 2003).
"Scorpion is an arachnid. And it bites, beware of the bite, can kill! Take care when you step on the leaves" (Teacher, EVB, 40 years old).	It is estimated that 5,000 people per year die from scorpion bites. As a result, these animals are among the invertebrates that cause most human deaths in the world, after the bee sting (Hymenoptera) (Ruppert et al. 2005).
"Frog is a disgusting amphibian and is very smooth, but are important for the ecological balance by feeding on insects that cause plagues" (Teacher, VL, 26 year old).	The amphibian mucous glands secrete a clear, watery to viscous substance that cover their integument, which makes the species most slippery when captured by predators or handled by humans (Wells 2007).
"[Scorpions] ... are poisonous creature that attack with the tail, causing death. They live in rotten pieces of wood" (Teacher, VL, 26 years old).	The use of the tail or post-abdomen as a defensive weapon in prey capture is characteristic of scorpions and the venom produced in the bottom of this apparatus can be lethal to humans (Ruppert et al. 2005).
"Don't know if there is scorpions here, but I think that there is no scorpions here in this region" (Teacher, MSFS, 34 years old).	Amazonas State has the greatest diversity of scorpions in Brazil, with 38 described species (Brazil and Porto 2010). In addition, 11 species of scorpions were recorded for the Environmental Protection Area Adolpho Ducke. Some of them occur in the areas of the forest edge, being closest to the population (Araújo 2007).

Table 3. Percentage of impacts of sources of information on the attitudes of students towards scorpions and frogs.

Source	Scorpions	Frogs
Family/Friends	65	51
Teacher/School	24	29
Media	11	20

e.g., "Don't know if there are scorpions here, but I think that there are no scorpions here in this region."

Impacts of Different Sources of Information on the Attitudes of Students Towards Scorpions and Frogs

Family represented the main source of information of the students, namely 65% in relation to scorpions ($p = 0.001$; chi-square = 39.7) and 51% in relation to frogs ($p = 0.004$, chi-square = 11.1) (Table 3). In addition, further experiences originated from the school, teachers, and social life (media) were also important in the narratives.

Discussion

We examined the extent to which students and teachers living near a tropical rainforest interact with frogs and scorpions, including gender and age as independent variables. Our research provides the first example of people's attitudes towards animals in the vicinity of the Environmental Protection Area Adolpho Ducke, one of the best-studied tropical reserves in the world (Oliveira et al. 2008). As we anticipated, the students showed more negative than positive attitudes towards scorpions and frogs. Effects of gender (where boys tended to be more interested in terms related to animal's biology) and age (where attitudes became more negative in older individuals) were restricted to specific sets of data in relation to scorpions. These results do not uniformly corroborate previous investigations showing that individuals become more scared of animals as they get older, probably by the accumulation of negative perceptions over time (Ceríaco 2012; Ericsson and Heberlein 2003; Kleiven et al. 2004).

Ceríaco (2012) found that older people had fewer negative attitudes about frogs compared to younger people. Higher levels of experience and knowledge are to be expected in much older individuals, like those interviewed by Ceríaco (2012). We interviewed individuals in a shorter and complementary age group, which varied from eight to 16 years. Therefore, future studies on the effects of gender and age in relation to attitudes towards animals should encompass a wider age group in the sampling universe.

Our results are also contrary to our expectations that animals would be generally perceived as more dangerous or disgusting by girls than by boys. Previous investigations reported that human females have a greater tendency to show negative attitudes towards animals considered dangerous, probably because of the

different cultural contexts in which distinct genders are raised (Ceríaco 2012; Curtis et al. 2011; Oaten et al. 2009; Prokop and Fancovicova 2013; Prokop et al. 2009).

Negative impressions related to frogs are especially surprising given that, unlike scorpions, the region of Manaus City does not harbor epidemiologically important amphibian species (Lima et al. 2008). It is well known that human attitudes are more positive towards mammals and birds and generally negative towards ectothermic animals such as arachnids, insects, reptiles, and amphibians (Czech and Krausman 2001; Prokop and Tunnicliffe 2008; Rakison and Derringer 2008). Possible reasons for these differences in attitudes are phylogenetic distance between humans and these animals (Herzog and Burghardt 1988), difficulties to domesticate them (Pagani et al. 2007), and minimal direct effect on human survival as main source of food (Ungar and Teaford 2002). Taken together, these studies suggest that the bond between persons and the natural world (biophilia, Kellert and Wilson [1993]) is highly dependent on the life forms' attributes.

Importantly, arachnids (including scorpions) and amphibians (including frogs) are reported to contain a higher percentage of threatened species than endothermic vertebrates (IUCN 2014). Threatened and impaired animal groups should be considered with special attention in environmental education curricula in order to promote protection efforts. Since this study was performed from an educational perspective, the negative perceptions registered here can be translated into negative attitudes towards nature and specifically towards these animals. This shows that the formal curriculum deserves revision in order to consider human-environment interactions as part of a cultural, behavioral, and attitudinal complex (Ardoíno 2002).

The narrative of students (Table 1) and teachers (Table 2) showed that biological misconceptions do exist in the popular imagination, especially with regards to frogs. Some individuals expressed strong life-threatening attitudes towards frogs, which were depicted as intentionally evil. Such humanization of animals is the basis of human-wildlife interactions among many traditional Amazonian indigenous peoples (Descola 1997). The interviewed population, although living in Manaus, a city with several policies of urban development, public education, health, and environment, is largely composed of the descendants of people who migrated from the interior of the Amazonas State (Azevedo 2007). The majority of this population came from riparian areas, which implies the survival of key aspects of their traditional culture, such as myth, religious aspects, and beliefs, influencing their modus vivendi and modus operandi. Thus, the results show that even in an urban environment there are narratives about the intentionality of animals for evil practices against humans.

The main source of information for students was the family. As a group, they form a microenvironment derived from the social world, which is not always in full agreement with academic knowledge (Fagundes 2001). Thus, teachers must be prepared to deal with knowledge and perceptions acquired outside school that can impede species conservation. Further research involving students' parents and relatives, reaching a larger universe of age, gender, and experiences, must shed light on the complex network of social and cultural interactions that influences the children's behavior.

We detected a large gap in knowledge on the ecology and biological importance of scorpions and frogs, associated with aversion towards these animal groups. Therefore, we suggest that combining traditional lessons with educational activities focused on emotional affinity of students with animals can be very effective for the conservation of these animals. Such an approach might be especially successful in relation to scorpions, frogs, and other animal taxa for which human aversion seems to be primarily a sociocultural construct rather than evolutionarily inherited.

Results on people's attitudes concerning endangered species can be useful for developing management plans and in our case, a plan for the Environmental Protection Area Adolpho Ducke. We must consider the establishment of links between communities to stimulate a larger commitment in the preservation of the area via environmental education. The challenge is to change the way people value the wilderness of which scorpions and frogs are a part, breaking down cultural biases and emphasizing their ecological importance in the environment. This way, the local population can contribute strongly to the success of conservation efforts.

Communities surrounding parks and reserves need to be educated about conservation and the importance of local species. Although potentially harmful to biodiversity, popular knowledge, myths, folklore, and every day practices of local people must be incorporated in every discussion regarding conservation strategies. Additional research with an ethnozoological approach is undoubtedly needed in order to expand the understanding of the relationships between residents and the existing fauna in the region. In addition, environmental education might improve the emotional perception of animals by the human population living on the edge between cities and tropical reserves.

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