

Research Article

The thin-spined porcupine, *Chaetomys subspinosus* (Rodentia: Erethizontidae), within protected areas in the Atlantic Forest, Brazil: local knowledge and threats.

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Abstract

The thin-spined porcupine, *Chaetomys subspinosus*, is an endemic mammal of the Atlantic forest of northeastern Brazil. With its population declining, it has been listed as "vulnerable" in the Brazilian Red List. Its National Action Plan, published in 2011, intended to develop awareness projects about the species in local communities, to implement alternative income projects and protein consumption, and to evaluate hunting pressure. This study investigates rural residents' knowledge of the thin-spined porcupine and its uses within two protected areas. We also examine residents' behaviour and perceptions about wildlife conservation. One hundred twenty-five semi-structured interviews were conducted with rural residents of the Una Wildlife Refuge and the Serra do Conduru State Park. Local knowledge was higher among males with lower levels of formal education who were current or past hunters. Negative behaviour occurs among residents in both protected areas. There is a need for greater control of potential threats such as hunting, use of fire and deforestation, which are inconsistent with the existence of protected areas and conservation of the thin-spined porcupine. Information provided by this study can improve and promote actions within the National Action Plan for the conservation of *C. subspinosus*.

Key words: Human Behaviour; Hunting; Local people; Perception of rural residents; Thin-spined porcupine.

Resumo

O ouriço-preto, *Chaetomys subspinosus*, é um mamífero endêmico da Mata Atlântica do nordeste brasileiro. Devido ao declínio populacional da espécie, ele tem sido listado como "vulnerável" pela IUCN. O Plano de Ação Nacional da espécie foi publicado em 2011 e tem como objetivos desenvolver projetos de conscientização sobre a espécie, implementar projetos de renda alternativa e fonte de proteína alimentar e avaliar a pressão da caça. Esse estudo investiga o conhecimento de moradores rurais sobre o ouriço-preto e seus usos em áreas protegidas. O comportamento e percepções dos moradores com relação à conservação da fauna também foram investigados. Foram conduzidas 125 entrevistas semi-estruturadas com moradores rurais do Refúgio de Vida Silvestre de Una e do Parque Estadual Serra do Conduru. O conhecimento local sobre a espécie foi maior em homens com pouca escolaridade e que estavam envolvidos com a atividade de caça. Comportamentos negativos são realizados pelas pessoas em ambas as áreas. É necessário que haja um maior controle sobre as potenciais ameaças a espécie como caça, uso do fogo e desmatamento, pois tais práticas são inconsistentes com a existência das áreas protegidas e com a conservação do ouriço-preto. As informações fornecidas por esse estudo visam melhorar e direcionar as ações do Plano de Ação Nacional para conservação da espécie.

Palavras-chaves: Caça; Comportamento humano; Comunidades Locais; Ouriço-preto; Percepção de moradores rurais.

Received: 4 April 2013; Accepted 31 June 2013; Published: 16 December 2013

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Cite this paper as: Castilho, L. C., Martinez, R.A., Giné, G. A. F., Ribeiro, G. C., and Schiavetti, A. 2013. The thin-spined porcupine, *Chaetomys subspinosus* (Rodentia: Erethizontidae), within protected areas in the Atlantic Forest, Brazil: local knowledge and threats. *Tropical Conservation Science* Vol.6 (6):796-810. Available online: www.tropicalconservationscience.org

Introduction

Protected areas are key for conservation of threatened habitats, such as the Brazilian Atlantic Forest [1]. This ecosystem is considered one of the five "hotspots" of global biodiversity [2-3]. It shelters 22,315 species of flora and fauna, with 8,725 endemics [4] and more than 530 species belonging to the IUCN Red List [3], including the thin-spined porcupine, *Chaetomys subspinosus* (Rodentia: Erethizontidae; Figure 1) (Olfers 1818) [5].

The thin-spined porcupine represents a single evolutionary lineage within the family Erethizontidae [6-8]. It is listed as "vulnerable" by the IUCN [5], and populations are apparently declining, mainly as a result of high forest loss and hunting pressure [5, 9]. It occurs from northern Rio de Janeiro to southern Sergipe [6]. These animals are arboreal, nocturnal, and solitary [10-11], passing unnoticed by most casual observers [10-11]. Their diet is strictly leaves [10, 12-14]. They inhabit mature and secondary forests, occasionally shaded cocoa plantations [6], but prefer patches of native forest with high vertical complexity, such as forest edges [15].

Porcupines are commonly perceived as a threat because dogs and people can be seriously injured by their quills. Although this is not the case with the thin-spined porcupine's quills, they are often confused with the sympatric Bahia hairy dwarf porcupine, *Coendou (= Sphiggurus) [8] insidiosus*, (which is mainly responsible for accidents among local people and their pets) and killed by mistake. The thin-spined porcupine also represents a protein and medicinal resource [6].

The main goal of the National Action Plan for the conservation of the thin-spined porcupine [16] is to reverse the population decline of the species. Five major goals were established: to reduce habitat loss and expand forest areas in the species' occurrence area; to reduce hunting pressure; to increase conservation-related knowledge about the species; to establish management procedures; to disseminate information and strengthen public policies that help to conserve the species.

To achieve the second goal (reduce hunting pressure on the species), three milestones were established by the Action Plan: develop and implement awareness projects in local communities, develop alternative income projects and protein consumption in local communities, and investigate hunting pressure to produce a combat program [16].

Our intention was to explore human behaviour and knowledge about the thin-spined porcupine, among residents of protected areas within its extent of occurrence. This proved impossible without assessing people's perceptions of wildlife and the concept of the protected area itself. As a working hypothesis, we assumed that the thin-spined porcupine is a poorly known species, often confused with the Bahia hairy

dwarf porcupine and treated as such, but the extent of this fact (and its consequences) is unknown. We also based our initial planning on some common assumptions about human-wildlife interactions, such as the existence of a correlation between socio-demographic background and knowledge. Since the species is a potential target for hunting, hunters should have more ecological knowledge about the thin-spined porcupine than other people. The ultimate goal of this study is to strengthen strategies for protected area management and for the species' conservation.



Fig. 1. The thin-spined porcupine, *Chaetomys subspinosus* (Photo: Gaston Giné).

Methods

Study area

Research was conducted in two protected areas in southern Bahia state, northeastern Brazil: the Una Wildlife Refuge (RVSU) and the Serra do Conduru State Park (PESC; Figure 2). Both areas are located in a region that includes the most significant remnants of Atlantic Forest in northeastern Brazil [17-19]. These remnants are home to endemic and endangered mammals, some of which have been subjects of international concern, such as the golden-headed lion tamarin (*Leontopithecus chrysomelas*), the yellow-breasted capuchin monkey (*Sapajus xanthosternos*) and the maned sloth (*Bradypus torquatus*) [5, 20-22]. The Una Wildlife Refuge (RVSU) is located within the counties of Ilhéus and Una (15°04'– 15°18'S; 38°59'– 39°15' W). It has an area of 23,404-ha and was established in December 2007 to protect the local flora and fauna in the habitat fragments surrounding the Una Biological Reserve (Rebio-Una), under legal protection since 1980. Unlike the Rebio-Una, which allows only indirect use of natural resources, the RVSU allows private land to be held within its limits. However, land use must be coupled with the reserve's conservation goals. If this condition is not met, the private land will be legally expropriated by the Federal government [23]. There are more than 250 private holdings in the RVSU [24]. The main economic activity in the region is agriculture, primarily cocoa (*Theobroma cacao*) and rubber (*Hevea brasiliensis*) plantations and subsistence crops such as cassava [17, 25].

The Serra do Conduru State Park (PESC) was established in 1997. This 9,275-ha protected area is located within the counties of Ilhéus, Itacaré and Uruçuca (14°20'– 14°30'S; 39°02'– 39°08'W). It was created as a compensation for the asphaltting and lengthening of a major state road (BA 001), in order to preserve the Atlantic Forest remnants within it [20]. Nowadays, it is a regional conservation priority for mammals and birds [26]. It has at least 39 species of mammals, with eight Atlantic Forest endemics and four exclusive to southern Bahia [20].

In spite of the strict legal rules regarding any State Park in Brazil, there are more than 50 families living within the PESC. The existence of residents inside the park is the largest problem with the full implementation of this as a protected area. Ineffective law enforcement also allows local people to perform agricultural activities, to hunt, and to remove timber [20].

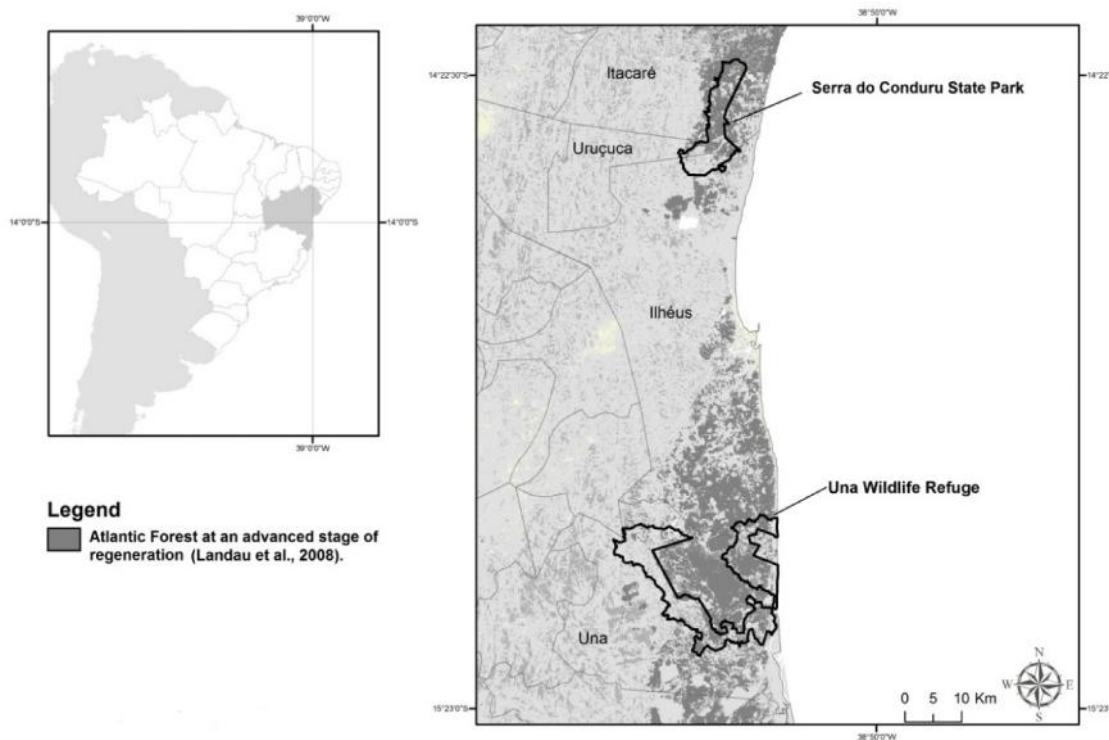


Fig. 2. Una Wildlife Refuge (RVSU) and the Serra do Conduru State Park (PESC) in southern Bahia, Brazil.

Data collection and analysis

A pilot study was carried out on a subsample of participants in each protected area to highlight potential biases related to interview conduction and minimise errors in data collection. The results of this pilot study assisted in proper data assembly and analysis. Subsequently, 125 rural residents were interviewed within the two protected areas. Interviews were conducted in 2006-2007 (PESC) and 2010 (RVSU). Random sampling was done to select the properties where the interviews were conducted. Property owners, inhabitants or managers who were present at the time of the visit were targeted as respondents. Participants signed an Informed Consent stating that they agreed to contribute voluntarily to the survey (Ethics Committee Protocol of the State University of Santa Cruz: 291/09).

The interview script for residents of the protected areas (Appendix 1) was organised into four sections, covering personal variables such as education, age, duration of residence and occupation; knowledge about the thin-spined porcupine; behaviour related to wildlife conservation, and perceptions about conservation and protected areas. Questions about perceptions of the protected area were made only at the RVSU. In both areas, interviews were recorded on paper, although sometimes a mini-recorder was used, with authorization of the respondents. To check for consistency and accuracy, some interviews were repeated [27]. In the PESC, 22 people were interviewed more than once, and five interviews were repeated in the RVSU. When respondents gave different answers to the same question at different times only the last response was used for data analysis.

To analyze levels of knowledge, data were converted using a three-point Likert scale (correct answers = 1; partial answers = 0.5; wrong answers = 0). An indicator was created for both areas, to quantitatively compare the respondents' knowledge about the species. A final value was obtained by adding the scores of each subject and dividing by the maximum possible score [28-29]. The reliability of the indicator was

measured using Cronbach's Alpha index, which assessed the level of correlation established among the questions used for the indicator [30-31].

To evaluate possible threats to the species, we investigated residents' behaviour and activities towards wildlife conservation. We used a time scale of five years to define residents' current and past behaviour, and used a descriptive approach to analyze residents' perceptions of conservation and the species' uses.

Kellert's attitudinal scale [32] was used to assess the relationship of RVSU respondents with local wildlife through their feelings about animals' relevance. This scale classifies human values regarding wildlife in ten dimensions: naturalistic, moralistic, aesthetic, utilitarian, humanistic, ecologic, scientific, dominionistic, neutral and negative. Two questions of the interview script were used to construct this scale: "How important are animals?" and "What do they exist for?"

The data were analysed using software R [33]. Nonparametric tests (Wilcoxon and Kruskal-Wallis) were used to compare the indicator of knowledge among categorical variables. Spearman Correlation was used to identify the relationship between knowledge and continuous socio-demographic variables.

Results

Profile of respondents and properties

Sample size consisted of 125 interviews (99 men and 26 women). Table 1 lists the major socio-demographic variables researched within both areas. Thirty-eight per cent of respondents in both areas had no formal education. Most were involved in agricultural activities (85% in RVSU and 56% in PESC). The predominant crops were rubber, cocoa, coconut, cassava, palm fibre, banana, soursop, cupuaçu and other fruits. The animals raised on farms are mainly chickens, cattle, pigs, geese, mules, donkeys, cows and sheep. Twenty-eight per cent of properties in RVSU and 36% in PESC have no type of livestock that could serve as a food source for residents.

Table 1. Socio-demographics of respondents in protected areas^a.

	RVSU ^b	PESC ^c
Age (years)	49 (22-83)	54 (19-80)
Duration of residence (years)	11 (0.17-60)	35 (1-76)
Nº of children	3 (0-11)	4 (0-12)
Nº of people living at home	3 (0-12)	-
Land (ha)	39 (2-1270)	-
Forest area (ha)	10 (0-900)	-
	(%)	(%)
Formal Education		
No education – primary education (until 4 th grade)	71	82
Middle-High school (5 th to 9 th grade)	16	8
High school completed- College	13	10
Male	81	78
Female	19	22

^a Median (minimum- maximum);

^b RVSU= Una Wildlife Refuge; N= 75

^c PESC= Serra do Conduru State Park; N= 50

Knowledge about the thin-spined porcupine

Barely half the respondents (57%) in the RVSU were able to describe the thin-spined porcupine or identify its image. In the PESC, less than half of participants (46%) recognised the animal. In both areas the species is known as "Luis-cacheiro-preto," "Luis-cacheiro-de-cabelo," "Gandú," or "Luís-cacheiro-sem-espinho." The popular names recorded for this species use morphological characters for identification and differentiation, mainly related to coat color and quill shape. The quills deserve special attention in the respondents' comments, with observations such as "the quill is soft," "the quill sticks, but doesn't come loose," "the animal doesn't have quills," "it is curly," "the quill is fragile." Local descriptions of the quills agree with the scientific literature. The thin-spined porcupine has hard quills only in the area close to the head, neck and forelimbs. Otherwise, the coat is evenly wavy, looking more like bristles than quills [34-35].

Most respondents in both protected areas cited a solitary and nocturnal behavior for the species, spending most of the daytime hours sleeping in hollow trees and tangles of lianas. These are also facts reported in the current literature [10-11]. On the other hand, the species' folivore diet [10, 12-14] was poorly known among residents. Only a few mentioned that leaves were part of its diet (14% in RVSU and 2% in PESC). Its main predator, cited by 18 respondents, was the owl (unidentified species). RVSU respondents related that the species preferred habitats such as mature and secondary forests (72%), shaded cocoa plantations (54%) and early-growth secondary forests (44%). According to ecological studies, the thin-spined porcupine occurs preferentially in patches of native forest (mature and secondary forests) with high vertical complexity [15]. Most RVSU respondents said that the species weighs around one or two kilograms. Thirty-seven per cent said they had seen a thin-spined porcupine for the last time less than a year ago, while 30% saw the animal between one and five years ago, and 33% saw it more than five years ago. Comparing the two species of porcupines, 74% of RVSU respondents said that the Bahia hairy dwarf porcupine is more common than the thin-spined porcupine. Respondents mentioned that the thin-spined porcupine has slower movements than the Bahia hairy dwarf porcupine ("the animal is sluggish"). The species has low activity levels and short daily movements because its diet is based on leaves [11]. Some respondents related that the Bahia hairy dwarf porcupine has more aggressive behaviour than the thin-spined porcupine ("the animal is more aggressive than the thin-spined porcupine, it throws its spines to defend itself"). The thin-spined porcupine's quills are softer than those of other porcupines like the Bahia hairy dwarf porcupine and don't come loose when an aggressor attacks [34].

Respondents (43% in RVSU and 30% in PESC) were familiar, directly or indirectly, with medicinal purposes for the thin-spined porcupine and the Bahia hairy dwarf porcupine. Residents said the quills served to cure diseases such as strokes (previously known as "wind illness" or "evil-of-the-wind"), sinusitis and fatigue. Two administration methods were referred: infusion of the smoke from burning the quills, or drinking a solution of grinded quills in water or milk. The quills are also used to improve the accuracy of hunting dogs in detecting scents. A previous study [6] obtained similar information and showed that the thin-spined porcupine's quills are burnt or roasted, and patients are advised to inhale the smoke or drink the infusion of the quills' ashes to cure diseases like strokes, toothache and asthma [6]. Many residents said there are cultural or religious beliefs associated with the porcupines' quills. They said "the quill is alive," "the quill enters the body and disappears," "if you don't take away the quill, it walks in the flesh," "the quill just dies when burnt," "the quill is poisonous," "place the quills in a bottle for a few days, and the bottle will be full of quills." Similar descriptions were obtained by Oliver and Santos [6].

According to the Knowledge Indicator, men had a more knowledge about the focal species than women. There was a significant difference in knowledge among educational categories, showing that people with lower formal education have more ecological knowledge. There was no correlation between knowledge and the percentage of forest coverage on the property, age, time of residence, number of children or number of people living at home (Table 2). The knowledge indicator was reliable for both areas (Cronbach's alpha index= 0.95 in RVSU and 0.73 in PESC).

Table 2. Relationship of residents' demographic variables to knowledge indicator^a.

Variables	RVSU ^b		PESC ^c	
Gender	W= 617	p = 0.009	W = 297	p= 0.05
Education	H ₍₂₎ = 12.722	p = 0.002	H ₍₂₎ = 7.802	p = 0.02
Age		p = 0.574		p= 0.235
Duration of residence		p = 0.442		p= 0.125
Number of children		p = 0.210		p= 0.778
Percentage of forest coverage		p = 0.085		-

^a W= Wilcoxon test; H= Kruskal-Wallis test; p= significance; ^b RVSU= Una Wildlife Refuge; N= 75;

^c PESC= Serra do Conduru State Park; N= 50

Threats to the species conservation

Residents in both areas behave negatively towards wildlife conservation, considering current and past practices (Table 3). Activities such as hunting, replacement of forest by pasture or small scale agriculture, and selective logging were more frequent in the past. An occasional use of fire is especially associated with slash-and-burn practices. Birds are the most domesticated wild animals. Some respondents reported that the thin-spined porcupine is easily domesticated when captured young.

Extraction of wood for personal use is frequent, especially for heating and cooking. Additionally, buildings are constructed and repaired using local wood. Twenty-four per cent of RVSU and 34% of PESC residents said they had no forest areas preserved inside their properties. Positive practices that encourage the recovery of deforested and degraded areas are still very scarce.

Our results showed that hunting was predominantly a male activity, and selective logging and forest replacement were exclusively male activities. Nineteen respondents admitted to hunting for feeding purposes. Twelve have some form of farming that ensures animal protein intake for their families.

In both areas, hunting was significantly related to knowledge, showing that past and current hunters know more about the thin-spined porcupine than non-hunters (W = 367, p= 0.005 in RVSU, W = 158.5, p= 0.008 in PESC). The species is under hunting pressure, cited by 54% of respondents as a hunting target. Although its meat is not coveted throughout the study area, the main reason for hunting it is for food. Another motivation for hunting is for medicinal uses. Some respondents in both areas have cited using the thin-spined porcupine' quills to treat diseases, especially strokes, and to improve the accuracy of hunting dogs.

Twenty three percent of respondents who identified the species at the RVSU admitted to have eaten its meat. On the other hand, some respondents reported the existence of taboos and diet restrictions, related either to unsavoury features of the meat (PESC and RVSU) or to being inappropriate during pregnancy or illness (RVSU). There were particularly evil properties associated with the meat, such as being able to cause "death to a post-partum woman by smelling it from afar" (RVSU). Respondents from the PESC catalogued it as "the worst game that exists," and as only being edible if you "know how to treat it before consumption."

Table 3. Assumed behaviour of local residents towards wildlife conservation^a.

	RVSU ^b (%)		PESC ^c (%)	
	Current	Past	Current	Past
Wild animal live capture	17	7	18	36
Hunting	13	19	18	46
Forest replacing for pasture or small scale agriculture	1	29	6	52
Secondary forest replacing for pasture or small scale agriculture	20	36	32	56
Selective logging	0	15	4	28
Fire	25	9	44	44
Reforestation with native trees	3	1	18	6
Pasture replacing by agroforestry	7	12	4	2

^a Current= Behaviour held in the last five years; ^b RVSU= Una Wildlife Refuge; N= 75; ^c PESC= Serra do Conduru State Park; N= 50

Perception about conservation

There is a slight difference in replies from the two sampled areas regarding animal abundance. Ninety-two percent of respondents in the RVSU stated that animals in the region had been more abundant in the past, citing deforestation and hunting as the main causes of reduction. People from the PESC agreed with this general idea. However, they believed that animal abundance decreased because of migration, with the same species richness. Even so, they admitted that some species are currently more abundant than in the past, due to the creation of the PESC and the reduction of hunting.

In the RVSU, people demonstrated moralistic (35%), aesthetic (32%), utilitarian (20%), humanistic (13%), ecologic (6%), neutral (4%) and negative (3%) feelings towards animals, according to Kellert's scale [32]. Regarding landscape conservation, when asked about the control of illegal activities in the RVSU, 55% said greater awareness is needed, with more guidance and information on allowable practices. Half of the respondents (51%) agree on the need for more efficient supervision to prevent hunting and deforestation. Other measures, such as greater government incentives for conservation and more job opportunities for residents, were also cited. Five percent say that the existing level of control is sufficient to prevent exploitation of natural resources in the region.

When asked about the main reasons to preserve the remaining forests, most of RVSU respondents said that was to ensure a natural area for the future (25%), because it is illegal to deforest (17%) and to preserve water bodies (16%). Some people (21%) cited benefits such as waterway maintenance, rainfall quantity and air temperature and protection of animals and their habitats. Most (80%) asserted that everyone can contribute to conservation by obeying conservation laws; however, many of them said that the difficulties

encountered in the rural environment - such as lack of energy (60% of properties had no electricity), deficient roads and transportation, poor health and education, lack of employment opportunities and lack of government incentives for conservation - reduce residents' quality of life and discourage conservation practices in the region.

Discussion

The results regarding wildlife knowledge highlight the need for greater attention to less charismatic endangered species such as the thin-spined porcupine. The species is recognized by a little more than half the respondents within the RVSU and less than half in the PESC. Furthermore, creation of protected areas *per se* hasn't been effective at increasing knowledge of the endangered species within them, even though the creation process theoretically involves public consults and information. In RVSU, 93% of respondents recognized the sympatric Bahia hairy dwarf porcupine. Research previous to creation of both protected areas has similar results to ours [6], with the thin-spined porcupine consistently less known than the Bahia hairy dwarf porcupine (44% and 87% respectively). Well-known porcupine species, such as *Erethizon dorsatum*, are relative generalists in habitat use, including human-used land in their range [36-37]. Similarly, the Bahia hairy dwarf porcupine seems to have a higher survival rate than other arboreal mammals in extremely modified habitats [6]. Local people may know less about the thin-spined porcupine because it is scarcer and less adaptable to human habitats, remaining secretive and unnoticed within the forests [11].

Most people who did recognize the species had good knowledge about its biology and behaviour. Knowledge was concentrated in residents who engage or have engaged in hunting and have low levels of formal education. These results confirm the hypothesis that hunters know more about the species and that socio-demographic variables can influence knowledge. Our results therefore suggest that dependence on forest resources seems to be directly related to involvement in agriculture and forestry activities and inversely related to education, as shown elsewhere [38]. There is a clear generic differentiation in the depth of knowledge, with men more knowledgeable than women, probably because of their closeness to the environment through rural work or hunting [38].

Destructive behaviours such as hunting, secondary forest cutting, use of fire and domestication of wild animals are still practiced by rural residents of both protected areas and may especially affect the survival of threatened species, as the thin-spined porcupine. Besides serving as a food source, the species is also used for medicinal and hunting purposes [6].

Hunting, use of fire, and deforestation are actively practiced and need urgent control as such behaviour is inconsistent with protected areas and conservation of the thin-spined porcupine. Despite its low intensity, hunting was considered the most constant threat inside the Atlantic Forest protected areas in the Bahia state [39]. Hunting is traditionally considered an important practice in the Una region, admitted by at least half of the population before the legal protection of the area [24]. Some indigenous communities, such as the Tupinambás de Olivença, hunt regularly around the Una Biological Reserve, reporting porcupines among their kills [40]. Hunting was carried out by employees of large farms as well as by smallholders and constituted a supplemental food source for villagers, leading to a reduction in preferred species, such as pacas (*Cuniculus paca*) and armadillos (*Dasypus* sp.) [24]. The decline of coveted game, combined with low income, could result in the hunting of less desirable animals, such as small marsupials and rodents [16]. Despite the perceived reduction in game abundance, illegal hunting is still practiced. *C. subspinosus* is not among hunter's favorites, (especially because of taboos described previously), but nevertheless suffers from hunting pressure, especially in the RVSU area. Healing attributes of the quills are another reason for hunting, as are its "malicious" attributes, which could make people wish to see it dead or far away.

Though not thoroughly explored, the thin-spined porcupine' quills have a place in traditional medicine, and like other popular knowledge, it might not be just the common imagination. Roze [41] found that the quills of the North American Porcupine (*Erethizon dorsatum*) are coated by antibiotic substances that prevent infection if an animal is hurt by its own quills. So the popular use of quills of the thin-spined porcupine may have an actual therapeutic basis and could be proven effective by science. Taboos expressed by some respondents could not be linked to any known scientific information, but should not be utterly discarded.

The use of fire is a traditional practice developed by rural communities to clear the land, prepare the natural environment for agriculture, and regenerate pastures [42-43]. Residents of both protected areas associate this practice with the replacement of secondary forest for small-scale agriculture. However, the use of fire, along with deforestation, is considered a threat to the thin-spined porcupine [16]. These practices, in addition to destroying and fragmenting habitat, mainly affect preferred forest edge areas [15]. Because of its slow movements and arboreal behaviour, this animal's ability to escape fire is limited and may have been the main reason for local extinctions in other regions [16].

Local residents recognize some of the benefits of forest conservation, both for themselves and for the local fauna. There are also positive feelings about the existence and importance of wildlife. However, feelings and beliefs do not always translate into behaviour [44]. This apparent conflict could be related to residents' low quality of life. The needs most mentioned by RVSU respondents are related to basic infrastructure. Mehta and Kellert [45] showed that community development is the main priority for people living in the vicinity of the Makalu-Barun National Park in Nepal, while wildlife conservation is the least. Concerns and issues identified by local communities should receive more attention from managers of protected areas, which could strengthen local conservation efforts [46-47].

Implications for conservation

Interviews are a widely accepted way to obtain information about human perceptions, attitudes and behaviour. However, when illegal activities are being investigated, false and misleading answers are not uncommon [48]. Rural residents living in RVSU and PESC are aware of the illegality of activities such as hunting and deforestation, and they could therefore have provided false or incomplete answers. To overcome this bias in future studies, a combination with other methods such as Direct and Indirect Observation, Randomized Response Technique, or Law-enforcement Reports could be a valuable approach [48].

This research showed local knowledge of the thin-spined porcupine and identified threats that may jeopardize the species' survival within protected areas. Improvements in implementation of these protected areas are needed to effectively increase local support for protecting biodiversity, especially threatened species. The establishment of private reserves in the shaded cocoa region, under a uniform system supported by federal legislation, could conceivably improve conservation efforts. These benefits would be especially noticeable along the boundaries of the Una Biological Reserve (RVSU area) and the Serra do Conduru State Park. This would be the most viable strategy for creating biological corridors to help conserve the endemic regional fauna [49].

In addition to law enforcement, more attention should be paid to local residents living inside and around these protected areas. Dependence on wildlife resources, especially among farmers and agriculture dependents, must be reduced through livelihood security [50]. Incentives for raising animals (such as green livestock programs) as an alternative source of food are desirable, even though this might not be enough to prevent hunting, considering that some residents who still hunt already have some types of farm animals. This result suggests that hunting represents more than a subsistence measure, with cultural values involved. This calls for an educational and awareness program focused mainly on regional endangered and

endemic species, because information can be useful in changing a person's attitude and behaviour [51, 44]. Outside schools, efforts should focus on rural residents, especially men, who have negative attitudes toward wildlife conservation. Particularly, hunters and consumers should be educated about how overhunting threatens both biodiversity and rural livelihoods [52-53]. The very complex matter of current residents within protected areas must also be carefully approached; restrictions on their use of the land must come along with actions promoting engagement in conservation. To enforce the law and apply fees and penalties alone might create resentment and deepen environmental malpractices, as a way of expressing rebelliousness and discontent.

Such measures and information would strengthen and improve proposals by the National Action Plan for the conservation of the thin-spined porcupine within protected areas. Additionally, the species becomes more than a paper-protected figure, for the knowledge acquired from academic research can be linked to actual law enforcement and community efforts to equally improve quality of life and ecosystem preservation.

Acknowledgements

Financial support was granted by CNPq and State University of Santa Cruz (UESC). MSc fellowships from CAPES and FAPESB were granted to L. Castilho and G. Ribeiro, and a Productivity fellowship was granted to A. Schiavetti. Logistical facilities during field work were provided by UESC. Special thanks go to Tatiana Alves, environmental analyst of Una Wildlife Refuge. We also wish to recognize the rural communities for their willingness to participate in the interviews.

References

- [1] Rylands, A. B. and Brandon, K. 2005. Brazilian Protected Areas. *Conservation Biology* 19(3):612–618.
- [2] Myers, N., Mittermeier, R. A., Mittermeier, C. G., Fonseca, G. A. B. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403:853-845.
- [3] Tabarelli, M., Pinto, L. P., Da Silva, J. M. C., Hirota, M. M. and Bedê, L. C. 2005. Challenges and Opportunities for Biodiversity Conservation in the Brazilian Atlantic Forest. *Conservation Biology* 19(3):695–700.
- [4] CI. 2011. Biodiversity Hotspots. www.biodiversityhotspots.org
- [5] IUCN. 2011. 2011 *IUCN red list of threatened species*. www.iucnredlist.org
- [6] Oliver, W. L. R. and Santos, I. B. 1991. Threatened endemic mammals of the Atlantic forest region of south-eastern Brazil. *Wildlife Preservation Trust Special Scientific Report* 4:1-126.
- [7] Vilela, R. V., Machado, T., Ventura, K., Fagundes, V., Silva, M. J. and Yonenaga-Yassuda, Y. 2009. The taxonomic status of the endangered thin-spined porcupine, *Chaetomys subspinosus* (Olfers, 1818), based on molecular and karyologic data. *BioMed Central Evolutionary Biology* 9:29-46.
- [8] Voss, R.S., Hubbard, C. and Jansa, S. A. 2013. Phylogenetic Relationships of New World Porcupines (Rodentia, Erethizontidae): Implications for Taxonomy, Morphological Evolution, and Biogeography. *American Museum Novitate* 3769:1-36.
- [9] Machado, A. B. M., Martins, C. S. and Drummond, G. M. Eds. 2005. *Lista da fauna brasileira ameaçada de extinção: Incluindo as Espécies Quase Ameaçadas e Deficientes em Dados*. Belo Horizonte: Fundação Biodiversitas.
- [10] Chiarello, A. G., Passamani, M. and Zortéa, M. 1997. Field observations on the thin-spined porcupine, *Chaetomys subspinosus* (Rodentia: Echimyidae). *Mammalia* 61(1):29-36.
- [11] Giné, G. A. F., Duarte, J. M. B., Motta, T. C. S. and Faria, D. 2012. Activity, movement and secretive behavior of a threatened arboreal folivore, the thin-spined porcupine, in the Atlantic forest of southern Bahia, Brazil. *Journal of Zoology* 286(2):131–139.
- [12] Oliveira, P. A. 2006. *Ecologia de fêmeas de ouriço-preto Chaetomys subspinosus (Olfers 1818) (Rodentia: Erethizontidae) nas florestas de restinga do Parque Estadual Paulo César Vinha, Guarapari, Espírito Santo*. Master Thesis. Minas Gerais. Pontifícia Universidade Católica de Minas Gerais.

- [13] De Souto Lima, R. B., Oliveira, P. A. and Chiarello, A. G. 2009. Diet of the thin-spined porcupine (*Chaetomys subspinosus*), an Atlantic forest endemic threatened with extinction in southeastern Brazil. *Mammalian Biology* 75(6):538-546.
- [14] Giné, G. A. F., Duarte, J. M. B. and Faria, D. 2010. Feeding ecology of a selective folivore, the thin-spined porcupine (*Chaetomys subspinosus*) in the Atlantic forest. *Journal of Mammalogy* 91(4):931-941.
- [15] Giné, G. A. F. 2009. Ecologia e comportamento do ouriço-preto (*Chaetomys subspinosus*, Olfers 1818) em fragmentos de Mata Atlântica do município de Ilhéus, sul da Bahia. PhD Thesis. São Paulo. Universidade de São Paulo.
- [16] Faria, D., Gaiotto, F. and Giné, G. 2011. *Plano de Ação Nacional para a Conservação do ouriço-preto. Brasília: Instituto Chico Mendes de Conservação da Biodiversidade, ICMBio. www.icmbio.gov.br/*
- [17] Alger, K. and Caldas, M. 1994. The declining Cocoa economy and the Atlantic Forest of Southern Bahia, Brazil: Conservation attitudes of Cocoa planters. *The Environmentalist* 14(2):107-119.
- [18] Leal-Galindo, C. and Câmara, I. G. 2003. Atlantic forest hotspots status: an overview. In: *The Atlantic Forest of South America: biodiversity status, threats, and outlook*. Leal-Galindo, C. and Câmara, I. G. (Eds.), pp.3-11. Island Press, Washington D.C.
- [19] Martini, A. M. Z., Fiaschi, P., Amorim, A. M. and Paixão, J. L. 2007. A hot-point within a hot-spot: a high diversity site in Brazil's Atlantic Forest. *Biodiversity and Conservation* 16:3111–3128.
- [20] BAHIA/SEMARH. 2005. *Plano de Manejo do Parque Estadual da Serra do Conduru*, Bahia, Brasil.
- [21] Cassano, C. R., Kierulff, M. C. M. and Chiarello, A. G. 2011. The cacao agroforests of the Brazilian Atlantic forest as habitat for the endangered maned sloth *Bradypus torquatus*. *Mammalian Biology* 76(3):243–250.
- [22] Raboy, B. E. and Dietz, J. M. 2004. Diet, Foraging, and Use of Space in Wild Golden-Headed Lion Tamarins. *American Journal of Primatology* 63:1-15.
- [23] MMA. 2000. *Sistema Nacional de Unidades de Conservação (SNUC)*. www.mma.gov.br/
- [24] Santos, G. J. R. 1999. *Caracterização da caça na região do entorno da Reserva Biológica de Una – BA*. Projeto Remanescentes de Florestas na Região de Una, BA, Resta Una/PROBIO. Universidade Estadual de Santa Cruz, Ilhéus, Brasil.
- [25] Araújo, M., Alger, K., Rocha, R. and Mesquita, C. A. B. 1998. A Mata Atlântica no sul da Bahia: situação atual, ações e perspectivas. *Reserva da Biosfera da Mata Atlântica, MAB–UNESCO*, Caderno 8:1–36.
- [26] MMA. 2000. *Avaliação e ações prioritárias para a conservação da biodiversidade da Mata Atlântica e Campos Sulinos*. Secretaria de Biodiversidade e Florestas, Ministério do Meio Ambiente, Brasília.
- [27] Fita, D. S., Costa Neto, E. M. and Schiavetti, A. 2010. 'Offensive' snakes: cultural beliefs and practices related to snakebites in a Brazilian rural settlement. *Journal of Ethnobiology and Ethnomedicine* 6:1-13.
- [28] Ditt, E. H. 2002. *Fragmentos florestais no Pontal do Paranapanema*. Editora Annablume, São Paulo.
- [29] Nazário, N. 2003. *Atitudes de produtores rurais: perspectivas de conservação dos fragmentos de cerrado do assentamento Reunidas, Promissão, SP*. Master Thesis. São Paulo. Universidade de São Paulo.
- [30] Cronbach, L. J. 1951. Coefficient alpha and the internal structure of tests. *Psychometrika* 16(3):297-334.
- [31] Oviedo, H. C. and Campo-Arias, A. 2005. Metodologia de investigación y lectura crítica de estudios: Aproximación al uso del coeficiente Alfa de Cronbach. *Revista Colombiana de Psiquiatria* 34(4):572-580.
- [32] Kellert, S. R. 1980. Contemporary values of wildlife in American Society. In: *Wildlife values*. Shaw, W. W. and Zube, E. H. (Eds.), pp.31-60. US Forest Service, Ft. Collins.
- [33] R Development Core Team. 2011. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL.
- [34] Moojen, J. 1952. *Os roedores do Brasil*. Instituto Nacional do Livro: Rio de Janeiro.
- [35] Nowak, R. M.; Paradiso, J. L. 1983. *Walker's mammals of the world*. The Johns Hopkins University Press: London.
- [36] Roze, U. 2012. *Porcupines, the animal answer guide*. Johns Hopkins University Press, Baltimore.

- [37] Sweitzer, R. A. and Berger, J. 1992. Size-related effects of predation on habitat use and behaviour of porcupines (*Erethizon dorsatum*). *Ecology* 73:867-875.
- [38] Gunatilake, H. M. 1998. The role of rural development in protecting tropical rainforests: evidence from Sri Lanka. *Journal of Environmental Management* 53(3):273-292.
- [39] Schiavetti, A., Magro, T. C. and Santos, M. S. 2012. Implementation of protected areas for central corridor of Atlantic Forest in Bahia: challenges and limits. *Revista Árvore* 36(4):611-623.
- [40] Rezende J. P. and Schiavetti A. 2010. Conhecimentos e usos da fauna cinegética pelos caçadores indígenas "Tupinambá de Olivença" (Bahia). *Biota Neotropica* 10(1):175-183.
- [41] Roze, U., Locke, D. C. and Vatakis, N. 1990. Antibiotic properties of porcupine quills. *Journal of Chemical Ecology* 16:725-734.
- [42] Pyne, S. J. 1995. *World fire: the culture of fire on earth*. Holt, New York.
- [43] Eriksen, C. 2007. Why do they burn the 'bush'? Fire, rural livelihoods and conservation in Zambia. *The Geographical Journal* 173(3):242-256.
- [44] Pickens, J. 2005. Attitudes and perceptions. In: *Organizational behavior in health care*. N. Borkowsky, N. (Ed.), pp.43-76. Jones and Bartlett Publishers, Sudbury.
- [45] Mehta, J. N. and Kellert, S. R. 1998. Local attitudes toward community-based conservation policy and programmes in Nepal: a case study in the Makalu-Barun Conservation Area. *Environmental Conservation* 25(4):320-333.
- [46] Alexander, S. E. 2000. Resident attitudes towards conservation and black howler monkeys in Belize: the Community Baboon Sanctuary. *Environmental Conservation* 27(4):341-350.
- [47] Kideghesho, J. R., Roskaft, E. and Kaltenborn, B. P. 2007. Factors influencing conservation attitudes of local people in Western Serengeti, Tanzania. *Biodiversity and Conservation* 16:2213-2230.
- [48] Gavin, M. C., Solomon, J. N. and Blank, S. G. 2010. Measuring and Monitoring Illegal Use of Natural Resources. *Conservation Biology* 24(1): 89-100.
- [49] Schiavetti, A., Oliveira, H. T., Lins, A. S. and Santos, P. S. 2010. Analysis of Private Natural Heritage Reserves as a conservation strategy for the biodiversity of the cocoa Region of the southern state of Bahia, Brazil. *Revista Árvore* 34(4): 699-711.
- [50] Bitanyi, S., Nesje, M., Kusiluka, L. J., Chenyambuga, S.W. and Kaltenborn, B. P. 2012. Awareness and perceptions of local people about wildlife hunting in western Serengeti communities. *Tropical Conservation Science* 5(2):208-224.
- [51] Zelezny, L. C. 1999. Educational interventions that improve environmental behaviors: a meta-analysis. *Journal of Environmental Education* 31:5-14.
- [52] Milner-Gulland, E. J. and Bennett, E. L. 2003. Wild meat: the bigger picture. *Trends in Ecology & Evolution* 18(7):351-357.
- [53] Mgawe, P., Mulder, M. B., Caro, T., Martin, A. and Kiffner, C. 2012. Factors affecting bushmeat consumption in the Katavi-Rukwa ecosystem of Tanzania. *Tropical Conservation Science* 5(4):446-462.

Appendix I
INTERVIEW SCRIPT

Part I: Information about the properties

- Property location:
- Territorial extension:
- Forest area:
- Livestock (food source):
- Agriculture:

Interviewee information

- Name:
- Age:
- Duration of residence:
- Formal education:
- Occupation:
- Number of children:
- Number of people living at home:

Part II: Knowledge about the thin-spined porcupine (*Chaetomys subspinosus*)

- Do you know any animal with quills? () Yes; () no
- Do you know only one kind of animal with quills or more? () *Chaetomys subspinosus*; () *Coendou insidiosus*; () other
- Local common names: () ouriço-preto; () ouriço-cacheiro; () luis-cacheiro; () espeta-mangaba; () gandu; () other
- Recognition of the animal in the pictures:
- *Chaetomys subspinosus* () yes; () no
- *Sphiggurus insidiosus* () yes; () no
- Where did you see this animal? () Mature or late secondary forest; () early secondary forest; () shaded cacao plantations; () rubber plantation; () other
- When did you see this animal?
- What is the animal's weight?
- What kind of food does this animal eat? () flowers; () fruits; () leaves; () others; () don't know
- Does it have a predator? () yes; () no. Which animal?
- This animal lives: () alone; () in pairs; () group; () don't know
- Is this animal hunted? () yes; () no. Why?
- Is this animal aggressive? () yes; () no
- Do you know someone who tried to domesticate this animal? () yes; () no
- Have you heard about any remedy made from parts of this animal? () yes; () no
- Do you think there were more of these animals in the past than nowadays? () Yes; () no; () I guess nothing has changed

Part III. Conservation behaviour

- Have you ever eaten meat from an animal with quills (*Chaetomys subspinosus*)? Did you like it? () yes; () no
- Have you ever captured a wild animal and kept it captive? When?
- Have you ever hunted a wild animal for food? When?
- Have you ever replaced a forest area for pasture or small scale agriculture? When?
- Have you ever replaced a secondary forest for pasture or small scale agriculture? When?

- Do you usually use fire to clear some areas?
- Have you ever extracted wood from the forest? When?
- Have you done reforestation in a degraded area of the property? When?
- Have you ever replaced pasture for agroforestry? When?

Part IV. Perception about protected areas and conservation

- Do you think there were more or fewer animals in the past than nowadays in the region? If yes, what happened to decrease?
- How important are animals? What do they exist for?*
- What are the reasons for existing forest areas in the property?*
- Do you think protected areas are important tools for environmental conservation?*
- How should the exploitation be controlled in the region?*
- Do you think residents can contribute to wildlife conservation? How?*
- What do you think should be done to improve residents' lives within the area?*

* Question made only for RVSU residents.