

Human perceptions and practices related to the squirrel monkeys (*Saimiri sciureus*) in a forest area of Pernambuco, Brazil



Dimas Maranhão de Lima^a | Juliana Ribeiro de Albuquerque^{a*}  | Maria Adélia Borstelmann de Oliveira^a 

^aDepartamento de Morfologia e Fisiologia Animal, Universidade Federal Rural de Pernambuco, Brazil.

*Corresponding author: julidealbuquerque@gmail.com

Abstract In the 1980s, squirrel monkeys (*Saimiri sciureus*) apprehended during an operation to combat animal trafficking in the state of Pernambuco, Northeastern Brazil, were released into the Atlantic Forest of the Reserva Biológica de Saltinho (REBio Saltinho). As this is an exotic species, which is rapidly disseminated throughout the area, it is necessary to understand the perceptions and attitudes of the reserve residents, workers, and visitors in order to identify potential interactions, conflicts and social factors that may influence the relationship between people and monkeys. Thus, between April and October 2019, three human groups answered semi-structured questionnaires about their perceptions of the squirrel monkey and their attitudes towards primates. Altogether, 70 people were interviewed, of which 94.3% claimed to know of the squirrel monkey. While residents of the surrounding areas of REBio Saltinho described the squirrel monkey using mainly morphological and behavioral characteristics (65%), workers and visitors related their descriptions to the fact that these animals are invasive in 46% and 40% of responses, respectively. Most respondents (80%) were not bothered by the presence of these monkeys, and 86% denied interacting with the animal, while the remaining 14% admitted to trying to interact with the monkeys in some way, usually through offering food. This research will contribute to the improvement and promotion of the actions of environmental management by REBio Saltinho.

Keywords: ethnoprimateology, Cebidae, exotic species, conservation unit, one health

1. Introduction

The study of human perceptions and practices related to non-human primates is part of the recent scientific area of ethnoprimateology. The assessment of interactions between human and non-human primates allows us to understand some of the attitudes that humans have towards the presence of monkeys, which are formed by their individual perceptions, judgments, and expectations (Faggionato 2007).

With the increase of human population densities, deforestation and alteration of forested habitats, and the associated decrease in available ranging areas for primates, a continued increase in the spatial and ecological overlap between humans and our closest living relatives is expected (Fuentes and Hockings 2010). Several researchers (Hill 2000; Sabbatini et al 2006; Saito et al 2010; Estrada et al 2018) agree that the proximity between humans and monkeys can generate negative effects, such as hunting and the transmission of zoonoses. On the other hand, in certain cultures, monkeys are revered by humans and are tolerated and treated with kindness (Schilaci et al 2010). Therefore, in order to achieve a broad understanding of the relationships between humans and monkeys and to implement effective strategies that allow for the coexistence of primates and humans, with minimum or no conflict between them, the needs of both the humans and animals involved should be considered (Sampaio et al 2016).

Around 1987, approximately 20 squirrel monkeys (*Saimiri sciureus*, Figure 1a and 1b) were apprehended during an operation to combat the trafficking of wild animals. They were later released into the Atlantic Forest of the State of Pernambuco, in the Reserva Biológica de Saltinho (REBio Saltinho). This primate species occurs naturally in the Amazon basin (Dukelow 1983; Rowe 1996), however, it was introduced anthropically into the Northeastern and Southeastern regions of Brazil (Camarotti et al 2015). As these primates are omnivores, have a short non-seasonal gestation period and do not have natural predators, squirrel monkeys were locally favored and thus, adapted and spread widely throughout the REBio Saltinho, with a total population of over 400 individuals (Lins 2014).





Figure 1 Squirrel monkey (*Saimiri sciureus*) during rest (a), and two animals collecting fruits to eat (b), at REBio Saltinho in 2019.

Despite being a conservation unit, REBio Saltinho is heavily impacted by hunting, the illegal harvesting of wood and is crossed by two state highways. Additionally, the areas surrounding the reserve have multiple land uses and are characterized by subsistence agriculture, sugarcane agriculture, livestock, and tourism activities, with the establishment of settlements and communities in the vicinity. Since the socio-geographic conditions were favorable for the contact between humans and squirrel monkeys, the aim of this research was to investigate the perceptions of REBio Saltinho workers and visitors, as well as the residents of its surrounding areas about *S. sciureus*, and to identify types of human behavior towards the monkeys, what their motivations were for adopting such behaviors and if there was any kind of conflict between those involved.

2. Materials and Methods

2.1. Study area

The Reserva Biológica de Saltinho (REBio Saltinho) (coordinates 08°43'59.21"S; 35°10'25.39" W) is located between two municipalities in the state of Pernambuco, Brazil, with the largest portion falling in Tamandaré (93.66 % of the total area) and the smaller part in Rio Formoso (6.34% of the total area). Defined as a conservation unit, with an area of approximately 475.21 hectares, the REBio Saltinho originated from an old sugarcane mill, the "Engenho Saltinho", which was purchased in 1905 by the federal government through the Ministry of Justice, with the aim of guaranteeing the water supply for the former village of Tamandaré (IBAMA 2003).

The reserve has Dense Ombrophilous Lowland secondary forest cover, which has been in regeneration since 1923. According to Köppen's classification, the predominant climate in reserve is humid tropical type As', where the autumn-winter rains are predominant (CPRH 1999; IBAMA 2003). The rains, in general, are well distributed throughout the year, with greater observed levels during May to July. The driest months are October, November, and December. The average rainfall is 1500 mm (CPRH 1999; IBAMA 2003). The REBio Saltinho is surrounded by roads, farms, sugarcane plantations, and human communities (Andrade and Moura 2011; Oliveira 2013; Camarotti et al 2015).

2.2. Subjects and questionnaire application

The data presented here are the results of an extension project entitled "Each monkey on its branch? Human perceptions and practices related to the squirrel monkey (*Saimiri sciureus*) in the municipality of Tamandaré, Pernambuco". This project was approved by the administrative-technical council (decision number 119/2017) of the Department of Animal Morphology and Physiology of the Universidade Federal Rural de Pernambuco (UFRPE), by the Biodiversity Information and Authorization System (SISBIO, authorization number 64492-1) linked to the Ministry of Environment.

During the period from April to October 2019, REBio Saltinho workers and visitors, and surrounding residents answered a semi-structured questionnaire composed of nine objective questions (Table 1), which were discursive in nature, based on the models proposed by Albuquerque and Oliveira (2014) and Batista et al (2017). When necessary, the questions were improved to suit the interviewee group and the subjects needed to agree to answer the questions in order to participate in the research.

Ten different points were selected for the interviews (Figure 2), four points within the conservation unit and six points in communities close to the REBio Saltinho. The questionnaire consisted of three topics that were common to all the interviewed groups: characterization of the subjects, squirrel monkey perception, and location of squirrel monkey occurrence (Table 1). The interviews were performed in the following manner: first, the reason for carrying out the research was explained

to the subjects, then a photograph of a squirrel monkey was presented at similar resolutions and scales. After, the respondent was asked whether or not they recognized the animal and/or if they had already seen it in the area.

Upon the positive affirmation of recognizing the squirrel monkey, the questionnaire was filled out by the researcher using the answers provided by the interviewees. To locate the areas of *S. sciureus* occurrence, the interview locations were marked on a Garmin® GPS (eTrex10x model) and later transferred to the Google Earth Pro® program (version 7.3.2.5776).

Table 1 Questions asked on basic topics during interviews that were carried out with REBio Saltinho workers and visitors and its surrounding residents.

Topics	Questions
Characterization of the subjects	Sex: Age: Education: Municipality of residence:
Squirrel monkey perception	1 - Do you know of the squirrel monkey? If so, what do you know about the animal? ____ Yes ____ Not 2 - Do you think the presence of squirrel monkeys is disruptive? Why? ____ Yes ____ Not 3 - Have you ever interacted, in any way, with squirrel monkeys? ____ Yes ____ Not 4 - Do you know what the squirrel monkeys eats? ____ Yes ____ Not 5 - Have you seen squirrel monkeys interacting with domestic animals? ____ Yes ____ Not
Location of squirrel monkey occurrence	6 - Have you ever seen squirrel monkeys outside of the municipality of Tamandaré/Rio Formoso? ____ Yes ____ Not 7 - Have there always been squirrel monkeys around here? ____ Yes ____ Not 8 - Do you often see squirrel monkeys in this region? ____ Yes ____ Not 9 - How many squirrel monkeys do you usually see, approximately?

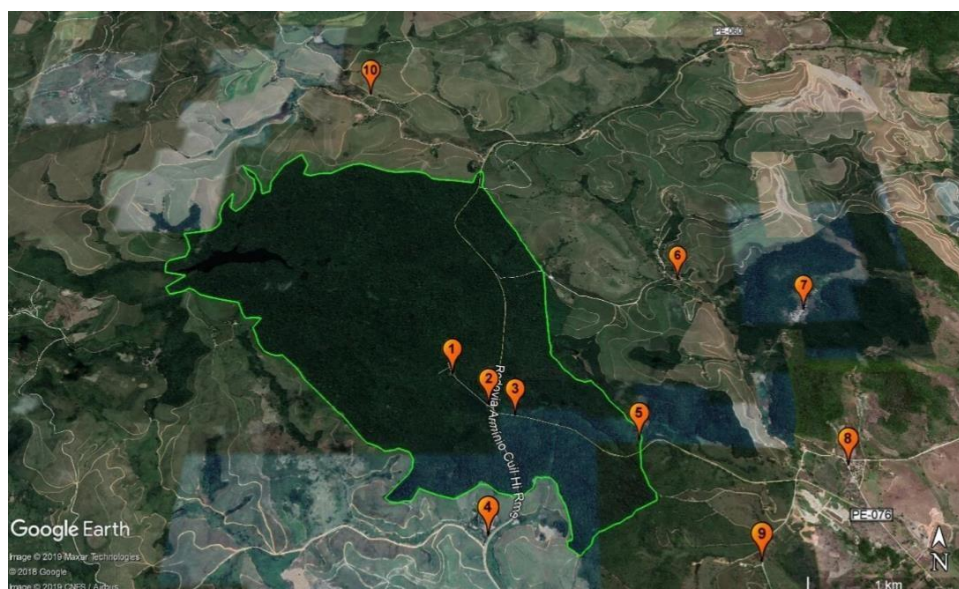


Figure 2 Interview points (in orange) in the REBio Saltinho and surroundings.

2.3. Data analysis

The data obtained were transferred to Microsoft Excel® spreadsheets for categorization, which allowed for the performance of quali-quantitative analyzes using descriptive statistical methods (summations and percentages). The answers to open questions were grouped according to the similarity of the reports in order to analyze and interpret interviewee responses.

3. Results and discussion

3.1 Characterization of the subjects

A total of 70 people were interviewed. The interviewees were grouped into three categories according to the relationship that each participant had with the REBio Saltinho: surrounding residents (73%), workers (20%), and visitors (7%). Eight interviewees, in addition to being workers at the REBio Saltinho, were also residents in the surrounding area. However, they were only considered in the workers category. The detailed profile of the research subjects can be found in table 2.

Table 2 Basic information on the profile of REBio Saltinho workers and visitors and its surrounding residents. Values are expressed in percentage (%).

Categories	Profile	Surrounding residents	Workers	Visitors
Sex	Man	70	93	100
	Woman	30	7	-
Age	Under 18	12	-	20
	18 - 40	41	57	80
	41 - 60	41	43	-
	Over 60	6	-	-
Education	Illiterate	57	-	-
	Incomplete primary school	13,5	29	-
	Complete primary education	13,5	-	40
	Complete high school	16	71	20
	Complete higher education	-	-	40
Municipality of residence	Tamandaré	65	50	80
	Rio Formoso	35	43	-
	Barreiros (Neighboring municipality to Tamandaré)	-	7	20
	Recife (capital of Pernambuco)	-	-	-

The predominance of men in the three respondent categories was likely associated with the fact that the majority of employees at the REBio Saltinho are men. Furthermore, many women that live in the surrounding area did not demonstrate interest in participating in the present study.

3.2 Squirrel monkey perception

Regarding the total number of respondents, 94.3% reported that they knew of the squirrel monkey. More than half (65%) of the residents described the primate using morphological and behavioral characteristics (for example, the fact that squirrel monkeys sleep at 5 pm in bamboo groves). Another portion of the residents (31%) did not know anything about the behavior of squirrel monkeys, and 4% said *S. sciureus* is an invasive species. Previous studies on the behavioral ecology of squirrel monkeys performed in the study area confirm that these monkeys sleep in bamboo groves during the late afternoon (Camarotti et al 2015). This fact was also confirmed by the interviewer through personal observation. Thus, most residents had correct knowledge about *S. sciureus*.

The majority of workers at the REBio Saltinho (46%) perceived the squirrel monkey to be an invasive species that harms the local fauna (for example, some workers described the squirrel monkey as an "enemy" of the marmoset and/or that it is not from that location and has become a pest). Morphological and behavioral characteristics were cited by 31% of workers and 23% did not provide information on their knowledge of this non-human primate. Of the visitors, 40% reported that the animal has characteristics of an invasive species. A further 40% also described some squirrel monkey behavioral characteristics and 20% were unable to provide any information.

The dispersal of invasive alien species harms natural biological richness, in addition to harming human populations (Vale and Prezoto 2015). In the case of the REBio Saltinho squirrel monkeys, Lins (2014) claims that the presence of the Amazonian primate has negatively impacted the avifauna found in the reserve, causing a decline in bird populations. Camarotti et al (2015) also explain that interactions between *S. sciureus* and native marmosets (*Callithrix jacchus*), are common however, during periods of food scarcity in the forest, competition for food increases between the two species. The REBio Saltinho receives researchers from various scientific fields who carry out their studies in the conservation unit. Contact between workers and

researchers and the dissemination of information from scientific studies is also recurrent. Visitors (school excursions or bathers visiting the Saltinho waterfall) often receive information about the fauna and flora present in the reserve and the attitudes they should adopt during their visit. Thus, these factors undoubtedly explain the difference between the perceptions of the majority of workers and visitors and the majority of local residents.

When asked if the presence of squirrel monkeys is disruptive, 80% of the total respondents answered that they did not feel bothered by the animals. Some of the justifications provided included "appreciation for monkeys and/or that they are beautiful and funny, even becoming an attraction". Twenty percent of interviewees said they felt bothered because the squirrel monkeys cause damage to the local fauna, or if one day the food in the forest runs out, it is likely that monkeys will break into houses to get food.

In agreement with our findings, ethnoprimate data collected in other studies showed that most respondents felt comfortable with the presence of monkeys and considered them to be funny (in the case, *C. jacchus* by Albuquerque and Oliveira 2014), attractive animals (such as *Sapajus libidinosus* by Sabbatini et al 2006) or animals that can be domesticated (*Callithrix kuhlii* by Rodrigues and Martinez 2014). According to Padua (2010), the existing empathy between humans and non-human primates is especially important, as educating communities on the importance of conservation can encourage people to change their values and attitudes and aid in the development of conservation strategies.

Regarding contact interactions, 86% of respondents said they had never had any type of interaction with squirrel monkeys and 14% admitted to having interacted or attempted to interact with these monkeys by offering food, especially bananas. In the latter case, the humans wanted to get closer to the animals in order to see squirrel monkeys up close or to touch them. The tendency of most respondents to deny attempting to interact with monkeys, as well as the use of food to attract animals by the smaller portion of interviewees who admitted to interacting with the primates, was also found by Sabbatini et al (2006) and Brasileiro et al (2011). Indeed, during the data collection phase of this study, no traces or remnants of discarded food scraps that squirrel monkeys could eat were observed. This is a positive finding since the establishment of interactions between humans and primates involving food can provoke conflict, as monkeys can associate humans with food (Engeman et al 2010). Another important aspect of being considered is the risk of the bidirectional transmission of zoonoses (Loudon et al 2006).

When asked what squirrel monkeys feed on, 53% of the total respondents mentioned food of animal origin (such as insects or bird eggs) and/or plant origin (fruit and/or gum). The remaining 47% were unable to provide information about the squirrel monkey diet. The diets of primates of the *Saimiri* genus include mainly fruits and insects, and thus they are considered as frugivore-insectivores (Boinski 1999). However, the gum is the basis of the diet of marmosets *C. jacchus* (Power and Myers 2009; Francisco et al 2015), a native primate in the region. We did not find any reports in the literature of the inclusion of gum in the diet of primates of the *Saimiri* genus.

When asked if they saw any type of interaction between squirrel monkeys and domestic animals, the three interviewee target groups were unanimous in stating that they had never witnessed any type of contact or attempt at contact (100% of responses). Primates can be chased or preyed upon by free-living domestic dogs (Srbek-Araujo and Chiarello 2008). Although the presence of domestic dogs that are trained to hunt terrestrial mammals is not uncommon in the REBio Saltinho (interviewer's personal observation), the absence of such reports is positive, particularly in terms of one health, since the transmission of diseases on a global scale is imminent (Fiocruz 2020).

3.3 Location of squirrel monkey occurrence

Of the 70 respondents, 93% reported to know of the squirrel monkey, *S. sciureus*, only within the REBio Saltinho area, and 7% claimed to have seen the species in other locations, outside the REBio Saltinho, including in other Brazilian states. For 58.5% of the interviewees, the occurrence of squirrel monkeys within the conservation unit has always existed, while 41.5% of respondents reported that squirrel monkeys began to appear recently. These results show a lack of knowledge about the introduction of the Amazonian primate into the REBio Saltinho and the historical context of this species is likely to be of low relevance to REBio Saltinho workers, visitors, and nearby residents. However, in certain cultures such as the Waorani, for example, the historical context of primates is of paramount importance to understanding the current relationships between monkeys and humans (Papworth et al 2013).

When asked about the frequency of squirrel monkey sightings, 59% of respondents reported seeing the animals frequently (weekly at least), including in locations outside the legal limits of the REBio Saltinho, close to homes and 41% reported seeing them infrequently. In the analysis using interviewee categories, 51% of the surrounding residents did not observe squirrel monkeys frequently, compared to 49% of those who said they saw the animals frequently. The proportion of sightings increased in relation to the REBio Saltinho workers and visitors, where 71% of the total workers said they frequently saw squirrel monkeys and 100% of the visitors made the same claim.

Since squirrel monkey populations have grown significantly since the first group was released into the area in the mid-1980s, it is very likely that groups of these primates will visit locations outside the conservation unit, as there are patches of forest located within the protected area and outside it, forming a single green area through which the monkeys can move.

Regarding the number of animals seen in squirrel monkey groups, local residents mentioned that they usually see between 10 and 15 animals. Workers reported seeing more than 20 animals and visitors between 16 and 20 squirrel monkeys. The social organization of *Saimiri* spp. is formed by 25 to 75 animals (Boinski 1999; Burnie and Wilson 2001). Thus, the REBio Saltinho workers reported numbers that were closer to reality than local residents and visitors

4. Conclusions

We can conclude that the relationship between humans and squirrel monkeys in the REBio Saltinho and its surroundings are peaceful. The answers provided by the interviewees show, in most cases, an agreement with studies previously carried out in this locality and also with similar ethnoprimate research collected in different studies. However, it is necessary to emphasize that human activities such as sugarcane monoculture, agriculture and cattle raising and deforestation that are recurrent in the study area, can reduce the size of this animal's habitat and can generate problems, in either the long or short term, such as competition for space and/or food between humans and monkeys, as well as initiating pursuits such as hunting *S. sciureus* individuals.

Therefore, the results of this study are essential for reserve workers, visitors and other community members, as they will help the REBio Saltinho managers to better understand the ecological context of living with this monkey species.

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Conflict of Interest

The authors declare no conflict of interest.

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