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Wildlife in our backyard: interactions between Wied's marmoset *Callithrix kuhlii* (Primates: Callithrichidae) and residents of Ilhéus, Bahia, Brazil

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Ecological and behavioral plasticity allow marmosets, genus *Callithrix*, to adapt and succeed in urban areas. This research assess proximity and relationships between Wied's marmoset *Callithrix kuhlii*, domestic animals and residents of Ilhéus, Bahia, Brazil. We collected data on the species' urban ecology and biology, since it has been little studied so far. Tools for data gathering included semi-structured interviews, direct observations and GPS-mapping. There were sightings within the three major districts of Ilhéus, with 37% of positive questionnaires (n = 359) for marmoset sighting at least weekly. Therefore, marmosets were considered common in this city. Most records and frequent sightings were associated with secondary forest fragments, backyards with fruit trees and mangroves. Marmosets travel among urban fragments using electrical and phone wires and crossing roads. There is a relatively small number of accidents when compared to the number of sightings, with electrocution as the most common. Visitation of marmosets to households, attracted by food provisioning, was considered frequent. People feel pity for the marmosets and lure them to their houses through food, but offered items are not always suitable. Marmoset exploration of uncommon habitats, such as mangroves, might be driven by a lack of larger forest fragments within the city.

Primates around the world are under different degrees of human influence, which affect their population sizes and behavior (Hill 2000, Scott and Lockard 2006, Hanya et al. 2008, Mori et al. 2008, Pirta 2009). Some species are highly opportunistic and adaptable to anthropogenic environments (Mittermeier and Cheney 1987, Goulart et al. 2010). Marmosets of the genus *Callithrix* are endemic Brazilian primates, typically frugivore–insectivores, but with a strong omnivorous tendency (Coimbra-Filho and Mittermeier 1973, Hershkovitz 1977). There are records of its presence as exotics or native populations in large numbers in some of the major Brazilian cities (Victor 2007, Lourenço 2011, Goulart et al. 2010, Leite et al. 2011). A rapid adaptation to marginal habitats allow populations of several species of *Callithrix* to live in parks, squares or any forest fragment, regardless of their extent (Ruiz-Miranda et al. 2006).

Despite informal records of the Wied's marmoset *Callithrix kuhlii* in urban communities of southern Bahia, no survey has been carried out on the number of groups in such environments, types of habitats, incidents involving marmosets and relationships with the humans living in these communities. The city of Ilhéus is rapidly growing in population size, with its mangroves, hills, forest fragments

and riverbanks unduly occupied (IBGE 2010). Secondary forest fragments within the city might act as potential habitats for groups of marmosets.

There is little research on *C. kuhlii* in its natural environment, and only two studies (Rylands 1989, Raboy et al. 2008) addressing its ecology and behavior. Therefore, our goal was to characterize the potential urban habitats of *C. kuhlii*, estimate the location of groups within the city of Ilhéus, the threats these environments pose to them and levels of coexistence and proximity between marmosets, people and domestic animals.

Methods

A survey was conducted in the urban area of Ilhéus (39°00'–39°04'W, 14°44'–14°51'S), southern Bahia. The city has 176 917 inhabitants and an area of 1841 km² (IBGE 2010). For simplicity, the urban area of Ilhéus was divided in three districts: north (north of 'Malhado' neighborhood to city limits), downtown (between Pontal Bridge and 'Malhado' neighborhood) and south (south of Pontal Bridge to city limits). This is a common division of

the city by its inhabitants, and was useful to understand certain comments when interviewing, for often people referenced their experiences in other areas of Ilhéus. Since districts have different sizes, data was standardized when necessary to allow comparisons among them.

Data was gathered from September 2009 to May 2010 in field excursions covering all three districts and along all daylight hours throughout the months. A street map made by the City council was used as a reference, together with a vegetation map of the city (Moraes et al. 2007). To determine the potential habitat available for *Callithrix kuhlii*, suitable vegetation types (following Rylands 1989 and Raboy et al. 2008) in the map were measured, and verified in the field by personal observation. Marmoset searches (direct and indirect) were made at all times during field excursions. Sightings were recorded with a GPS along with a site description (e.g. backyard, secondary forest fragment, public park, road, etc). These data were used to assemble distribution maps, with the software ARGIS 9.3, using WGS 84 Datum. When marmosets were spotted within the final hours of daylight, next-day observations started at this same site at dawn (whenever possible), to register marmosets leaving the site, and therefore mark it as a 'sleeping site'. Data were processed using descriptive analyses and the χ^2 -test to assess the independence of data among districts, with software BioEstat 5.0.

Anonymous semi-structured interviews were conducted with people of both sexes, 18 years or older, chosen by non-probabilistic sampling, in all areas identified as containing suitable habitat for marmosets. The only criteria for selection was to currently live or spend more than six daylight hours daily within the area. The number of interviews was proportional to the size of each district.

Two interview scripts were adopted. When the answer was positive for the occurrence of marmosets, the script contained 20 questions addressing: recognition of Wied's marmoset through pictures, frequency of sighting, time of the day, proximity to houses, backyards, etc; handling, supplementation, feeding items (if offered), information about other people seeing or making contact with marmosets, interaction with domestic animals and/or humans, and any other incident involving *C. kuhlii*.

When the answer was negative for marmosets, the script contained seven questions assessing their knowledge of marmosets in that area or other places, third-party information on sightings or contact with them, and the neighborhood where they lived. If seen elsewhere, we asked for group size, feeding habits, and interactions.

Sometimes respondents did not complete all questions. This happened when, for instance, people had seen the marmosets but couldn't recall for how long, or if they had ever visited their backyard trees. In spite of incomplete, these interviews were not discarded, for questions were analyzed individually. As a result, the numbers of answers for each question are different, and absolute numbers of replies per question are shown in parentheses. Interviews with conflicting information (e.g. contradictions such as "have never seen the marmosets" and "feeds them bananas" in the same interview) were solved during the data gathering (e.g. using phrases such as "explain yourself a bit more on this subject" when a contradiction was spotted), or information was discarded.

To determine sex and age class, phenotypic characteristics, such as presence of fully-grown testicles, reddish-brown patch in the thighs and an approximately 300 g size were considered (Digby and Barreto 1993, 1996), as well as independent locomotion and interactions with other members of the group.

Results

After 640 h of observation and interviewing, 359 semi-structured interviews were conducted in 34 localities (neighborhoods, streets, slums) in the northern, central and southern districts of Ilhéus, with 37% (132/359) of them positive for the occurrence of *Callithrix kuhlii* in situ. There was a significant difference in the number of reported sightings of marmosets between the northern, downtown and southern districts ($\chi^2 = 37.81$, $p > 0.05$; $DF = 2$) (Fig. 1). Although no animal has been captured for anthropometric measurements or museum comparisons of color and pelage, our direct observations confirm the phenotype described for the species (Coimbra-Filho 1984). Respondents identified *C. kuhlii* from pictures, and 94% of them were able to distinguish it from *C. jacchus*, the white tufted marmoset. However, recognition failed in most cases (37%) when compared to *C. penicillata*, the black tufted marmoset, a species living slightly up north in Bahia. Fifty-four percent (194/359) of respondents also saw marmosets in other neighborhoods, and 38% (140/359) knew people who have seen or maintained contact with them. Animals were seen in the morning (between 6:00 and 11:00 am) by 61% (101/165) of the people, while 39% (64/165) mentioned animals were seen in the afternoon (between 1:00 and 5:00 pm).

Marmoset presence in Ilhéus couldn't be well placed in time. According to the survey, 24.5% (24/98) of respondents have seen the animals 'for a long time', representing more than 10 years, but not specifying an exact date. More than 50% saw marmosets over the last 10 years. There was no significant difference in the length (in years) of marmoset sightings in the three districts ($\chi^2 = 5.98$; $p > 0.05$; $DF = 2$). However, there are no reports of marmoset sightings for more than 10 years in the south.

Urban forest fragments in Ilhéus are of different sizes. In the north, the largest forest fragment had 13.5 ha. In downtown, the largest fragments had 20.9, 9 and 11 ha (except for an uncolonized island); in the south, fragments ranged between 40.8 and 11.15 ha. Our average group size was 7.4 individuals. However, we found groups with 3 individuals and others with more than 20, where exact counting was very difficult. Marmoset sightings were associated to some type of feeding and/or sleeping attractant, such as: backyards with secondary vegetation, orchards or mangroves, houses with large yards and abundant fruit trees and secondary forest fragments (Fig. 1). Most marmosets were seen in secondary forests (38.5%), backyard orchards (17%) and mangroves (15.4%). A very common sighting of marmosets (at least three times a week) always occurred within areas of secondary forest fragments, mangroves and orchards.

Although respondents (and personal observations) prove marmosets actively cross streets and avenues, on the ground

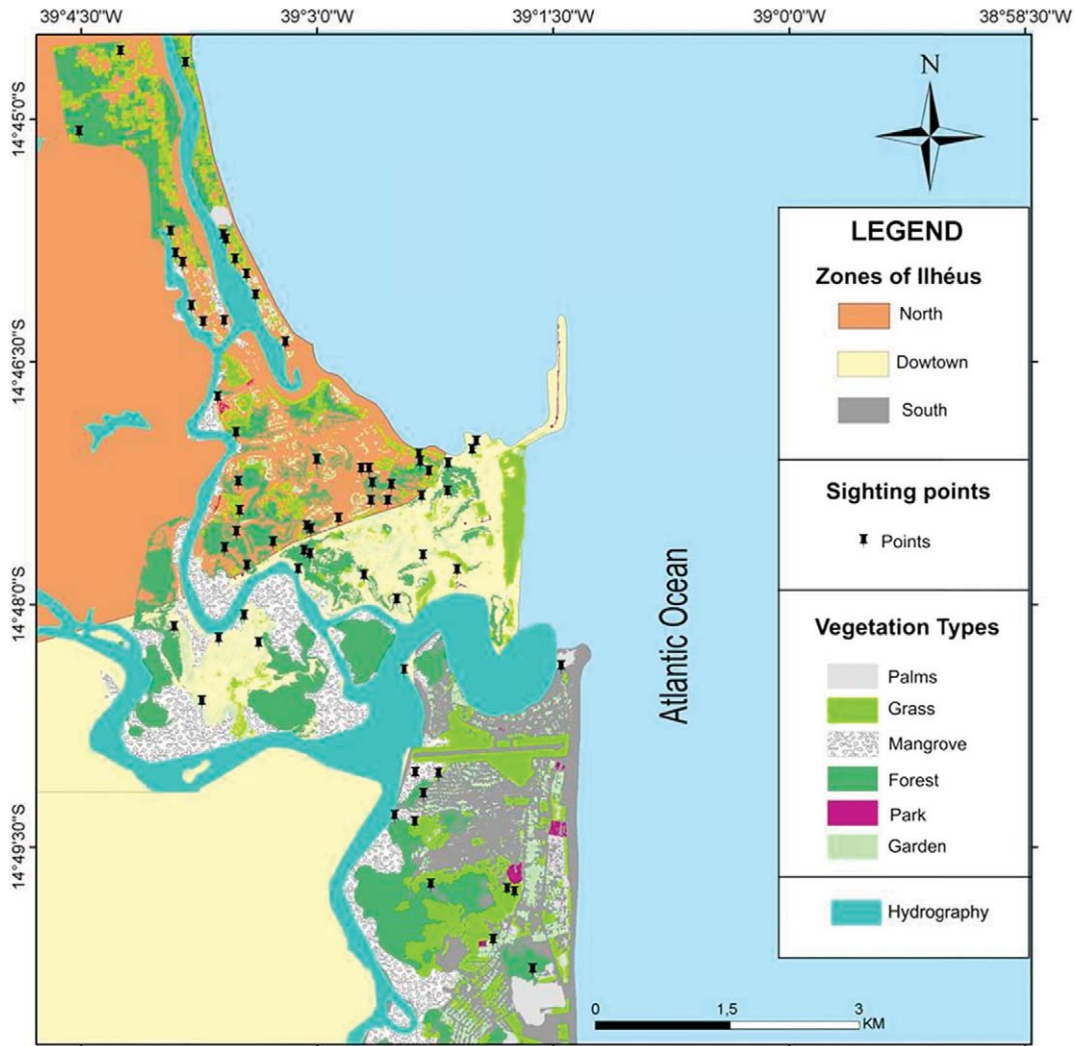


Figure 1. Vegetation map of Ilhéus (De Moraes et al. 2007) marking direct/indirect observations of *C. kublii*. Marmosets could have been observed more than once in the same spot.

or through electrical and telephone wires, 79% (107/136) of respondents did not report accidents as common (defining 'common' as at least once a month).

Figure 2 details the types of accidents found in Ilhéus. By far, wire crossing is the most dangerous activity, with

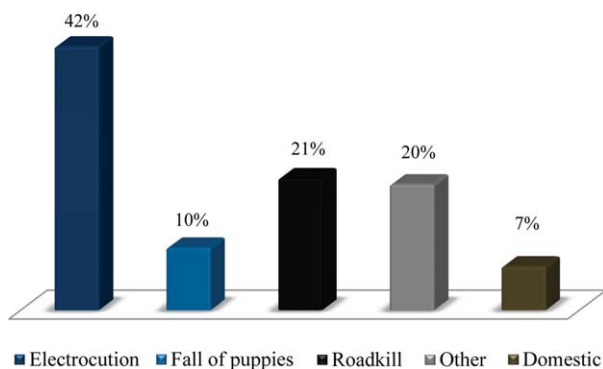


Figure 2. Accidents involving marmosets in Ilhéus as reported in the interviews.

marmosets electrocuted or falling while transporting their young. 28% of accidents involved humans, with 21% being roadkills, all on the road between Ilhéus and Itacaré (north district) and domestic accidents such as marmoset bites, poisoning, etc. Accidents classified as 'others' include falling from trees, being attacked by animals or other incidents not directly related to human interaction.

We also gathered data from the epidemiological monitoring system of Ilhéus on primate bites/scratches on city residents. There were 12 registered cases of aggressions (e.g. bites, scratches) to humans by primates between 2006 and 2009. The two primate species involved were *Sapajus* (= *Cebus*) *xanthosternos* (3/12 cases) and *C. kublii* (9/12 cases). Unfortunately, people do not always report being bitten by a marmoset because of fear of the rabies shot and because of ignorance of the potential consequences of the bite.

Proximity to marmosets is also an ordinary issue. Two-thirds (66%, 80/121) of respondents say they have been 'very close' (within contact) and 12% (14/121) have even touched the animals. The most common contact

between people and marmosets was through food provision, with 57% (68/121) of responses. Furthermore, 21% (25/121) of respondents said they had seen marmosets near domestic animals, 48.5% being dogs (16/33). However, other animals such as tortoises *Chelonoidis carbonaria*, guinea pigs *Cavia porcellus* and birds, like the song-thrush *Turdus rufiventris* were mentioned. Behaviors between marmosets and domestic pets include playing, delousing and aggression, the latter usually occurring with dogs attempting to bite or capture marmosets. Cats were mentioned trying to prey on adult marmosets and also eating their young. Only song-thrushes (*Turdus* sp.) were reported as predated by marmosets.

Regarding food offer by humans, 50% (34/68) report bananas as the only offered food. Marmoset appearances in people's backyards are seasonal and associated with fruit trees (exotic or native). Other items such as bread, rice, human food leftovers and biscuits (22%) were also placed on feeders or tree branches to allure marmosets. Some marmosets have entered people's kitchens, service areas or even living rooms. However, this is not common and only happens when food is left on tables, open pans or cabinets.

Discussion

The presence of *Callithrix kuhlii* is regarded as common within the urban perimeter of Ilhéus, although it was not possible to determine a colonization pattern for the city's districts. North of Ilhéus had more visualizations and positive interviews, suggesting either a greater population size or more familiarity of marmosets with people. Since there is significantly less suitable vegetation downtown, it might be possible that it has a smaller population size. Fewer sightings in the south might be explained by recent urban expansion in this area, implying less familiarity of marmosets with people, therefore less sightings. We have found an association between longer sighting periods (above 10 years) and more preserved forest fragments, and sightings for less than five years with backyard orchards and mangroves. Forest fragments and stable groups of marmosets is an expected result, and recent sightings in uncommon habitats, such as mangroves, might indicate a recent occupation of these areas. However, animals apparently are still following the activity patterns reported for pristine areas (Rylands et al. 1989, Raboy et al. 2008). Leite et al. (2011) showed that marmosets *Callithrix penicillata* express normal behaviors such as foraging, feeding and socialization even when surrounded by a high human density, as close as 10 m away from their home range. As seen with other marmosets, *C. kuhlii* gets easily accustomed to people, and since proximity to humans usually involves food, they might get a positive reinforcement every time they accept human contact.

Due to our sampling design, we cannot allocate a specific number of hours to sole marmoset observations. Our goal was to gather as much information as possible from interviews and direct/indirect observations in a place where there was no previous information, other than anecdotic comments. Ours are the first systematic records of

marmoset ecology, biology and behavior within urban spaces of southern Bahia.

Marmosets were more frequently seen in secondary forests, since resources such as fruits, insects, small vertebrates and plant exudates are more abundant in degraded or secondary environments where a sparser canopy allows greater light penetration (Pinto et al. 1993). There is also protection against predators and structural support for displacement associated to secondary environments (Blake and Loiselle 2001).

Backyard orchards also stood out as important areas used by marmosets. This is expectable, since their diet is heavily dependent on fruit and nectar, even above the average consumption by other Cebidae monkeys (Rylands 1989, Raboy et al. 2008). Mangroves appeared as areas used by marmosets elsewhere (Mendes Pontes and Monteiro da Cruz 1995), but it is the first report for *C. kuhlii*. Interviews and observations in the mangrove areas of northern Ilhéus highlight a daily presence of marmosets, feeding on small arthropods and using mangrove roots and branches as sleeping sites. However, we did not perform a systematic study of mangrove use by this species.

Home range of *C. kuhlii* was reported as 38 ha, with a density from 4.3 (Raboy et al. 2008) to 6.6 individuals (Rylands 1989) per group. Our average number group size (7.4 individuals group⁻¹) falls out of the usual wildlife range. Since urban Ilhéus has no single fragment large enough to sustain one group of marmosets (according to fragment sizes in the map by Moraes et al. 2007), human supplementation, whether intentional (i.e. food provisioning in platforms or alike) or not (through access to backyard orchards or trees) seems vital for marmoset survival in the city. The common marmoset, *Callithrix jacchus*, shows great adaptability to urban environments and, when supplemented, large groups can survive in small fragments (Pontes et al. 2006), as seems to be the case for *C. kuhlii* in Ilhéus. This might suggest that humans are vital for marmoset survival through food provision. This could be potentially disastrous for marmoset's physiology and nutrition, as our data points out industrialized and exotic food (i.e. cookies, candies and chocolates) offering. People tend to feed marmosets believing they are hungry, since there is a common perception that they are similar to pets or zoo animals and need to be constantly fed (Leite et al. 2011). De Paula et al. (2005), show that around half of the people feed marmosets with banana and/or papaya, placed on artificial feeders or other locations above the ground. For other primates, 79% of interactions with humans involve food provision, potentially decreasing the motivation of animals for foraging in their natural habitat and facilitating a potential spread of diseases (Sabbatini et al. 2006).

Food provision was also used as a strategy for attracting marmosets. Some people not only provided food in their houses or backyards, but also stored it to maintain their constant visitation, just for the pleasure of seeing them closely. In general terms, people assume if something is 'good' for humans it must be 'good' for animals as well. This is the common explanation for the provision of processed foods, dressing of marmosets and other humanized actions

found during our interviews. People also showed disappointment when the visiting marmosets displayed ordinary marmoset behavior, such as genital licking or urine marking, considering them 'dirty' or 'mannerless'.

Our study describes the spontaneous affinity between marmosets and people, a relationship of 'closeness' seen by people as positive and beneficial for both parts. In other cities of Brazil people also love marmosets within their homes (De Paula et al. 2005). However, many of the accidents involving marmosets result from the habit of feeding them in gardens or inside the house, as they might eventually become aggressive (Goulart et al. 2010). Still, most of these people did not admit or perceive how irresponsible they were by letting marmosets within their physical contact.

Despite the fact that accidents involving cars and electricity are fully compatible with the forms of displacement used by marmosets in Ilhéus, the number of reported accidents was small when compared to the number of sightings. Marmosets move among fragments in the city using electrical and phone wires and directly crossing roads and avenues. Some of the threats of the urban environment for marmosets are car accidents, electrocution, falling of infants during wire crossing, poisoning, stoning and predation by domestic animals. Residents from a neighborhood in the southern district installed a hand-made rope bridge to reduce marmoset crossing through electric wires. Marmosets were also seen using a rope bridge installed in the Ilhéus-Itacare road, northern district. Goulart et al. (2010) report notifications from Environmental Police of Belo Horizonte-MG about marmosets with some type of injury, whereof most are caused by cars, falling trees or electrocution and attacks by domestic animals.

Even though few accidents have been reported in the past five years in Ilhéus, 75% were marmoset bites, probably because people want to touch and be close to them. The lack of knowledge on their zoonotic potential reinforces the importance of an awareness program that addresses the possible diseases these animals may transmit. Rabies vaccination is compulsory in Brazil after a primate bite or scratch, but general perception in Ilhéus does not place marmosets as 'primates' (Alkmim and Martinez unpubl.).

Marmosets transit through backyards where dogs, cats or chickens live, and are likely to have contact with feces and urine from these animals and also produce their own feces in these areas. According to the Ministry of Health, marmosets can transmit diseases such as smallpox, syphilis and rabies to domestic animals and humans. Still, the interviews show no concern about the possible consequences of the contact between marmosets, humans and other animals. Likewise, respondents have not expressed any secluding behaviors among them, their pets and marmosets. Basic information on the ecology and behavior of these animals may be the necessary to change the mild attitude of the population of Ilhéus, channeling their attraction in a conscious manner beneficial for them and marmosets, now part of their 'backyard wildlife'.

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