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FIRST RECORD OF NATURAL PREDATION ON BATS BY DOMESTIC CAT IN BRAZIL, WITH DISTRIBUTION EXTENSION FOR *Phyllostomus discolor*

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Abstract: Domestic cats (*Felis catus*) prey upon bats, but the impact of this predation on bats, and their populations, by domestic cats worldwide has been underestimated. In Brazil, there is no scientific record of this natural predation event. In this paper, I report firsthand observations of domestic cat natural predation on bats in Brazil. The observations took place in an urban area in northeast Brazil and revealed a female cat attacking *Artibeus lituratus* (Olfer, 1818) and *Phyllostomus discolor* (Wagner, 1843). It is also the first record of *P. discolor* in Alagoas state. Two out of five predation records consist of parts of bats (skull and wings) left by the cat. The other three are from entire bats rescued. As many species of bats live in urban environments, information on predation gives access to some threats wildlife living in the cities could be submitted, especially when the predator is a domestic animal.

Keywords: Chiroptera; feeding ecology; Felidae; pale-spear-nosed bat.

A simple definition of predation includes the consumption of a living organism by another. This is an important selective pressure that can influence prey populations or species, from the control of population growth to the selection of individuals more likely to contribute to the future population or of the species itself (Begon *et al.* 2006, Mikula *et al.* 2016). In natural predation, predators are known to regulate the prey population, but also the predated individual is often the weakest, such as the sick, old or young and naive, so the individual preyed would probably die anyway (Hastings 2013). On the other hand, non-natural predation happens with human interference in an opportunistic way. Opportunistic predation is usually determined by the local availability of prey and therefore the predator spends less time and energy in foraging (Begon *et al.* 2006).

Bats can be opportunistically prey when they are extremely vulnerable, which usually happens when they are trapped in mist nets during research activity. However, this type of opportunistic predation in mist nets does not necessarily reflect a relationship that occurs naturally among species. There are records of such predation on bats by birds (Carvalho *et al.* 2011, Rocha & Lopez-Baucells 2014, Serra-Gonçalves *et al.* 2017), opossums (Gazarini *et al.* 2008, Patrício-Costa *et al.* 2010, Breviglieri & Pedro 2010), fox (Novaes *et al.* 2010), wild cats (Rocha-Mendes & Bianconi 2009), domestic cats (Breviglieri & Pedro 2010) and even other bats (Nogueira *et al.* 2006, Oprea *et al.* 2006). A recent review on opportunistic predation on bats in Brazil pointed out 50 species of predators (Bigai & Faria 2018), although it is not clear how many cases would be predation in mist nets or not.

Natural predation on bats have been recorded by centipede, spider, fish, frogs (Gouveia *et al.* 2009, Da Silva *et al.* 2010), snake, bird, primates and other bats (Esbérard & Vrcibradic 2007, see Costa *et*

al. 2016 for review), but there are still few records and studies on this kind of predation on bats in Brazil. On their recent review, Costa *et al.* (2016) pointed 107 records of natural predation on bats by 36 different species. None of those species being exotic or domestic, although it is commonly known that domestic cats pursue bats and such behavior may be a widespread phenomenon. Felines are generally known as carnivorous predators, having a strong hunting instinct and preying on various organisms such as birds, lizards, mammals, among others (Reis *et al.* 2011). Such instinct can be notice in domestic cats, since exploring is an important behavior specially in foraging activities for predator species like cats. Therefore, environmental novelty can increase motivation to explore (Ellis 2009, Machado & Genaro 2010).

The impact caused by domestic cats *Felis catus* on wild fauna populations, especially bats, has been studied in a few countries like USA, Australia, Italy and United Kingdom (Woods *et al.* 2003, Rodríguez-Durán *et al.* 2010, Scrimgeour *et al.* 2012, Ancillotto *et al.* 2013). Nevertheless, published analyses of these interactions remain rare. Mikula *et al.* (2016) assign this scarcity of publication, among others reasons, to the nocturnal habit of bats, which makes it difficult to observe and study behavioral events. Here, I report observations of domestic cat predation on bats in an urban area in northeast Brazil and discuss perceived patterns on these occurrences. Although anecdotal information is available, it is the first record on scientific literature of bat natural predation by domestic cat in Brazil.

Further, I report the first record of *Phyllostomus discolor* in Alagoas State. This bat occurs from Mexico to Paraguai (Díaz *et al.* 2016), having a wide distribution including in Brazilian territory, where it is present in all biomes except the Pampas and all in states except Santa Catarina and Rio Grande do Sul (Reis *et al.* 2017, Vargas-Mena *et al.* 2018, Almeida *et al.* 2019) (Figure 1). Alagoas was the only state in northeastern Brazil where *P. discolor* had not been registered (Reis *et al.* 2017, Vargas-Mena *et al.* 2018), although its occurrence was expected since it occurs in the neighboring states of Sergipe (Brito & Bocchiglieri 2017) and Pernambuco (Queiroz Guerra 2007). Here I am filling this gap in the known geographic distribution on this species about 120 km south and 175 km north from its nearest registers: Saltinho Biological Reserve in Pernambuco and Wildlife Refuge Mata do Junco in Sergipe, respectively (Figure 1).

Predation events took place at the former building of the Natural History Museum of the Federal University of Alagoas (9°39'41.64"S, 35°43'50.97"W, *datum* WGS 84) (Museu de História Natural da Universidade Federal de Alagoas, MHN/UFAL), while it still operated in this locality. This former museum address was located in a predominantly residential neighborhood in the city of Maceió, capital of the State of Alagoas, northeastern Brazil. Behind the building there is a small secondary Atlantic Forest remnant, which is surrounded by human constructions - such as

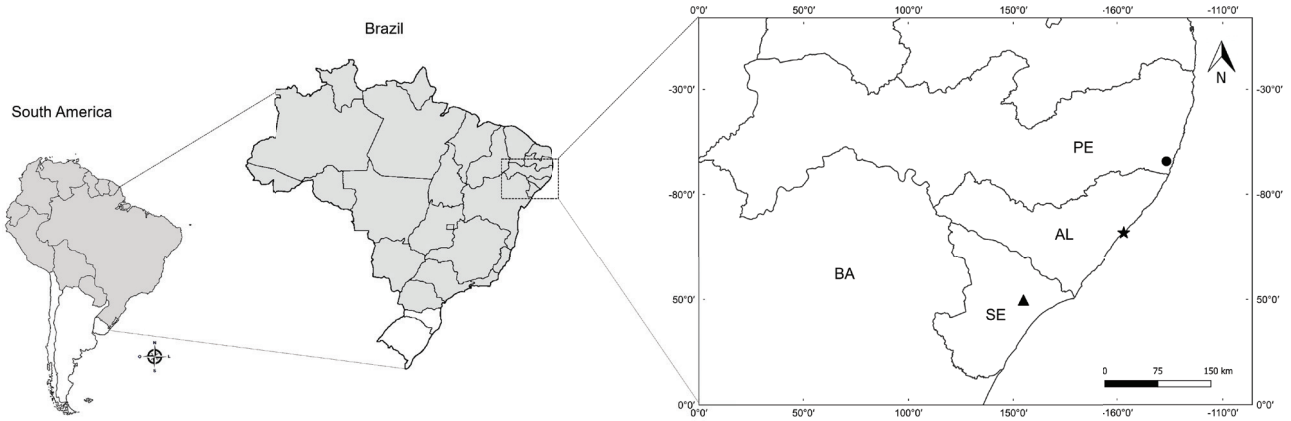

Figure 1. Countries in South America and states in Brazil with confirmed occurrences (in grey) for *Phyllostomus discolor*. In detail, the new record reported for Alagoas State (black star, Voucher number: MUFAL0321) and the nearest registers: Saltinho Biological Reserve in Pernambuco (black circle) and Mata do Junco Wildlife Refuge in Sergipe (black triangle). BA= Bahia, SE= Sergipe, AL= Alagoas, PE= Pernambuco States.

houses, buildings, and commercial establishments - and suffers from frequent burning events caused by humans. In this remnant there are fruit trees such as mango (*Mangifera indica* L.) and papaya tree (*Carica papaya* L.).

The bats were rescued already dead, and the specimens collected were preserved as fluid and deposited in the MHN/UFAL Collection of Mammals located in the new headquarters of the Museum, also in the city of Maceió. All the work was carried out with the fundamental help of the institution's night watchmen, who rescued entire specimens from the attacks and identified the cat responsible for them. Two felines permanently inhabited the Museum, raised by museum staff, both were fed with cat food and had free access to the outside environment and corridors of the building during the day and at night. According to the night watchmen, only one of the cats (an adult female) was responsible for predations.

In total, five attacks were recorded from July 2014 to August 2015. The watchmen were able to rescue three entire bats: (i) an adult female of *Artibeus lituratus* (Olfer, 1818) on August 6th 2014 (Voucher number: MUFAL0157), (ii) an adult male of *A. lituratus* (Voucher number: MUFAL0158) on September 18th 2014 and (iii) an adult female of *Phyllostomus discolor* (Wagner, 1843) (Voucher number: MUFAL0321) on August 5th 2015 (Figure 2). These specimens had minor injuries close to the head, possibly where the cat gave its first bite. The remaining records are from: (iv) a head without

Figure 2. Entire rescued bats from a domestic cat attack in the Natural History Museum of the Federal University of Alagoas (Alagoas State, Brazil). *Phyllostomus discolor* (Voucher number: MUFAL0321, left) and *Artibeus lituratus* (Voucher number: MUFAL0157, right) preserved on liquid. Frontal (A) and dorsal (B) view, with detail of the injured nape of *A. lituratus*.

the occipital region (Voucher number: MUFAL100) found on July 23th 2014; and (v) wings plus dental region on August 8th 2014 (Figure 3). After dental and wing analysis, both adults were identified as *A. lituratus*.

Regarding the identification of the *Phyllostomus discolor*, this is a medium-sized Phyllostomidae with the venter color distinctly lighter than the dorsal and that distinguishes itself from other members of genus by the calcar that is shorter than length of hind foot (Kwiecinski 2006). Measurements (in mm) from the specimen here reported are: head and body length = 88, tail length = 16, hind foot length with/without claws = 16/14, calcar = 10, ear = 19, tragus = 8, forearm = 61 and weight = 39g.

After the first time one of the night watchmen delivered the deadly remnant of a bat, both watchers were instructed to collect the material with gloves (which were made available) or plastic bags and then store the material in the taxidermy laboratory freezer. In addition, on of the night watchmen witnessed one attack, in which he saw the cat jumping, trying to reach the bat, which was flying with difficulty, probably already hurt. Finally, the cat caught the bat with its front paws and the night watchman managed to rescue the bat. This episode took place in a hallway that has an open side to the outside area. We were unable to identify whether the attack was initiated at the refuge, when leaving it, at feeding time or otherwise. Other whole bat was rescued from the cat's mouth, which ran holding it by the nape of the neck. The fact of leaving remaining parts like wings is similar to records in Puerto Rico, where cats also left wings and legs remains after consuming the bats (Rodríguez-Durán *et al.* 2010). Brand of canines in the throat or head/nape and partially eat prey, leaving the ends, is a pattern observed in wild cats such as *Panthera onca* and *Puma concolor* (Pitman *et al.* 2002).

None of bat species recorded in these attacks is currently listed for purposes of the National List of Threatened Species (ICMBio 2018). Both bat species are widespread in Brazil, though *Phyllostomus. discolor* had not yet been registered for the state of Alagoas (Reis *et al.* 2017). *Artibeus lituratus* and *P. discolor* are both found in artificial shelters, however, the former is most commonly found in treetops even in urban areas (Pacheco *et al.* 2010,

Figure 3. Remaining parts of bats (*A. lituratus*) left by the cat after predation in the Natural History Museum of the Federal University of Alagoas (Alagoas State, Brazil) and found on the floor in the museum: head without occipital region (A) and wings plus the upper and lower dental parts (B).

Reis *et al.* 2017). The Phyllostominae *P. discolor* is mainly omnivorous, feeding on insects and a variety of plant material, while the Stenodermatinae *A. lituratus* is a fruit-eating bat (Reis *et al.* 2017). All that said, is possible that three circumstances may have favored predation: 1) the cat was raised free, as warned by Loss *et al.* (2013); 2) the presence of fruit trees in the border of the build, which can serve as foraging point or even shelter, increasing the abundance of bats nearby (Reis *et al.* 2017); and 3) the presence of a wide roof with lining, that offers refuges for urban bats and, according to Ancilloto *et al.* (2013), bats are commonly preyed when emerging from refuges.

The results found here are similar to the patterns observed in Italy (N = 115): most preyed bats are those able to fly, which excludes non-volant juveniles and newborns; the most affected species are those adapted to the urban environment; some cat individuals may specialize and get more ability to prey bats (Ancillotto *et al.* 2013). This same study also revealed that only 2.4 % from 115 bats were newborn or young bats, and 90% of them fell from the shelter. We were not able to discover if the cat we observed ate newborns, as well as we found no mortal remains from newborns or the cat's feces.

Cats are widely known as conservation problem in urban and rural landscapes and their effects on bat populations can be significant, particularly on rarer species (Altringham 2011, Ancillotto *et al.* 2013, Loss *et al.* 2013). However, the impact of predation on bats by domestic cats worldwide has been underestimated. By year, approximately 250.000 bats are killed by cats on United Kingdom, with a domestic cat population of nine million in 2003 (Altringham 2011). According to the IBGE (2015), Brazil had 22 million domestic cats in 2013, an extraordinarily high number. Although there is no study in Brazil in this sense, it is important to us, as researchers, to be mindful of the potential for predation upon this species by domestic cats, how significant is this impact on bat populations and how this threat should be carefully considered in conservation plans. Strategies to mitigate this impact should encompass sterilization; night-time indoor restriction of cats, especially during bats reproduction periods; and, as suggested by Ancillotto *et al.* 2013, though not tested yet, the use of bells on the collars of cats may warn potential preys.

It is also important to point out that predation can influence prey species in many ways, not only by reducing populations, but also affecting their behavior and ecological responses (Lima & O'Keefe 2013). Pressure on wildlife from introduced predators may also induce changes in foraging patterns or habitat choice, which may decrease fertility and reduce population size (Beckerman *et al.* 2007). Preventing predation, for example, bats may delay or anticipate departure from the refuge, emergence in groups or exchange refuges (Altringham 2011).

The occurrence of *Phyllostomus discolor* in the state of Alagoas was confirmed, also bringing ecological information and observations of vulnerability that the species may have in urban environment. Besides, all information reported here represents an important source of new data, as it is the first record on scientific literature of bat predation by a domestic cat in Brazil, contributing to a subject little explored in this country as trophic ecology of bats. Further, because of many species of bats live in urban environments, all information associated with the predation itself is important, because it gives access to some threats wildlife living in the cities could be submitted to and how we could mitigate such impacts.

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