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First records of Ocelot *Leopardus pardalis* (Linnaeus, 1758) (Carnivora: Felidae) from Rio Grande do Norte, northeastern Brazil

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Abstract: We documented the first reports of Ocelot, *Leopardus pardalis* (Linnaeus, 1758), in the Rio Grande do Norte state, northeastern Brazil. In December 2014, one adult male was road-killed in an Atlantic Forest remnant in São Gonçalo do Amarante municipality. Another three animals were killed by hunters in the Caatinga between 2012 and 2014, in the municipalities of Lajes and Santana do Matos. These records provide important information about the occurrence and distribution and conservation of this mesocarnivore in northeastern South America.

Key words: Pernambuco Endemism Center; Seasonally Dry Tropical Forests; felids; mesocarnivores

The Ocelot, *Leopardus pardalis* (Linnaeus 1758), is a medium-sized mesocarnivore (8–14.5 kg; Emmons & Feer 1997) that plays an important ecological role in Neotropical ecosystems, whether as an intraguild predator/competitor (Oliveira et al. 2010) or through predation on small and medium-sized vertebrates (< 2 kg; Murray & Gardner 1997). The species can be found from the extreme south of the United States to northern Argentina, inhabiting both humid tropical forests and semiarid regions (Emmons & Feer 1997; Murray & Gardner 1997; Sunquist & Sunquist 2002). However, its occurrence is primarily associated with locations of dense vegetation or forest (Murray & Gardner 1997; Sunquist & Sunquist 2002). Ocelot is categorized as Least Concern by the IUCN (Paviolo et al. 2016) and appears in Appendix I of CITES (2012). In Brazil, the Ocelot was removed from the list of endangered species in 2014 (MMA 2014); however, some populations outside the Amazon are classified as vulnerable (Oliveira & Cassaro 2006; Paviolo et al. 2016).

Although the Ocelot is widely reported in South America (Nascimento 2010), its occurrence is known from just a few records in the Atlantic Forest remnants to the north of the São Francisco River (Pernambuco Endemism Center) or even in the Caatinga (Nascimento 2010; Feijó & Langguth 2013). In this context, Rio Grande do Norte is highlighted as the least known Brazilian state regarding its mammalian fauna, with insufficient records precluding a reliable assessment of their diversity (Ferreira et al. 2009; Feijó and Langguth 2013; Dantas et al. 2016). This lack of information about medium-sized and large mammals within the state hinders conservation and distribution assessments of the species (Feijó & Langguth, 2013). Only a few specific studies exist, reporting the occurrence of *Sapajus* spp. (Ferreira et al. 2009), *Cyclopes didactylus* (Miranda & Superina 2010), and *Sylvilagus brasiliensis* (Dantas et al. 2016).

Aiming to contribute to the knowledge of mammals in the state and of mesocarnivores in Northeast Brazil, we present the first records of Ocelots in Rio Grande do Norte state and we also discuss aspects of its conservation and distribution.

In December 2014, an adult male Ocelot (Figure 1) was road-killed near the Governador Aluízio Alves Interna-

Figure 1. Occurrence records of Ocelot, *Leopardus pardalis,* in Rio Grande do Norte state, northeastern Brazil. **A.** Road-killed animal in the immediate vicinity of the Aluízio Alves International Airport, Atlantic Forest remnant. **B, C.** Specimens killed by hunters in the Serra do Feiticeiro region, in Lajes. **D.** Ocelot killed by hunter in Santana do Matos municipality. Letters A–D indicate the sites described in Table A1 (numbers 1–4, respectively). (Photos B, C and D were obtained with the hunters.)

tional Airport (05°45′44″ S, 035°22′54″ W), situated in the peri-urban region of São Gonçalo do Amarante municipality, in the metropolitan region of the capital city of Rio Grande do Norte state, Natal, 15 km from the coast (Figure 2; Appendix, Table A1). This animal is deposited in the Museu de Ciências Morfológicas da Universidade Federal do Rio Grande do Norte (voucher number: 030MAM).

The collection site comprises a forest remnant of approximately 2,100 ha surrounded by access roads and airport facilities. The fragment is also surrounded by an agricultural matrix consisting mainly of pastures and sugarcane crops. Although this area falls outside of Atlantic Forest biome's, official boundary defined by federal law 11.428 (Brasil 2006; IBGE 2006) (Figure 2), the vegetation has floristic and structural elements of a seasonal semideciduous forest, with approximately 50% of individuals losing foliage in the driest periods, and a canopy height up to 15 m (Figure 3). Different studies have suggested the inclusion of this region within the Atlantic Forest dominium (Maciel 2011; Rufino 2016). The area presents typical plant species of this biome, such as *Bowdichia virgilioides* Kunth, *Salzmannia nitida* DC., *Tetracera breyniana* Schltdl and representatives of the family Myrtaceae, which is considered one of the most diverse and abundant families in the Atlantic Forest (Gentry 1988; Oliveira-Filho & Fontes 2000). In additional, it presents a warm and subhumid climate with annual average rainfall between 1200 and 1500 mm and concentrated rainfall from April to June, as temperatures are 26 °C on average (IDEMA 2012).

The three records from the Caatinga, corresponding to animals killed by hunters, were obtained from interviews with local residents during field expeditions that took place in Rio Grande do Norte in 2014. One of the records is based on the pelt of an adult male (Figure 1) killed in December 2014, in the proximity of the Serra do Feiticeiro (5°52′47″ S, 036°14′02″ W) in Lajes municipality (Figure 2; Appendix, Table A1). The pelt is deposited in the mammal collection of the Universidade Federal da Paraíba (voucher number: UFPB 9603). The second record is of an adult male (Figure 1) killed between 2012 and 2013, about 12 km east from the previous record (05°46′35″ S, 036°10′07″ W) (Figure 2; Apendix, Table A1). The third animal (Figure 1) is a male killed between 2012 and 2013, in the region of Serra de Santana (06°04′19″ S, 036°39′35″ W), Santana do Matos municipality (Figure 2; Appendix, Table A1). For the last two records we retrieved from the hunters only the reports

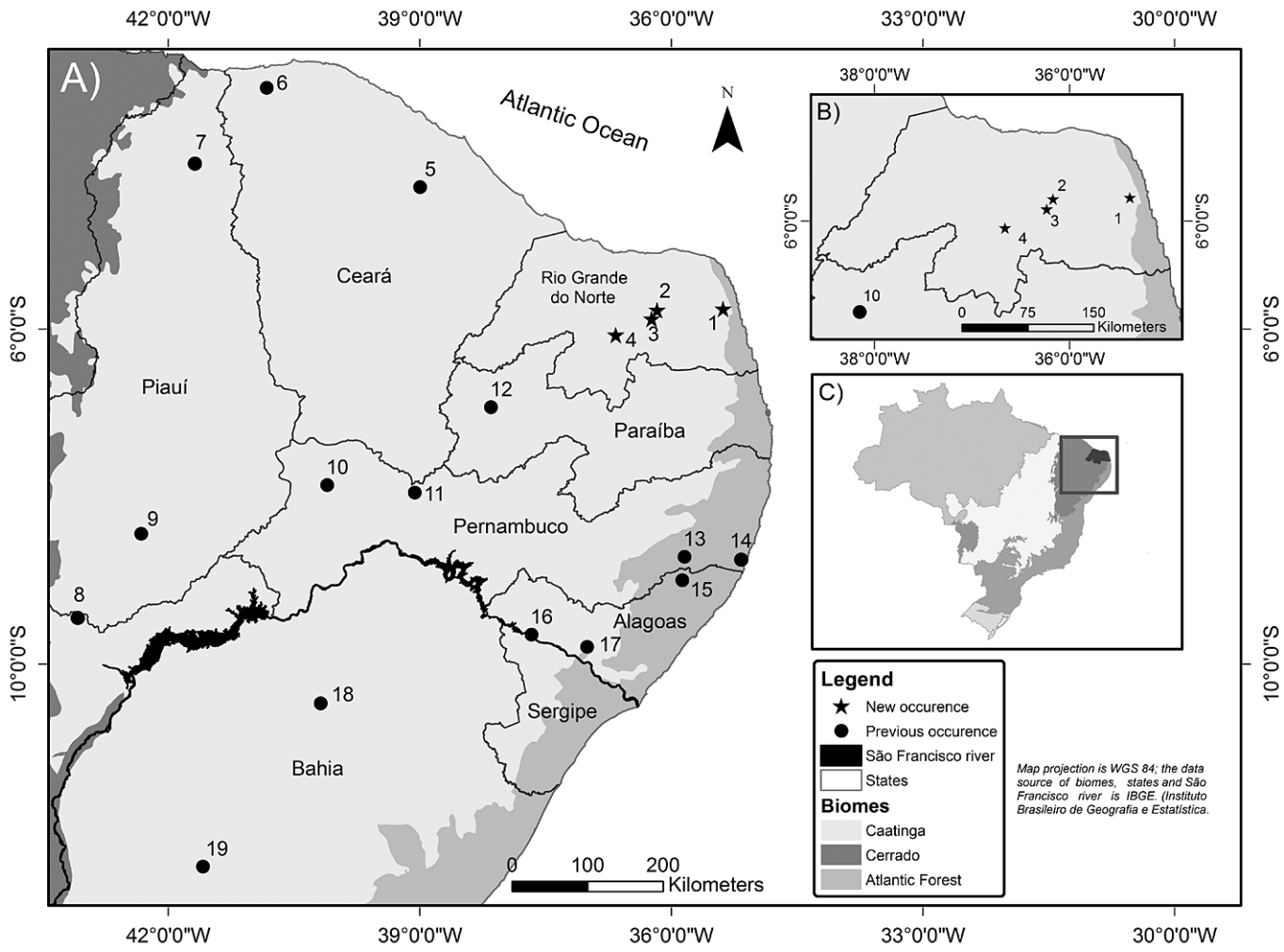

Figure 2. Geographic distribution of new (this study) and previous records (literature) of Ocelot Leopardus pardalis in Atlantic Forest to the north of the São Francisco River and Caatinga, northeastern Brazil (**A, B**). Although point 1 appears in Caatinga dominium (**B**), we argue that it is in an Atlantic Forest remnant (see the text for details). In **C,** the Rio Grande do Norte state location in Brazil is shown. See records identification in Appendix, Table A1.

and photos of the killed Ocelots. All the biological material was collected in accordance with the authorization of Sisbio/ICMBio: 42501-1.

The Lajes region, where this species was found in the Caatinga, is considered a priority for conservation of this biome (WCS/UFRN 2015). The area is well preserved and continuous, ranging from low to medium altitudes (160–570 m), with mostly dense arboreal-shrubby vegetation (pers. obs.) composed predominantly of *Croton blanchetianus* Baill., *Cenostigma pyramidale* (Tul.) E. Gagnon & G. P. Lewis, *Pilosocereus pachycladus* F.Ritter, *Myracrodruon urundeuva* Allemão, *Anadenanthera colubrina* (Vell.) Brenan and *Commiphora leptophloeos* (Mart.) J.B.Gillett (Figure 2). The area of Santana do Matos is also considered a priority area for conservation of the biome (WCS/UFRN 2015) and belongs to the same ecoregion as Lajes: the Borborema Plateau (Velloso et al. 2002). The climate of this ecoregion is hot, dry, and semiarid, with a rainy season extending from February to May; the average annual rainfall is 400 to 650 mm, mainly at high altitudes varying by 150 to 650 m, where the vegetation is more densely forested (Velloso et al. 2002). In Santana do Matos, in the flatter areas of the Serra de Santana, heavy human occupation restricts the remaining arboreal vegetation to the mountain slopes, where access is limited, making these environments wildlife refuges.

Specimen identification was based on the following characteristics, as described by Oliveira & Cassaro (2006), Nascimento (2010), and Feijó & Langguth (2013): large body (in comparison to other small spotted felids), tail short in relation to head and bory, solid black markings forming open rosettes that may be separate or may coalesce in longitudinal bands, and a forward orientation of the fur on the nape. External measurements of the Atlantic Forest remnant specimen (Figure 1) are as follows: length of the head and body = 750 mm; length of the tail = 320 mm; length of the hind paw = 130 mm; inner length of the ear = 49 mm; body weight = 6,900 g. External measurements are smaller than some of the species averages reported in the literature (Emmons & Feer 1997; Murray & Gardner 1997; Oliveira & Kassaro 2006; Nascimento 2010), but similar to the known values for the northeastern Brazil (Feijó & Langguth 2013; Kaminski et al. 2013). The smaller size of the specimens in the Caatinga and northern tip of the Atlantic Forest (very close to the border of Caatinga) coincide with the pattern reported by

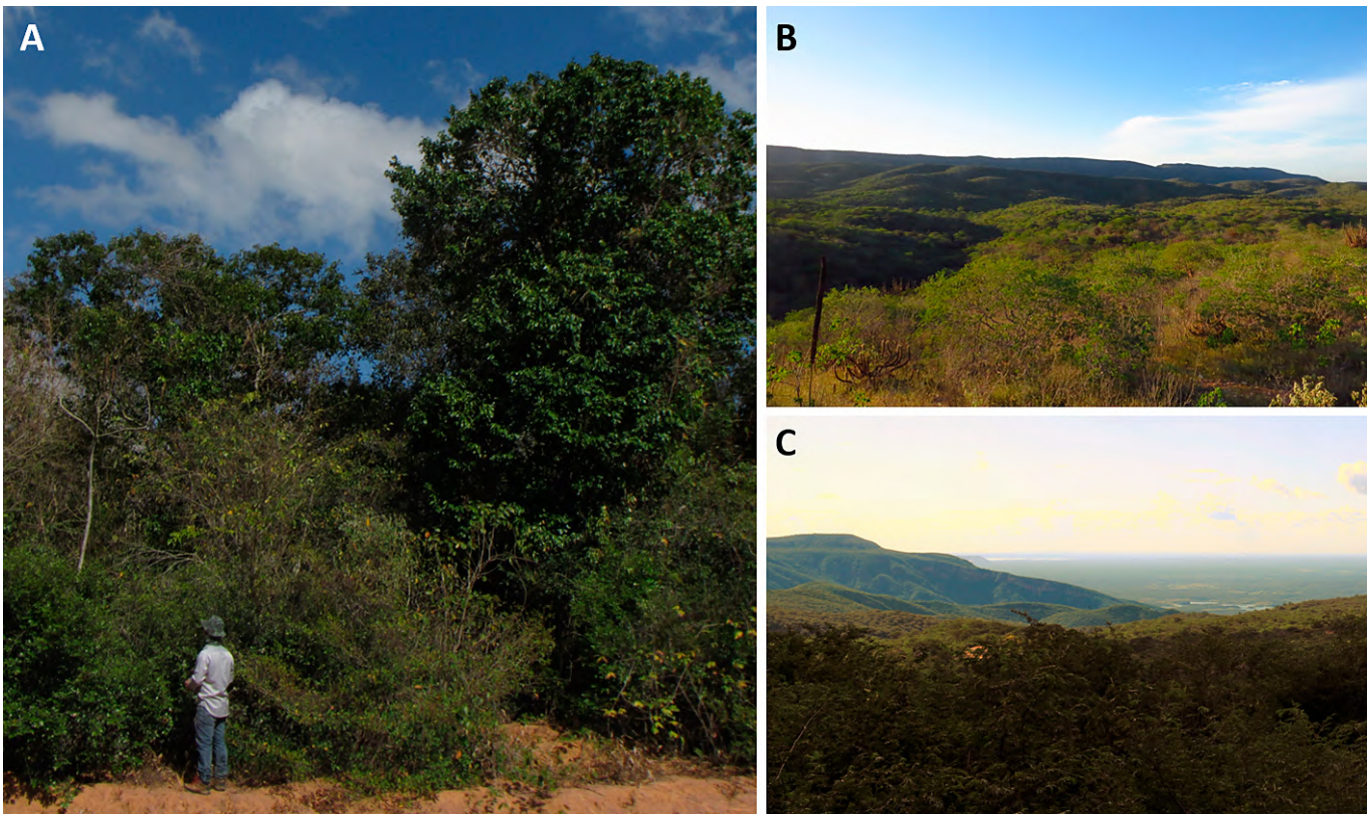

Figure 3. Vegetation characteristics of the areas of ocelot Leopardus pardalis records in Rio Grande do Norte State, Northeast Brazil. **A.** Atlantic forest remnant. **B.** Lajes, Caatinga. **C.** Santana do Matos, Caatinga. Photos B and C by Daniel Bezerra.

Oliveira et al. (2010) for specimens from more open and semiarid areas.

In relation to the specimens reported here for the Caatinga, the nearest previous literature record of this species is about 190 km to the south, and about 335 km south in relation to our specimen from the Atlantic Forest remnant (Figure 1; Appendix, Table A1). Therefore, our records not only contribute to the knowledge about the mammals of Rio Grande do Norte state, but also expand this species' area of occurrence in both the Atlantic Forest and Caatinga.

In the part of the Atlantic Forest remnant to the north of the San Francisco River, reports of Ocelot are rare (Figure 1), which is possibly due to the scarcity of surveys of medium-sized and large mammals (Feijó & Langguth 2013; Feijó et al. 2016), as well as the low quality of most northern Atlantic Forest remnants to sustain viable populations of mammals such as Ocelot (Silva Jr. & Mendes Pontes 2008; Mendes Pontes et al. 2016).

Regarding the Caatinga, the lack of knowledge is equally significant, with a large portion of the biome still unknown or subsampled (Hauff 2010; Feijó & Lannguth 2013). Despite having more reports of Ocelot in this biome, including in secondary areas (Kaminski et al. 2013), the majority of these records point to an occurrence restricted to the preserved forest environments of this semiarid ecosystem (Oliveira 2012; Silva & Palmeira 2014; Dias et al. 2016; Delciellos 2016), generally related to regions with mesic climates and to strictly protected areas, which represent just over 1% of the biome (Hauff 2010) (Figure 1). Moreover, Penido et al. (2016) found a low density of Ocelot in the Caatinga that must be related to the extreme conditions of this semiarid environment.

The locations of Ocelot occurrence in the Caatinga of Rio Grande do Norte state have a dense vegetation cover associated with more mesic environments, which confirms the environmental requirements described for this species (Sunquist & Sunquist 2002; Di Bitetti et al. 2008). In the Caatinga, these environments represent wildlife refuges, due to lower seasonal variation throughout the year and greater availability of food and shelter (Marinho 2015).

The way the present records were obtained emphasizes the vulnerability of Ocelots populations in the Northeast Region of Brazil. Pressure from hunting and from being killed by motor vehicles threatens the species in this area (Oliveira et al. 2013; Paviolo et al. 2016; Alves et al. 2016). The hunting of felids in northeastern Brazil is mainly related to cattle and poultry predation (Alves et al. 2016), which is associated with an increased degree of degradation leading to the near-extinction of large-sized species such as the Jaguar, *Panthera onca* (De Paula et al. 2012; Mendes-Pontes et al. 2016), and endangered small felids such as the Northern Tiger Cat, *Leopardus tigrinus* (Marinho 2015).

The extensive loss and fragmentation of habitats in the Atlantic Forest to the north of the São Francisco River leaves wild animals more exposed to secondary threats (Galetti et al. 2009; Mendes Pontes et al. 2016). This context of degradation and intensive human occupation in

the remnants of the northern Atlantic Forest (Ribeiro et al. 2009) represents a critical scenario for the occurrence of medium-sized and large mammals, with a clear trend towards simplification of the mammal community and local extinction of large mammals (Silva Jr. & Mendes Pontes 2008; Mendes Pontes et al. 2016).

In Rio Grande do Norte, the Atlantic Forest fragment where the specimen was found is considered one of the largest remnants in the state (Maciel 2011) and represents one of the last semi-deciduous seasonal forest fragments in the extreme north of the Atlantic Forest. Nevertheless, it lacks coverage under the Atlantic Forest Brazilian Federal Law (Brasil 2006), and this region experiences an accelerated and unrestricted loss of vegetation not effectively combated by environmental agencies. The recent construction of the Governador Aluízio Alves International Airport in 2014 resulted in strong real estate speculation, driving urbanization and putting at risk the preservation of this important forest remnant and its animal populations.

Therefore, effective management and conservation measures such as creation of protected areas and effective environmental education and fiscalization are critical and urgent to preserve the last remnants of the extreme north of the Atlantic Forest. Equally relevant is the maintenance of forest fragments and mesic habitats in the Caatinga region, which serve as refuges for biodiversity. Such forest fragments are some of the few capable of sheltering medium-sized animals, such as the Ocelots, in the current degradation of the biome. Future research efforts to assess the status and ecological aspects the Ocelot populations in these regions are equally important.

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APPENDIX

Table A1. Known records of Ocetot, *Leopardus pardalis,* in Atlantic Forest north of the São Francisco River and in Caatinga, northeastern Brazil. The ID numbers refer to the points shown in Figure 2.

ID Number	Biome	Locality (area, municipalities, State)	Latitude	Longitude	Record type	Source
1	Atlantic Forest	International Airport of Natal forest remnant, São Gonçalo do Amarante, Rio Grande do Norte	05°45′44″ S	035°22′54″ W	Road-killed specimen	New record
2	Caatinga	Serra do Feiticeiro, Lajes, Rio Grande do Norte	05°52′47″ S	036°14′02″ W	Skin of hunter-killed specimen	New record
3	Caatinga	Serra do Feiticeiro, Lajes, Rio Grande do Norte	05°46′35″ S	036°10′07″ W	Report and photographic record of hunter-killed specimen	New record
4	Caatinga	Serra de Santana, Santana do Matos, Rio Grande do Norte	06°04′19″ S	036°39′35″ W	Report and photographic record of hunter-killed specimen	New record
5	Atlantic Forest (remnant within the Caatinga dominium)	Serra de Baturité, Ceará	05°41′ S	040°27′ W	Voucher specimen	Feijó & Langguth 2013
6	Caatinga	Serra do Covão, Granja, Ceará	03°18′ S	041°41′ W	Voucher specimen	Feijó & Langguth 2013
7	Caatinga-Cerrado ecotone	Sete Cidades National Park, Piripiri, Piracurura and Brasileira, Piauí	04°02′ S	041°40′ W	Compilation of occurrence in protected areas	Oliveira & Bianchi 2008
8	Caatinga-Cerrado ecotone	Serra das Confusões National Park, Caracol, Guaribas, Santa Luz e Cristino Castro, Piauí	09°27′ S	043°05′ W	Compilation of occurrence in protected areas	Oliveira & Bianchi 2008
9	Caatinga	Serra da Capivara National Park, São Raimundo Nonato, São João do Piauí e Canto do Buriti, Piauí	08° 26′46′′ S	042°19′11″ W	Scientific report	Olmos 1993
10	Caatinga	Ourici, Pernambuco	07°51′ S	040°06′W	Footprint	Delciellos 2016
11	Caatinga	Serrita, Pernambuco	07°57′11″ S	039°15′25″ W	Captured specimen	Kaminski et al. 2013
12	Caatinga	Serra de Santa Catarina, São José da Lagoa Tapada, Paraíba	06°56′ S	038°9′ W	Voucher specimen	Feijó & Langguth 2013
13	Atlantic Forest	Mata do Espelho remnant, Frei Caneca forest archipelago, Pernambuco	08°43′12″ S	035°50′40″ W	Footprint	Silva Jr. & Mendes Pontes 2008
14	Atlantic Forest	Saltinho Biological Reserve, Rio Formoso and Tamandaré, Pernambuco	08°44′13″ S	035°10′11″ W	Compilation of occurrence in protected areas	Oliveira & Bianchi 2008
15	Atlantic Forest	Coimbra fragment, Usina Serra Grande, São José da Laje and Ibateguara, Alagoas	09°00′ S	035°52′12″ W	Visualization	Mendes Pontes et al. 2016
16	Caatinga	Grota do Angico Natural Monument, Poço Redondo e Canindé do São Francisco, Sergipe	09°39′ S	037°40′ W	Camera trap record	Dias & Bocchiglieri 2016
17	Caatinga	Serra da Mão, Traipu, Alagoas	09°47′39″ S	037°00′07″ W	Hunter-killed specimen	Silva & Palmeira 2014
18	Caatinga	Senhor do Bonfim, Bahia	10°27′59″ S	040°10′52″ W	Voucher specimen	Nascimento 2010
19	Caatinga (with areas of Atlantic Forest and Cerrado)	Chapada Diamantina National Park, Andaraí, Ibicoara, Itaetê, Lençóis, Mucugê and Palmeiras, Bahia	12°25′ S	041°35′ W	Compilation of occurrence in protected areas	Oliveira & Bianchi 2008