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FIRST RECORD OF *Xeronycteris vieirai* GREGORIN & DITCHFIELD, 2005 (CHIROPTERA, PHYLLOSTOMIDAE) FOR THE CERRADO BIOME

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Abstract: Vieira's long-tongued bat, *Xeronycteris vieirai*, is known from a small number of localities in the semiarid Caatinga biome of northeastern Brazil, but recent records from the Caatinga-Cerrado ecotone indicate that the species may also occur in the Cerrado biome. Here, we document the first record of *X. vieirai* from the core area of the Cerrado, in central Brazil. The specimen was collected in 1993 from a seasonal deciduous forest, in the area now submerged under the reservoir of the Serra da Mesa Hydroelectric Dam in the upper Tocantins River basin (*Alto Tocantins*), in the Goiás State. This record indicates that *X. vieirai* is not be restricted to the Caatinga but may be present in other areas along the diagonal of dry and open environments that crosses the central Brazil.

Keywords: Brazilian dry diagonal; Geographic distribution; Lonchophyllinae; Nectar-feeding bats; Vieira's long-tongued bat.

Vieira's long-tongued bat, *Xeronycteris vieirai* Gregorin and Ditchfield, 2005 (Chiroptera, Phyllostomidae) is a morphologically specialized, but poorly-known bat species found in northeastern Brazil. Recent evidence indicates that *X. vieirai* shelters in caves, feeds mainly on the nectar and pollen of bromeliads and cacti, and has be found in habitat mosaics of trees and non-spiny xerophytes, as well as in seasonal forests associated with limestone outcrops (Nogueira *et al.* 2015, Cordero-Schmidt *et al.* 2017, Gomes *et al.* 2018). This species is considered to be relatively rare and is known only from a few individuals collected at few localities (Figure 1), in the states of Bahia, Paraíba, Pernambuco, Rio Grande do Norte, Sergipe, and Minas Gerais (Gregorin & Ditchfield 2005, Astúa & Guerra 2008, Nogueira *et al.* 2014, Cordero-Schmidt *et al.* 2017, Gomes *et al.* 2018). At the present time, *X. vieirai* is classified as endemic to the Caatinga biome (Gutiérrez & Marinho-Filho 2017), but recent records from a Caatinga-Cerrado ecotone (Gomes *et al.* 2018) and a locality near the southern limit of the Caatinga, adjacent to the Cerrado (Nogueira *et al.* 2015), indicate that this species may also occur in the Cerrado biome. Here, we report the first record of *X. vieirai* for the Cerrado biome of the central Brazil, based on one specimen deposited in the mammal collection of Museu Nacional (MN), Universidade Federal do Rio de Janeiro, Brazil.

The specimen examined, MN 37197 (collector

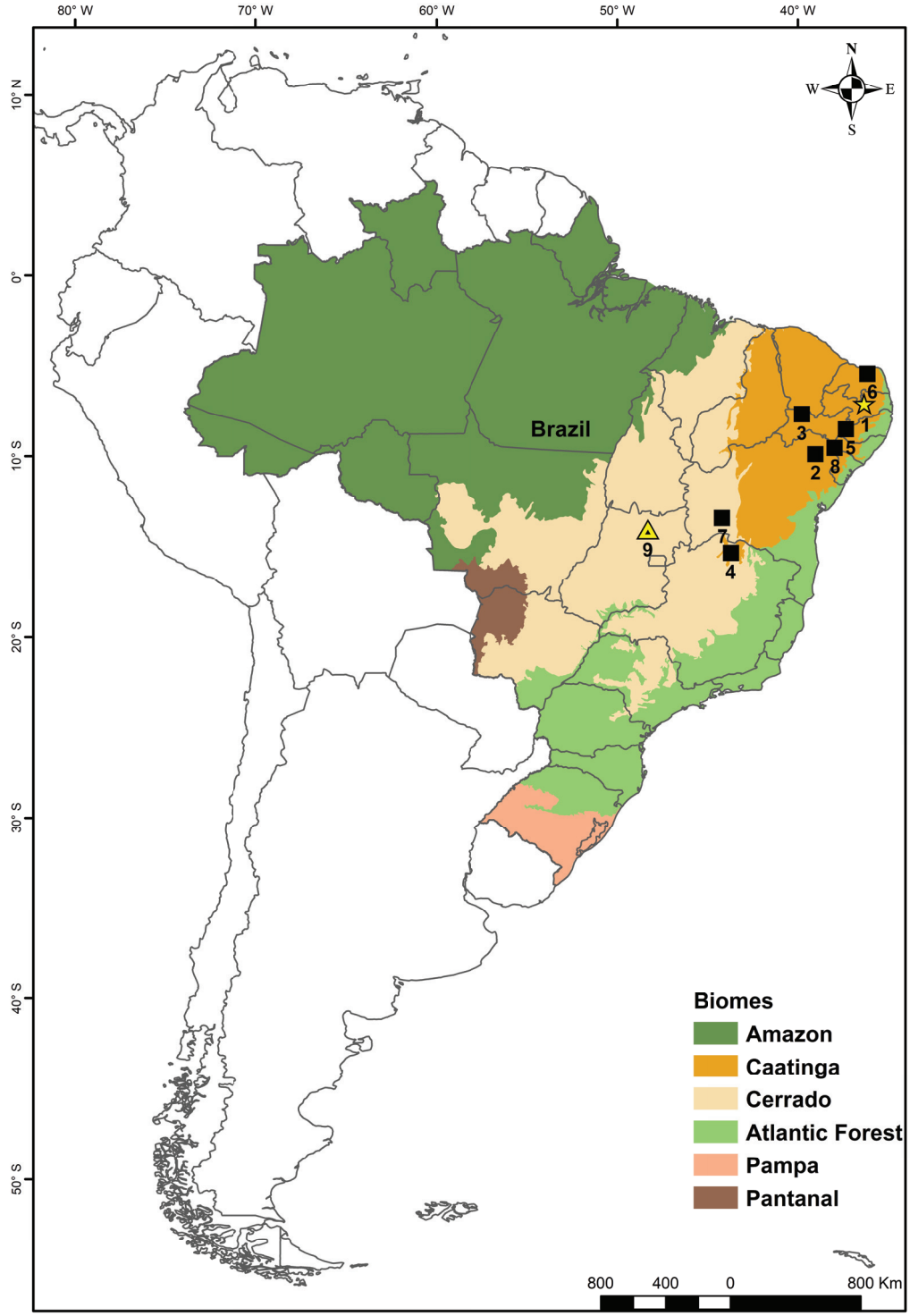

Figure 1. Occurrence records of *Xeronycteris vieirai*. Triangle: new record from the Cerrado biome; Star: type locality; Black squares: previous records. Localities: 1. Paraíba, Soledade, Fazenda Espírito Santo (07°05'S, 36°21'W; Gregorin & Ditchfield 2005); 2. Bahia, Cocorobó (09°53'S, 39°02'W; Gregorin & Ditchfield 2005); 3. Pernambuco, Exu, Serra da Gritadeira (07°40'S, 39°47'W; Gregorin & Ditchfield 2005); 4. Minas Gerais, Jaíba (15°20'S, 43°40'W; Nogueira *et al.* 2014); 5. Pernambuco, Buíque, Catimbau National Park (08°30'S, 37°20'W; Cordero-Schmidt *et al.* 2017); 6. Rio Grande do Norte, Lajes (05°26'S, 36°10'W; Cordero-Schmidt *et al.* 2017); 7. Bahia, São Félix do Coribe (13°25'S, 44°11'W; Gomes *et al.* 2018); 8. Sergipe, Canindé de São Francisco, Fazenda Novo Mundo (09°32'S, 37°58'W; Astúa & Guerra 2008); 9. Goiás, upper Tocantins River basin (*Alto Tocantins*), Serra da Mesa Hydroeletric Dam, Niquelândia (14°2'S, 48°18'W; this study).

number DSR 4252), is an adult female collected in 1993, during the inventory of mammals in the hydrographic basin of the upper Tocantins River (*Alto Tocantins*), near the confluence of this river with the Bagagem River (14°02' S; 48°18' W), in the municipality of Niquelândia, in northern Goiás State, within the core area of the Cerrado biome (Figure 1). The collecting locality is within the area currently submerged under the reservoir of the Serra da Mesa Hydroelectric Dam, whose construction was initiated between 1984 and 1987, and finalized between 1996 and 1998 (De Filippo *et al.* 1999). Prior to the flooding, the *X. vieirai* collecting locality was covered by seasonal deciduous forest, adjacent to riparian forests and tracts of shrubby savanna (cerrado *sensu stricto*). At the time of the construction of the dam, the vegetation in the Serra da Mesa region encompassed a mosaic of phytophysiognomies (Walter 2000), including (i) shrubby savanna (cerrado *sensu stricto*); (ii) woodland savanna (*cerradão*); (iii) gallery forest; (iv) deciduous dry forest; (v) different types of grassland formation (*campo limpo, campo sujo, campo úmido*, and *campo de murundus*); (vi) stony herbaceous formations on mountain slopes and high plateaus (*campo rupestre*); (vii) palm swamp (*vereda*), and (viii) areas dominated by babassu palms. The landscape also included several areas of ecotone between vegetation types. Inventories of the vegetation prior to the completion of the dam indicated the presence of more than 1,100 plant species in 589 genera and 145 families (Walter 2000). The most diverse genera were *Manihot* (Euphorbiaceae), *Miconia* (Melastomataceae), *Cuphea*, *Diplusodon*, (Lythraceae), *Myrcia* (Myrtaceae), *Vernonia* (Asteraceae), *Chamaecrista*, *Mimosa* (Fabaceae), *Habenaria* (Orchidaceae), *Rhynchophora* (Malpighiaceae), *Erythroxylon* (Erythroxylaceae), and *Serjania* (Sapindaceae). Species of the genera *Epiphyllum*, *Pereskia*, *Pilosocereus* (Cactaceae), *Bonamia*, *Cuscuta*, *Ipomoea*, *Operculina*, *Evolvulus* (Convolvulaceae), *Chorisia*, *Eriotheca*, *Pseudobombax* (Bombacaceae), *Justicia*, *Ruellia*, *Lepidagatis*, *Lophostachys* (Acanthaceae), *Aechmea*, *Bilbergia*, *Bromelia*, *Dyckia*, *Encholirium*, and *Tillandsia* (Bromeliaceae) were also recorded within the area of the reservoir and in the area surrounding the dam (Walter 2000). The region's climate is of the *Aw* type in the Köppen classification system, with mean annual temperatures of 19–20 °C, and mean annual precipitation of between 1,600 mm and 1,900 mm (Alvares *et al.* 2013).

The *X. vieirai* specimen consists only of preserved skeletal parts and the skull, and lacks the forearms and the skin, which was probably lost during taxidermy. The damage to the skull prevents the analysis of all its characters, but the rostrum and mandible are relatively well-preserved, and the teeth are intact (Figures 2 and 3). The dental morphology of the specimen has traits that are diagnostic of *X. vieirai* (Gregorin & Ditchfield 2005, Nogueira *et al.* 2014). The inner upper incisors are broad, spatulated in shape, and separated from the outer incisors by a distinct gap; the upper molar series is curved slightly inward, with the plane of occlusion of the teeth oriented lingually and at an angle to the transverse plane (Figures 2a and 2c). The mandible is long and slender; the lower incisors are in contact with one another, with the outer incisors being separated from the canines by a broad gap (Figures 2b and 2d).

The upper premolars are narrow and blade-like, and lack any lingual structures. The upper molars are extremely reduced, lacking a trigon basin, mesostyle, preprotocrest, postprotocrest or ectoflexus, with a protocone being connected to the tooth by a thin crest, parastyle extended anteriorly and reduced metastyles (Figure 3a). The lower premolars are narrow and blade-like and also lack lingual structures, while the lower molars are also extremely reduced in structure, with no hypoflexid, metacristid, entocristid or entoconid (Figure 3b). Given the damage to the specimen, only a few measurements could be taken, using a digital caliper accurate to 0.01 mm. These measurements (in mm) are the length of the mandible (ML)18.73, maxillary toothrow length (C-M) 8.71, mandibular toothrow length (c-m) 9.27, breadth across the upper canines (BAC) 3.40 and the breadth across the upper molars (BAM) 5.19. These values are close the ranges reported for *X. vieirai* (ML 19.30, C-M 8.10–8.59, c-m 8.62–9.16, BAC 3.48–3.56 and BAM 5.48–5.58, see Nogueira *et al.* 2014).

According to the database of the mammal collection of the Museu Nacional, the specimen (MN 37197) was previously identified as *Lonchophylla bokermanni* Sazima, Vizotto & Taddei, 1978. Prior to the description of *X. vieirai*, two of its paratypes, MZUSP 14170 and 14173, both from Cocorobó,

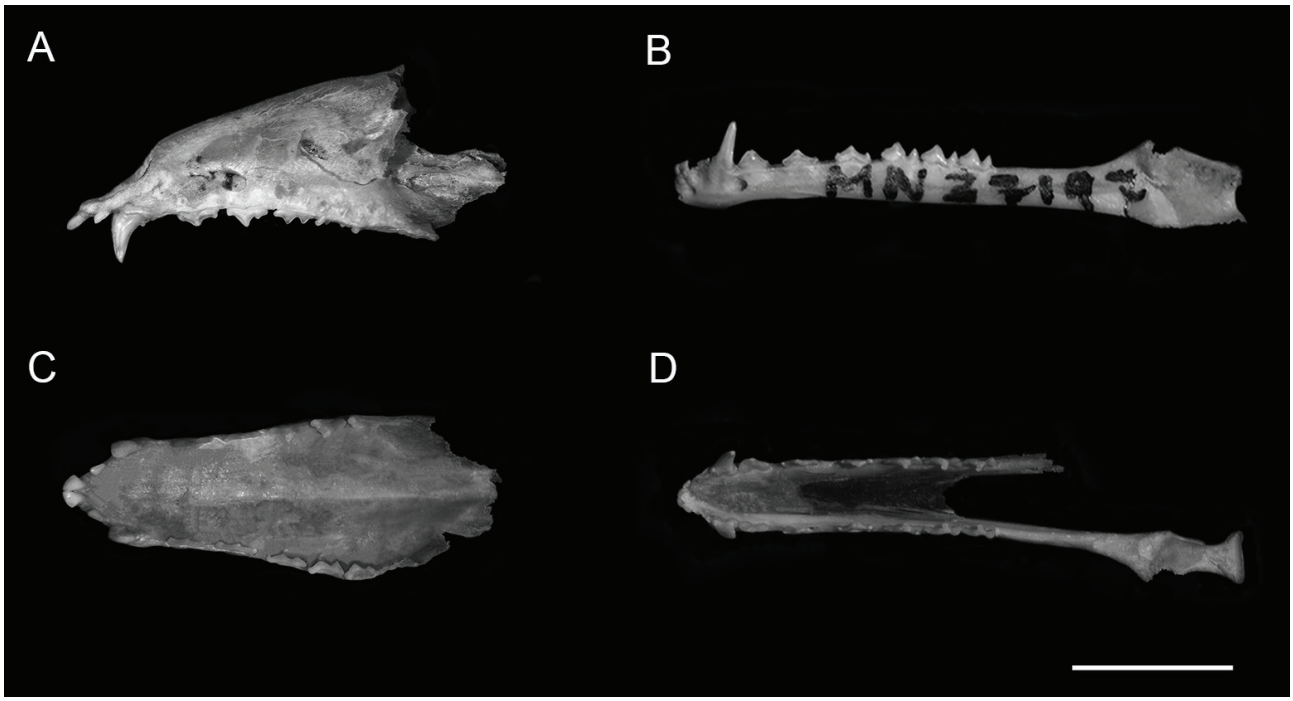

Figure 2. Lateral and ventral views of the part of the skull (A, C) and the mandible (B, D) of the *Xeronycteris vieirai* specimen (MN 37197) from the upper Tocantins basin (*Alto Tocantins*), in Goiás State, Brazil. Scale bar = 5 mm.

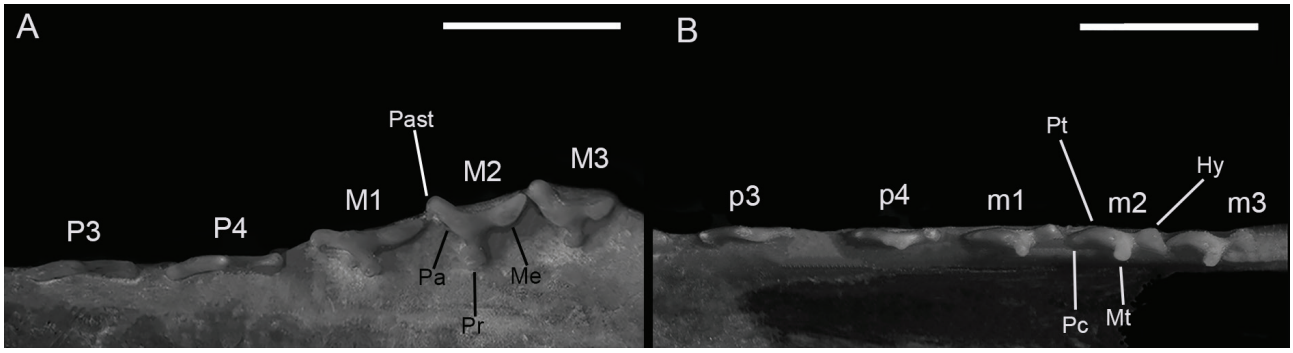

Figure 3. Oblique occlusal views of part of the upper (A) and lower (B) toothrows of the *Xeronycteris vieirai* specimen (MN 37197) from the upper Tocantins basin (*Alto Tocantins*), in Goiás State, Brazil. P3 and P4: upper premolars; M1, M2 and M3: upper molars; Past: parastyle; Pa: paracone; Pr: protocone; Me: metacone; p3 and p4: lower premolars; m1, m2 and m3: lower molars; Pc: paraconid; Pt: protoconid; Mt: metaconid; Hy: hypoconid. Scale bar = 2 mm.

in Bahia State (locality 2, Figure 1), had also been identified as *L. bokermanni* (Nogueira *et al.* 2014). *Lonchophylla bokermanni* is currently known to occur in parts of the Serra do Espinhaço mountain range, which lies within both the Caatinga and Cerrado domains in the states of Bahia and Minas Gerais (Cláudio *et al.* 2018), and is morphologically very similar to *X. vieirai*. The characters that distinguish *X. vieirai* from *L. bokermanni* include its entirely naked forearm, shorter thumb, the ridge that marks the connection of the base of the noseleaf spear with the upper limit of the horseshoe, the unscalloped dermal chin pads, and the symphysis in the mandible that projects beyond the level of the lower incisors. In *L. bokermanni,* the dorsal surface of the forearm is covered with fur, the thumb is longer, the base of the noseleaf spear is connected smoothly to the upper margin of the horseshoe, the dermal chin pads are distinctly scalloped, and the mandible is shorter (Nogueira *et al.* 2014). The conspicuously extreme reduction of the dental structures of *X. vieirai* (Figure 3) is a distinctive feature of this species in comparison with the other Brazilian bats of the Lonchophyllinae (Gregorin & Ditchfield 2005, Nogueira *et al.* 2014).

Our new locality record for *X. vieirai* reinforces

the hypothesis that this species would occur in the Cerrado biome (Nogueira *et al.* 2007, Gomes *et al.* 2018). The collecting locality in the upper Tocantins River basin is located 451 km west from São Félix do Coribe, western Bahia, and 519 km west from Jaíba, northern Minas Gerais. Prior to our record, Jaíba municipality, at the southern limit of the Caatinga biome (Nogueira *et al.* 2015) and São Félix do Coribe, in a Caatinga-Cerrado ecotone (Gomes *et al.* 2018), were the nearest localities to the Cerrado of *X. vieirai* (Figure 1). Gomes *et al.* (2018) concluded that the occurrence of *X. vieirai* in the Cerrado would likely be restricted to the peripheral, semiarid portion of this biome in northeastern Brazil, and in its ecotones and enclaves with the Caatinga biome. While a more comprehensive geographic survey is needed, our record from Goiás State, in the core area of the Cerrado, in central Brazil, indicates that *X. vieirai* may be present in other areas along the diagonal of dry and open environments that crosses the central Brazil. In this case, *X. vieirai* would join to *Micronycteris sanborni* Simmons, 1996 and *L. bokermanni* as one of three "Caatinga-Cerrado endemics" bat species (see Gutiérrez & Marinho-Filho 2017, Claúdio *et al.* 2018).

Despite the lack of more detailed data in the Museu Nacional database on the bat inventory conducted in the upper Tocantins River basin in 1993, given that *X.vieirai* is known to have a cave-dwelling habit, the occurrence of this species may have been favored by the presence of limestone caves in this region (Salles *et al.* 1999, Fracasso & Salles 2005). The vegetation along the Bagagem River, near its confluence with the Tocantins, was composed primarily of seasonal dry forests, a physiognomy associated typically with the limestone soils and karstic formations that cover approximately 15 % of the area of the Cerrado (Rizzini 1963, Veloso *et al.* 1991, Walter 2000, Felfili & Carvalho 2011). During the dry season, this forest is similar to the arboreal Caatinga, due to the predominance of deciduous trees, which lose their leaves during this period (Rizzini 1963, Veloso *et al.* 1991). These seasonally deciduous forests in the Cerrado are thought to represent remnants of a continuous forest that once connected the Caatinga of northeastern Brazil with the Chaco scrublands of Argentina, Paraguay, and Bolivia during the drier periods of the Pleistocene (Prado & Gibbs 1993). This remnants have complex connections to the residual Pleistocenic dry seasonal forests (Oliveira-Filho *et al.* 2006) and in the present day are poorly conserved (Särkinen *et al.* 2011). Further surveys along the central Brazil are required to confirm whether the occurrence of *X. vieirai* in Cerrado is associated with deciduous forests and assess accurately whether the presence of the species in these formations could represent relics of that ancestral connection or indicate a wider distribution in the Cerrado-Caatinga diagonal.

The *X. vieirai* specimen was collected more than 25 years ago, prior the flooding of the Serra da Mesa reservoir. The original local landscape has undergone extensive modifications since the construction of the dam, and the region of the upper Tocantins River basin is suffering a number of other ongoing impacts from agriculture, mining, tourism, and unplanned urban development (Ferreira & Tokarski 2007). The seasonal deciduous forest is still one of the predominant types of vegetation in the upper Tocantins River basin, and expressive enclaves on limestone outcrops can be found in some areas (Ferreira & Tokarski 2007). In this scenario, although it is open to the question due to the changes in the landscape, a more widespread occurrence of *X. vieirai* in that region can be expected. The few bat inventories available for the upper Tocantins River basin indicate the occurrence of 42 species in this region, although, prior to the present study, this total included only two lonchophylline species, *Lonchophylla dekeyseri* Taddei, Vizotto & Sazima, 1983 and *Lionycteris spurrelli* Thomas, 1913, both of which have been captured infrequently (Trierveiler 1998, Zortéa & Tomaz 2006, Tomaz 2007). Even so, a number of conservation units are located in this region, including the Veadeiros National Park, and the Pouso Alto and Alto Paraíso Environmental Protection Areas, which are located in the vicinity of the Serra da Mesa reservoir. These conservation units, which represent approximately 4 % of the protected area of Goiás State, may provide adequate conditions of roost and feeding resources to support the presence of *X. vieirai*.

Xeronycteris vieirai is classified as Vulnerable in the Red List of Brazilian Threatened Species (Nogueira *et al.* 2018) and as Data Deficient in the in the IUCN database (Solari 2015, IUCN 2019). The

species is relatively rare, and occurs at low densities in the localities where it has been recorded. While no long-term population data are available, populations of *X. vieirai* are predicted to decline by at least 30% in the near future (Nogueira *et al*. 2018), given that it is found in severely fragmented and threatened environments. At the present time, only approximately 1 % of the original vegetation cover of the Caatinga and 2 % of the Cerrado is under strict protection in conservation units (Gutiérrez & Marinho-Filho 2017). Despite the enormous importance of the Cerrado for the conservation of South American biodiversity, as little as 19.8 % of this biome remains undisturbed, and the situation is worsening progressively, in particular through the ongoing advance of agribusiness frontiers and the development of infrastructure, as well as the reduced legal protection of natural environments in Brazil, and limited incentives for conservation (Strassburg *et al*. 2017).

Despite some recent advances, little is known of the natural history or the ecological requirements of *X. vieirai* (Cordero-Schmidt *et al*. 2017, Gomes *et al*. 2018). Further, long-term field surveys and ecological studies will be necessary to compile a more reliable database on the geographic distribution and conservation status of the species. Given the potential association of *X. vieirai* with limestone outcrops and caves found in these formations, surveys should focus on these areas in the Caatinga and Cerrado, especially those surrounded by remnants of arboreal Caatinga and seasonal deciduous forests. It will also be important to review the *Lonchophylla* specimens existing in museums, in order to verify whether other *X. vieirai* specimens have been misidentified, as in the case of our specimen that was reclassified here. This may help to elucidate key aspects of the biology and ecology of *X. vieirai*, in order to define appropriate conservation strategies.

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