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SHORT COMMUNICATION

Priodontes maximus (Cingulata: Chlamyphoridae) using a highway wildlife underpass in a fragmented Cerrado landscape from Eastern Goiás State, central Brazil

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Abstract We monitored a stretch of the BR-050 highway in the State of Goiás that crosses several natural environments used by the giant armadillo, a peculiar and endangered species whose survival is threatened by vehicle collisions. Here, we present the record of highway underpass use by *Priodontes maximus* in a fragmented Cerrado landscape in Ipameri, Goiás. The finding confirms the use of highway underpasses by the giant armadillo and highlights that these structures should be promoted at points where *P. maximus* occurs in the habitats isolated by the BR-050.

Keywords: BR-050 highway, habitat connectivity, large-sized mammals, mitigation measures, wildlife passages

***Priodontes maximus* (Cingulata: Chlamyphoridae) usando passagens subterrâneas em uma paisagem fragmentada de Cerrado do leste do estado de Goiás, Brasil central**

Resumo O trecho monitorado da rodovia BR-050 no Estado de Goiás atravessa vários ambientes naturais do tatu-canastra, espécie peculiar e ameaçada de extinção, que têm os atropelamentos em rodovias como um dos impactos para a sua sobrevivência. Aqui, nós apresentamos um registro de uso de passagem subterrânea por um indivíduo de *P. maximus* em uma paisagem fragmentada do Cerrado em Ipameri, Goiás. O achado confirma o uso de passagens subterrâneas de rodovias pelo tatu-canastra e destaca que essas estruturas devem ser promovidas em pontos de ocorrência de *P. maximus* nos habitats isolados pela BR-050.

Palavras-chave: conectividade de habitat, mamíferos de grande porte, medidas de mitigação, passagens de fauna, rodovia BR-050, tatu-canastra

The giant armadillo (*Priodontes maximus* Kerr, 1792) is a large, solitary mammal with semi-fossorial and nocturnal habits (Chiarello *et al.*, 2015). Its diet consists mainly of ants and termites, but it occasionally also ingests other insects, larvae, and vertebrates (Anacleto & Marinho Filho, 2001). It has the ability to transform ecosystems, whether by destroying termite mounds and anthills or excavating tunnel networks used by many other species. It is thus considered a terrestrial ecosystems engineer (Desbiez & Kluyber, 2013; Di Blanco *et al.*, 2020).

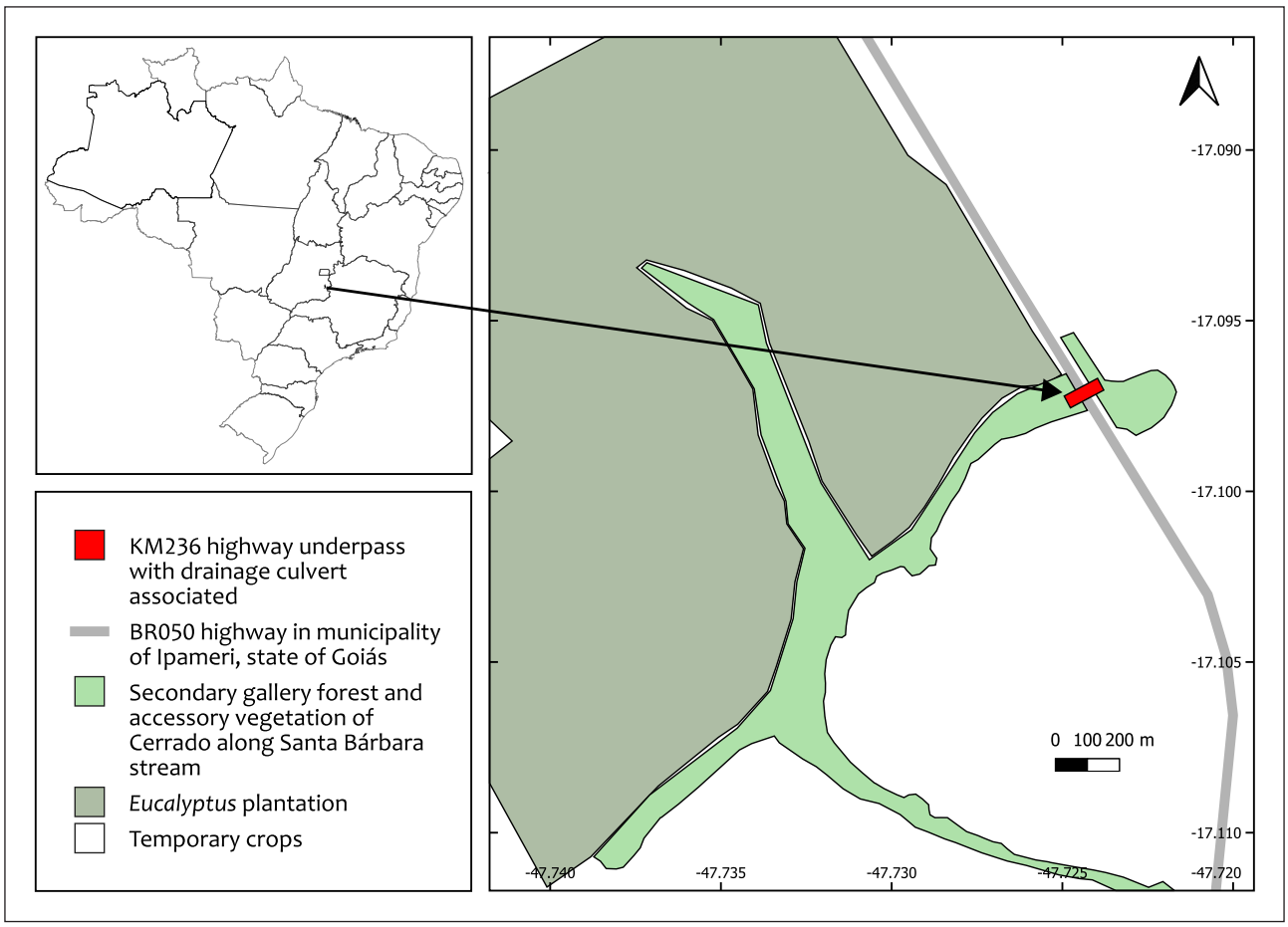

FIGURE 1. Location of the highway underpass and surrounding landscape.

Priodontes maximus is distributed in large parts of South America. In Brazil it can be found in the Amazon Forests, Pantanal, Cerrado, and edges of the Atlantic Forest (Carter *et al.*, 2016). The species is classified as Vulnerable in Brazil (ICMBio, 2018) and also globally by the International Union for Conservation of Nature (IUCN, 2023).

Threats to the conservation of the giant armadillo are present throughout its range. These include increasing deforestation in the Amazon, the rapid loss and fragmentation of the Cerrado, recent fires in the Pantanal wetlands, and the pressure on the remaining Atlantic forest (ICMBio, 2015). As a species that naturally occurs at low densities (Desbiez *et al.*, 2020), hunting and habitat loss are determining factors that affect its chances of long-term survival (Fontes *et al.*, 2020). Furthermore, wildlife vehicle collisions on highways have been identified as another threat to wildlife conservation in Brazil (Dornas *et al.*, 2012; Anacleto *et al.*, 2014).

Increased habitat fragmentation due to roads potentially leads to greater daily displacements and larger home ranges for giant armadillos (Banhos *et al.*, 2020). This in turn can lead to an increase in road crossings and therefore potential risk of roadkill (Hannibal *et al.*, 2018). Comprehensive information on fauna mortality in vehicle collisions is necessary for the establishment of monitoring programs and the implementation of mitigation measures (Ascensão *et al.*, 2017; Abra *et al.*, 2020, 2021).

A monitoring program of wildlife roadkills and the provision of wildlife underpasses in the 219 km stretch between Catalão and Cristalina since 21 January 2015 was required for construction work on BR-050 to be licensed. Records of roadkill animals were taken every hour by the concessionaire's road crews and the underpasses were monitored with one camera trap quarterly for seven consecutive days with a total of 168 h per monitoring period (672 h per year). This stretch has six monitored structures with camera traps: three bridge underpasses and three underpasses associated with drainage culverts.

At km 236, located in Ipameri municipality, there is a dry underpass through a drainage culvert that connects a fragment of gallery forest around a spring on the eastern side to a dam surrounded by *Eucalyptus* sp. plantation on the western side of BR-050. The landscape consists mainly of temporary crops (**FIG. 1**).

On the eastern side of this structure we installed a 0.55 m × 0.60 m raised platform (**Fig. 2**) for the camera trap used in monitoring. The camera traps (Bushnell Trophy HD) were configured to capture 15 seconds of videos with ten second intervals. The dry underpass through the drainage culvert is made of concrete, 2.00 m wide × 2.00 m high, and 45 m long.

We recorded a solitary individual using an underpass through a drainage culvert in 14 videos during two consecutive nights on 1 June 2023 and 2 June 2023 (**Fig. 3**). In three of the videos, it is possible to observe the scrotal sac from the posterior angle, which indicates a male individual (Luba *et al.*, 2020). Even so, other factors made it impossible to distinguish whether the videos showed one or several different individuals, such as the quality of the images, the distance and angle in the videos, and whether the individual was wet or muddy.

Priodontes maximus used the underpass between 18:53 hs and 4:16 hs. This time period matches the reported activity pattern of the species, which is predominantly nocturnal (Silveira *et al.*, 2009; Aya-Cuero *et al.*, 2017). The vehicle traffic peak on the BR-050 highway occurs between 8:00 hr and 17:00 hr, opposite to the activity peak recorded for the giant armadillo in the underpass.

This is the first record of *P. maximus* using a wildlife-dedicated underpass across the entire geographic range of the species. The use of drainage culverts,

Figure 2. Highway underpass structure, camera trap position and installation.

cattle underpasses, and bridges as underpasses by *P. maximus* has been observed in the past (Abra *et al.*, 2020; Banhos *et al.*, 2020). Despite the structure having a dry raised passageway, the giant armadillo used only the associated drainage channel, suggesting no preference for dry walkways (Brunen *et al.*, 2020).

The use of these structures can help *P. maximus* to overcome the lack of continuous natural habitats. The connectivity provided by the wildlife highway underpasses facilitate movement through the varied landscape compositions across the distribution

Figure 3. Giant armadillo recorded in the highway underpass.

of the species (Ferraz *et al.*, 2021). This may be determinant for the survival of current populations under some degree of anthropogenic threats (Lemos *et al.*, 2020).

Priodontes maximus increase their daily displacement using several habitat fragments even where the agriculture matrix is quite resistant to dispersion of individuals. For example, in the Pantanal, an adult giant armadillo has a daily displacement of 1.6 km. It is likely that in fragmented landscapes, giant armadillos spend most of their daily activity in human-altered habitats (Desbiez *et al.*, 2020).

The extent and composition of the vegetation that surrounds this monitored underpass do not correspond to the territorial needs, food, and reproductive resources of *P. maximus* as observed in the Cerrado of Mato Grosso do Sul (Silveira *et al.*, 2004; Ferraz *et al.*, 2021). In landscapes similar to our study, no changes were found in habitat use patterns between more and less fragmented environments when testing the hypothesis of behavioral plasticity in the Order Cingulata (Zimbres *et al.*, 2013).

Our findings provide evidence that mitigation measures such as highway underpasses, in this landscape context, can contribute to giant armadillo conservation, increasing connectivity between isolated habitats and reducing roadkills. We therefore recommend that road infrastructure managers incorporate wildlife underpasses as a mitigation measure in this and other remaining fragmented landscapes in the Cerrado biome where the species occurs.

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