GEOGRAPHICAL DISTRIBUTION OF *EREMOTHERIUM* (XENARTHRA, MEGATHERIIDAE) RECORDS IN MIDWEST BRAZIL

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ABSTRACT - The aim of this article was to present the current fossil record and geographical distribution of *Eremotherium* in midwest Brazil. The methodology employed here included a bibliographic survey and mapping of specimens. On the last years, new information has been revealed on these ground sloths mainly due to new fossil discoveries in the western region of Goiás and Mato Grosso states. The temporal distribution shows that these records range from the Pliocene to Holocene. This taxon is an important representative of the Brazilian megafauna, and despite its wide Pan-American distribution during the Pliocene-Holocene, there are few known *Eremotherium* records from this large geographic region of Brazil.

KEYWORDS: Geographical Distribution, Megafauna, *Eremotherium*, Midwest.

DISTRIBUIÇÃO GEOGRÁFICA DOS REGISTROS DE *EREMOTHERIUM* (XENARTHRA, MEGATHERIIDAE) NO CENTRO-OESTE BRASILEIRO

RESUMO - O objetivo deste artigo foi apresentar o atual registro fóssil e distribuição geográfica do Eremotherium no Centro-Oeste do Brasil. A metodologia utilizada aqui incluiu um levantamento bibliográfico e mapeamento de espécimes. Nos últimos anos, novas informações foram reveladas sobre essas preguiças terrestres, principalmente devido a novas descobertas fósseis na região oeste de Goiás e Mato Grosso. A distribuição temporal mostra que esses registros variam do Plioceno ao Holoceno. Este taxon é um importante representante da megafauna brasileira, e apesar de sua ampla distribuição pan-americana durante o Plioceno-Holoceno, há poucos registros conhecidos de Eremotherium desta grande região geográfica do Brasil.

PALAVRAS-CHAVE: Distribuição Geográfica, Megafauna, Eremotherium, Centro-Oeste.

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INTRODUCTION

The genus *Eremotherium* (Xenarthra, Megatheriidae) is represented by ground sloths that were endemic in the Americas from the Pliocene to Holocene, being considered important megafauna representatives in South America (PAULA COUTO, 1979; CARTELLE & DE IULIIS, 1995; PANSANI et al. 2016). The taxon has two known valid species: *Eremotherium laurillardi* Lund, 1842, reported in several localities in South America; and *Eremotherium eomigrans* Iulis & Cartelle, 1999, with records restricted to eastern United States. These authors affirm that the genus has a Pan-American distribution, from the New Jersey State, United States, to Rio Grande do Sul State, Brazil (CARTELLE & DE IULIIS, 1995).

The name Xenarthra refers to the presence of additional joints between the lumbar vertebrae, a characteristic known as xernathry (FERREIRA, 2008). *Eremotherium laurillardi* was one of the largest species of ground sloths during the Pleistocene, with estimated body weight of 5 tons, average body length of 6 meters, and reaching 2 meters height in quadrupedal posture. Given their sizes, it is unlikely that these animals inhabited dense forests, therefore, some authors suggest that they were adapted to open habitats and forest margins in tropical to subtropical environments (CARTELLE, 2000; SALLES et al. 2006; PAULO & BERTINI, 2013; PANSANI et al. 2016; VARELA et al., 2017). The most recent studies indicate that *E. laurillardi* was a generalist, due to its ability to consume hard to soft food (CARTELLE, 2000; OLIVEIRA, 2018).

The genus *Eremotherium* has one of the best fossil records among the Quaternary megafauna as well as a wide geographic distribution in Brazil. The first record of the taxon was made in 1842 by the "father" of the Brazilian paleontology, the Danish naturalist Peter Wilhelm Lund. The fossil remains were found in the municipality of Lagoa Santa, central region of Minas Gerais State (COUTO, 1979).

In Brazil, records of *E. laurillardi* have been found in the states of Acre, Alagoas, Bahia, Ceará, Espírito Santo, Goiás, Mato Grosso do Sul, Minas Gerais, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Rondônia, São Paulo, and Sergipe (CARTELLE; DE IULLIS, 1995; FERREIRA, 2008; OLIVEIRA et al., 2009; XIMENES, 2008; PAULO & BERTINI, 2013; PANSANI et al. 2016). The midwest region of Brazil is one of the newest areas of occurrence for this species, and recent publications have been showing the region's potential for new fossil findings. Thus, the aim of this study is to present a synthesis and the geographic distribution of the fossil record of *Eremotherium* in midwestern Brazil.

MATERIAL AND METHODS

The results presented here were obtained by assessing the trends and gaps in studies on the fossil materials of *Eremotherium* from midwestern Brazil in order to contribute to a better characterization of this subject. For the temporal trend analysis regarding the increase in publications about this taxon, the total number of published studies in a given year was divided by the total number of publications found during our survey. This calculation aimed to evaluate the general increase in publications on *Eremotherium.*

All data were collected from the Web of Science and Scopus databases using key term combinations and Boolean index expressions (eremotherium* AND brazil*) in order to include the largest number of publications that address different aspects of the mammalian within *Eremotherium* sensu lato. The data recovered from Web of Science and Scopus were combined in one file. Later, duplicates were removed, resulting in a total of 99 unduplicated records that were screened again to include only the studies made in midwestern Brazil. Additional

informations collected from the PaleoBiology Database were considered for final verification of the search results.

The fossil occurrences were distributed on a map of the midwest region of Brazil using the software *ArcGis* 10.2. The map was elaborated according to the geographical coordinates of each occurrence. When coordinates were not available, localities were marked by proximity according to the description given in the original study.

RESULTS

Overall, the *Eremotherium* (Fig. 1) records from midwestern Brazil comprise a seven *Eremotherium*-bering of discontinuous ages, ranging from the Pleistocene to the middle Holocene. Among these fossiliferous areas, two are located in the Goiás State, four are in the Mato Grosso State, and one is in the Mato Grosso do Sul State. The material recovered from these areas were identified both in genus and species level.

FIGURE 1 - Giant *Eremotherium* sloth reconstruction, specimens reported in Goiás, Mato Grosso and Mato Grosso do Sul states, Brazil (Drawing by Marlon A. Oliveira) (not scaled).

GOIÁS STATE

1) Jaupaci

Locality 1. “Pau Ferrado”.
Geology. Cenozoic unconsolidated sediments.
Taxa. *Eremotherium laurillardi*, *Eremotherium* sp.
Materials. Complete skull, complete and fragmented mandibles, proximals and distals epiphyses of humerus and ulnae and radii, distals epiphyses of femura and tibiae, a pelvis fragment, a lumbar vertebra, teeth, a rib fragment, an ungueal phalanx, and a sacrum. Those remains has been inferred to belongs to at least six individuals, among adults and juveniles.
Selected bibliography. Moreira & Melo (1969), Moreira (1971), Moreira et al. (1973), Paulo (2014), Paulo & Bertini (2015), Mendes et al. (2020).

2) Piranhas

Locality 1. Piranhas.
Geology. Cenozoic unconsolidated sediments.
Taxon. *Eremotherium laurillardi*.
Materials. A right maxilla, one lacrimal bone, part of a zygomatic bone, a cranial fragment with an incomplete left maxilla and the zygomatic bone, the palatine and lacrimal bones, and an incomplete tibia.
Selected bibliography. Oliveira (2018), Mendes et al. (2020).

MATO GROSSO STATE

1) Rosário do Oeste

Locality 1. Gruta do Curupira
Geology. Cenozoic unconsolidated sediments.
Taxon. *Eremotherium laurillardi*
Materials. A partially complete skeleton.
Selected bibliography. Cartelle & Hirooka (2005).

MATO GROSSO DO SUL STATE

2) Bonito

Locality 1. Serra da Bodoquena, riverbed of the Miranda river, nearby the Miranda municipality.
Geology. Presence of carbonate rocks from the substrate as well as caves, dolines, and other karst features.
Taxon: *Eremotherium laurillardi*.
Material. A calcaneus.
Selected bibliography. Pansani, Oliveira, Pacheco (2016).

Locality 2. Serra da Bodoquena, Gruta das Fadas.
Geology. Presence of carbonate rocks from the substrate as well as caves, dolines, and other karst features.
Taxon. *Eremotherium laurillardi*.

Material. A calcaneus.
Selected bibliography. Oliveira (2013)

Locality 3. Serra da Bodoquena, Gruta das Fadas.
Geology. Presence of carbonate rocks from the substrate as well as caves, dolines, and other karst features.
Taxon. *Eremotherium laurillardi*.
Material. A fragment of the left mandibular branch.
Selected bibliography. Oliveira (2013)

Locality 4. Serra da Bodoquena, Gruta das Fadas.
Geology. Presence of carbonate rocks from the substrate as well as caves, dolines, and other karst features.
Taxon. *Eremotherium laurillardi*
Material. A right astragalus.
Selected bibliography: Oliveira (2013).

DISCUSSION

Several Pliocene-Holocene fossils of terrestrial and aquatic taxa have been found in midwestern Brazil, such as plants, crustaceans, fish, anurans, birds, and mammals. Most materials were recovered in caves in the states of Goiás, Mato Grosso, and Mato Grosso do Sul. Some studies suggest that this fossil diversity can be verified through the many fragmentary specimens already found, revealing the great paleontological importance of this region (Salles et al., 1999, 2016; Paulo, 2014).

In the last years, the number of new *Eremotherium* records discovered in this region has increased, especially in the Goiás and Mato Grosso states (Fig. 2). Some previous studies briefly mention specimens of *Eremotherium laurillardi* described by Cartelle & Hirooka (2005). The new *Eremotherium* records found in the last three years helped to further elucidate the informational gap on the geographical distribution of this taxon in the midwest region. The most significant result shows that this region was an important distribution and evolutionary center for these widely spread ground sloths. As previously mentioned, the species has a large distribution in Brazil, but it is mainly reported in the northeastern region (Toledo, 1986; Cartelle & De Iuliis, 1995; Cruz, 2007; Silva, 2015; Valli & Mutzenberg, 2016). Although little studied, the megafauna specimens from Mato Grosso include many *Glossotherium lettsomi* materials. Vialou & Vialou (2019) demonstrated that these specimens were used as adornments by hunter-gatherers, corroborating the coexistence of humans and the megafauna between 11 to 27 thousand years before present (VIALOU & VIALOU, 2019).

It is likely that these ground sloths were more populous in the midwest region during the early Holocene, although there is a significant number of Pleistocene records in Goiás State and in other regions of Brazil. The descriptions of *Eremotherium laurillardi* from the middle Pleistocene of Goiás State made by Oliveira (2018) and Mendes et al. (2020) indicate that, by this period, these ground sloths were already established in this region.

During the Pleistocene-Holocene, the midwest region of Brazil favored the geographic distribution of *Eremotherium* as this was a region dominated by a savanna-like vegetation with enough food resources to this probably generalist mammal that fed on grass, fruits, and other vegetal sources (OLIVEIRA, 2018). In fact, other recent paleoecological study based on stable carbon isotopes and steremicrowear anlysis of a molariform of *E. laurillardi* from the midwest region (Piranhas municipality Goiás State) also revealed a mixed diet (Oliveira et al., 2020).

However, some variation existed in the predominance of the items consumed by this species, as the isotopic signal suggests predominance of C_4 plants (e.g. grasses) in some northeast localities and C_3 in others (see Dantas et al., 2013), for instance.

The recent Pleistocene-Holocene records from the Goiás and Mato Grosso states have been supporting new research frontiers to elucidate the *Eremotherium* record in midwestern Brazil. Due to this fact, some institutions were prone to resume paleontological studies. Among these, the most active research groups are from the Laboratório de Paleontologia de Evolução of the Federal University of Goiás and the Museu de História Natural Casa Dom Aquino/Cuiabá. Both institutions have *Eremotherium* specimens in their collections and perform relevant research on this taxon.

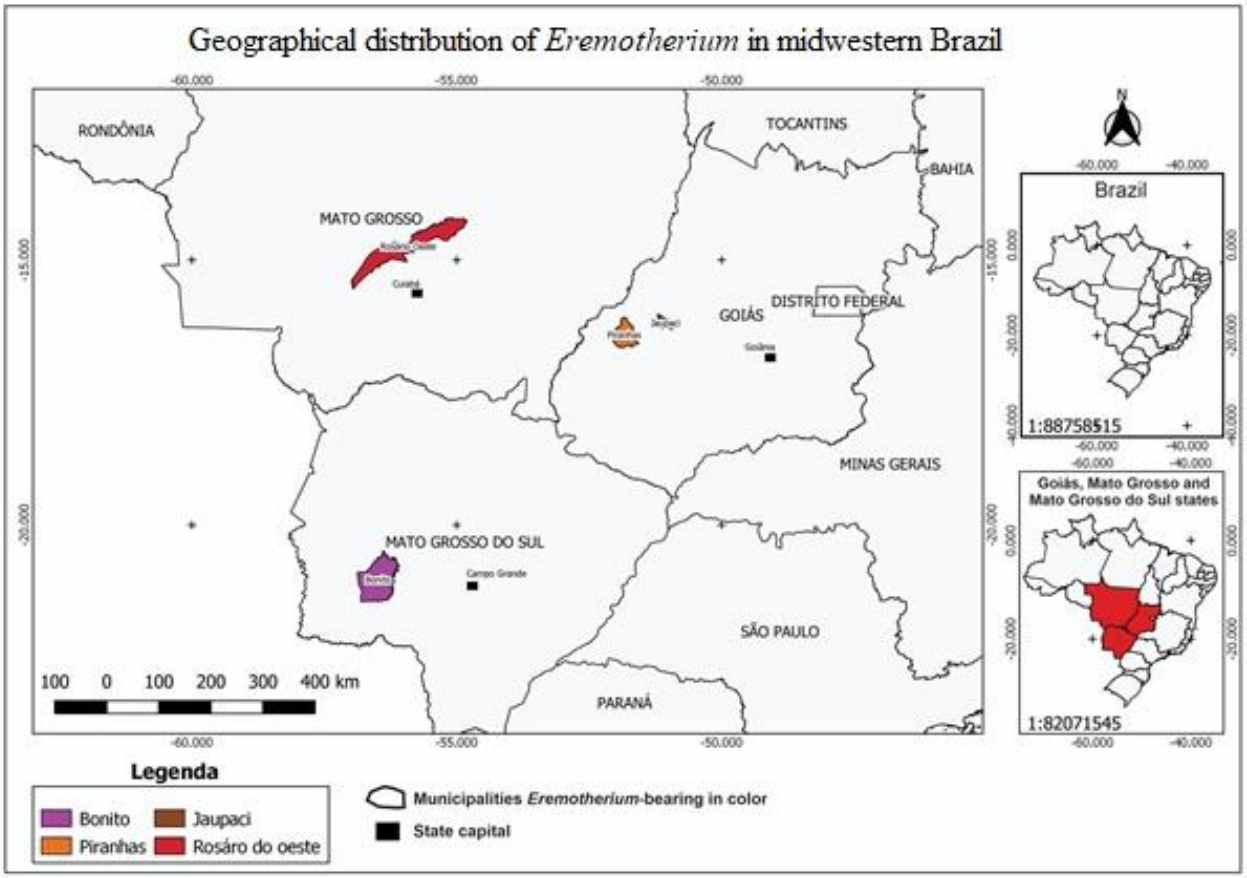

FIGURE 2 – Municipalities where *Eremotherium* fossils were found in the states of Goiás, Mato Grosso, and Mato Grosso do Sul, midwestern Brazil. Fossil-bearing deposits in each municipality (in color) (IBGE datbase, 2019 – organized by Vanessa Costa and Roberto Candeiro, 2020).

The new areas of occurrence presented here for *Eremotherium* show the need for a detailed assessment of its geographical distribution through further studies and prospections. These records corroborate the hypothesis of a wider distribution of this taxon in the Americas (e.g. Cartelle & De Iuliis, 1995). Therefore, midwestern Brazil was an important region to megamammals during the Pliocene-Holocene. The many observed distributional and biotic affinities are consistent with previous suggestions that the Pliocene-Holocene *Eremotherium* were effectively cosmopolitan.

CONCLUSION

The late Pleistocene – early Holocene fossil record of midwestern Brazil shows the long evolutionary history of *Eremotherium*. During this period, the geographical distribution of these ground sloths was far from static, as seen by its Pan-American fossil record. Previous studies already showed the presence of this taxon in the Mato Grosso do Sul State and in central Goiás State. The most recent publications also show their presence in far-west Goiás State and in the south-central region of Mato Grosso State. It is possible that future findings of *Eremotherium* specimens come to expand the geographical and/or temporal range of this group.

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