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FOSSIL MAMMALS FROM LAJEDO DE SOLEDADE, QUATERNARY OF RIO GRANDE DO NORTE, BRAZIL

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ABSTRACT – The Lajedo de Soledade site, located in the municipality of Apodi, State of Rio Grande do Norte, is a vast karstic platform formed by carbonate rocks belonging to the Jandaíra Formation (Upper Cretaceous of the Potiguar Basin). The uplift of sedimentary rocks has exposed the formation to processes of erosion and leaching, leading to the creation of ravines and caves. These geological features, during the Quaternary Period, became repositories of sediments containing vertebrate remains. Recent collections conducted by the research team at the Paleontology Laboratory of the Universidade do Estado do Rio de Janeiro in the Araras Ravine and a new analysis of the fossil accumulation in the Leon Ravine have revealed new vertebrate taxa, especially mammals. The taxonomic study of these faunal accumulations identified at least thirteen different mammal taxa: *Cerdocyon thous*, *Leopardus tigrinus*, *Puma concolor*, *Panthera onca*, *Mazama* sp., *Palaeolama major*, *Hippidion principale*, *Cuniculus* sp., *Euphractus sexcinctus*, *Glyptotherium* sp., *Tolypeutes* cf. *T. tricinctus*, *Dasypus novemcinctus*, and Megalonychidae indet. The mammal taxa discovered in the layers of the Araras Ravine indicate the presence of at least two distinct environments in the Lajedo de Soledade Region: an open environment associated with denser areas resembling the Cerrado Bioma, and a drier environment akin to the current Caatinga Bioma. In the faunal assemblage of the Leon Ravine, four additional mammal taxa were identified: *P. onca*, *Mazama* sp., *Cuniculus* sp., and Megalonychidae indet. The occurrence of *Cuniculus* sp. serves as a significant historical record for the genus within the state, further reinforcing the hypothesis that the paleoenvironment of the region comprised open areas intertwined with forested environments, potentially featuring small bodies of water. To gain a deeper understanding of the relationship between the ravines and any potential environmental transitions, geochronological, isotopic studies, and other data collections are crucial.

Keywords: Pleistocene, Holocene, small-sized mammals, megafauna, paleoenvironment.

RESUMO – O sítio Lajedo de Soledade, localizado no município de Apodi/RN, é uma vasta plataforma cárstica formada por rochas carbonáticas pertencentes à Formação Jandaíra (Cretáceo Superior da Bacia Potiguar). O soerguimento das rochas sedimentares expôs a formação à erosão e à lixiviação, resultando na formação de ravinas e cavernas. Essas características geológicas, durante o período Quaternário, tornaram-se repositórios de sedimentos contendo restos de vertebrados. Recentes coletas realizadas pela equipe de pesquisa do Laboratório de Paleontologia da UERJ na Ravina das Araras e uma nova análise do acúmulo de fósseis na Ravina do Leon revelaram novos táxons de vertebrados, principalmente mamíferos. O estudo taxonômico dessas acumulações faunísticas identificou pelo menos treze diferentes táxons de mamíferos: *Cerdocyon thous*, *Leopardus tigrinus*, *Puma concolor*, *Panthera onca*, *Mazama* sp., *Palaeolama major*, *Hippidion principale*, *Cuniculus* sp., *Euphractus sexcinctus*, *Glyptotherium* sp., *Tolypeutes* cf. *T. tricinctus*, *Dasypus novemcinctus*, e Megalonychidae indet. Os táxons de mamíferos encontrados nas camadas da Ravina das Araras indicam a presença de pelo menos dois ambientes distintos na região do Lajedo de Soledade: um ambiente aberto associado a áreas mais densas, semelhante ao Cerrado, e um ambiente mais seco, semelhante à atual Caatinga. Na associação faunística da Ravina Leon foram identificados mais quatro táxons de mamíferos: *P. onca*, *Mazama* sp., *Cuniculus* sp. e Megalonychidae indet. A ocorrência de *Cuniculus* sp. serve como um registro histórico significativo para o gênero no estado, reforçando ainda mais a hipótese de que o paleoambiente da região compreendia áreas abertas entrelaçadas com ambientes florestais, possivelmente com pequenos corpos d’água. Para obter uma compreensão mais profunda da relação entre as ravinas e quaisquer transições ambientais em potencial, estudos geocronológicos e isotópicos e outras coletas são cruciais.

Palavras-chave: Pleistoceno, Holoceno, mamíferos de pequeno porte, megafauna, paleoambiente.

INTRODUCTION

The interest in exploration of petroleum resources of the western region of the State of Rio Grande do Norte has spurred an increase scientific studies, primarily in geomorphology. In 1987, at the request of PETROBRAS, geologist Geraldo Gusso visited the Lajedo de Soledade, located in the municipality of Apodi/RN. He recognized the archaeological significance of the area due to the presence of various rock paintings. This realization prompted a “rescue mission” for the Lajedo de Soledade. In 1991, Eduardo Bagnoli spearheaded this mission, taking a stand against the indiscriminate exploitation of limestone resources in the region. In addition to raising awareness regarding preservation among the local community, Eduardo Bagnoli emphasized the area’s tourism potential (Bagnoli, 1994).

Beyond its substantial geological, geomorphological, and archaeological significance (due to the presence of rock art and ceramic fragments), the Lajedo de Soledade holds enormous paleontological importance due to its diverse fossil record (Porpino *et al*., 2009).

The initial descriptions of paleontological material were provided by Rosado (1957) and Souza-Cunha (1966), followed by contributions from Santos (2001), Santos *et al*. (2002), and Porpino *et al*. (2004). Collections conducted in 2019 by the research team from the Paleontology Laboratory of the Faculty of Geology of the Universidade do Estado do Rio de Janeiro (UERJ), in collaboration with researchers from the Universidade do Estado do Rio Grande do Norte (UERN) and the Universidade Federal of Rio de Janeiro (UFRJ) in the Quaternary deposit of the Araras Ravine at Lajedo de Soledade, have revealed new vertebrate remains, particularly a wide variety of fossil mammals. These materials require a detailed taxonomic study, as they can refine our understanding of regional Quaternary paleoenvironmental, paleoecological, and stratigraphic aspects of the region.

Recently, a new analysis of the fossil accumulations collected in the 1990s by Prof. Leon Diniz Dantas de Oliveira and his team in the Leon Ravine identified the presence of additional mammal taxa, allowing for further taxonomic research that may contribute to fresh insights into paleoenvironmental reconstructions of the Lajedo de Soledade region.

This study systematically examines the fossil remains of mammals collected from the Quaternary sedimentary deposits that fill the Araras Ravine and the Leon Ravine at Lajedo de Soledade, aiming to (i) characterize the local fauna, and (ii) infer paleoenvironmental aspects for the Lajedo de Soledade region.

STUDY AREA

The material was collected from the Araras (5°35.546’ S, 37°49.607’ W) and Leon Ravines (5°35.612’ S, 37°49.951’ W), both situated within the Lajedo de Soledade in the municipality of Apodi/RN (Figure 1). Lajedo de Soledade is one of the largest exposures of carbonate rocks from the Jandaíra Formation (Upper Cretaceous, Potiguar Basin), covering an area of approximately 3 km² (Bagnoli, 1994; Porpino *et al*., 2004). Karstification, acting on fractures and faults with a preferential NE/SW and NW/SE orientation, has resulted in the development of small caves and ravines in the outcropping carbonate rocks (Córdoba *et al*., 1994).

The ravines vary in depth, width, and level of sedimentary fill, characterized by clastic sediments with quartz grains exhibiting poor rounding, suggesting limited transportation from their source area (Santos, 2001; Porpino *et al*., 2009).

The excavation point in the Araras Ravine covers an area of 3.0 × 2.7 m, where a trench approximately 1.60 m deep was opened. The excavation was carried out under strict stratigraphic control, revealing four sedimentary layers, three of which contain fossils (Figure 2):

Layer “A”. The basal layer, with a minimum thickness of 90 cm, as its actual thickness is uncertain due to the interruption of the excavation upon reaching the water table. This fossil-bearing layer is composed of medium sand, silt, and clay.

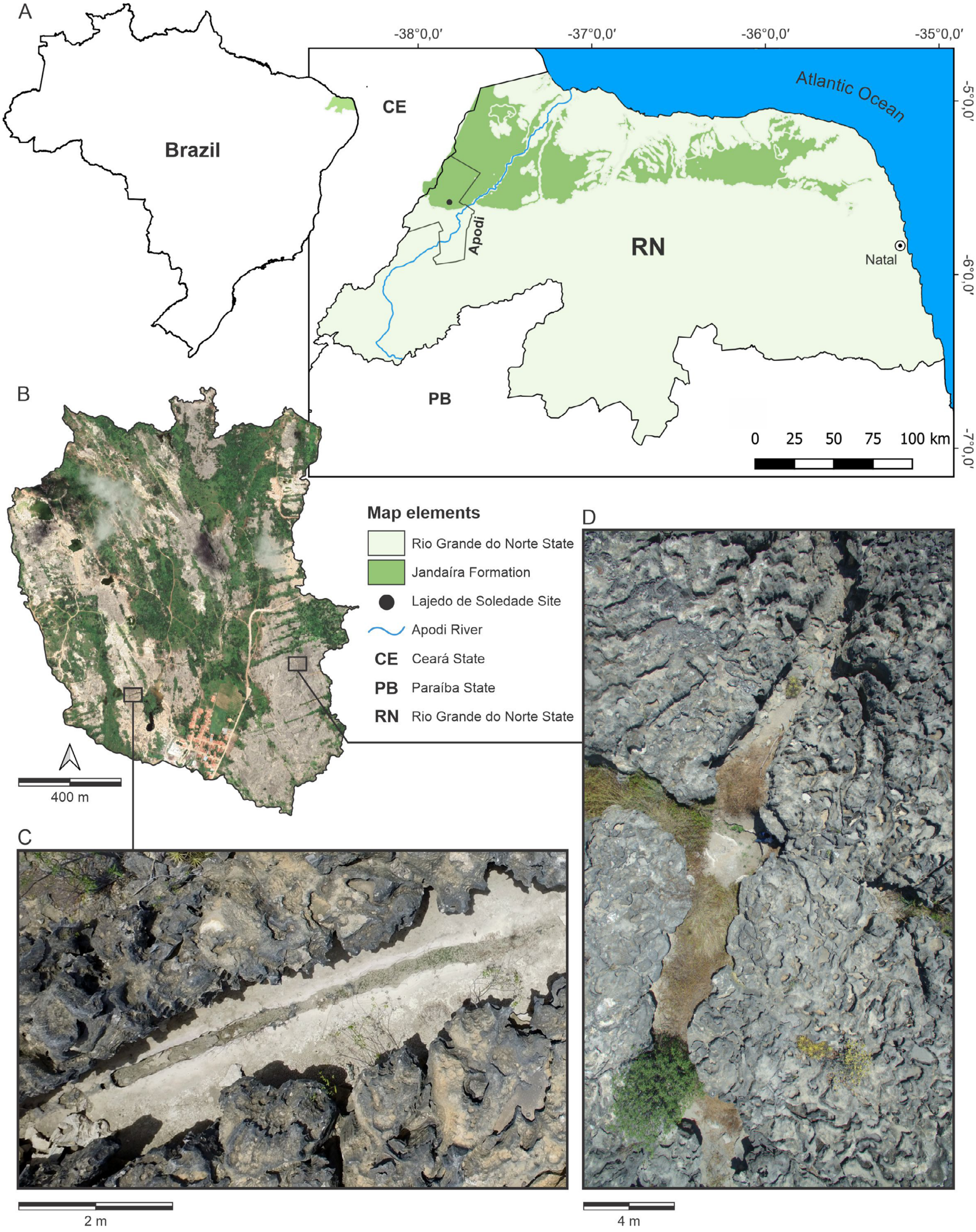

Figure 1. Location of Lajedo de Soledade, Apodi/RN. **A,** location map of Lajedo de Soledade. **B,** aerial image of Lajedo de Soledade, obtained from Google Earth. **C,** aerial image of the Leon Ravine. **D,** aerial image of the Araras Ravine.

Layer “B”. Approximately 28 cm of coarse sand, fossil-bearing, with a clay lens approximately 40 cm wide and 15 cm tall.

Layer “C”. Approximately 12 cm of fine, light-colored sand, containing gastropods and vertebrate fossils.

Layer “D”. Corresponds to the current surface layer (soil), with a thickness of 18 cm.

Three limestone slabs (projecting from the ravine wall) were found intercalated with the sedimentary masses during the excavation. Only the third slab was complete. The first slab, ranging in thickness from 1 to 10 cm, was situated between layers “D” and “C.” The second slab, approximately 18 cm thick, was positioned between layers “C” and “B.” The third slab, about 10 cm thick, separated layer “A” from the other layers. Hence, there seems to be no apparent stratigraphic correlation between layer “A” and the other layers. The Leon Ravine has a slightly triangular shape, measuring 60 m in length, up to 7 m in width, and with a

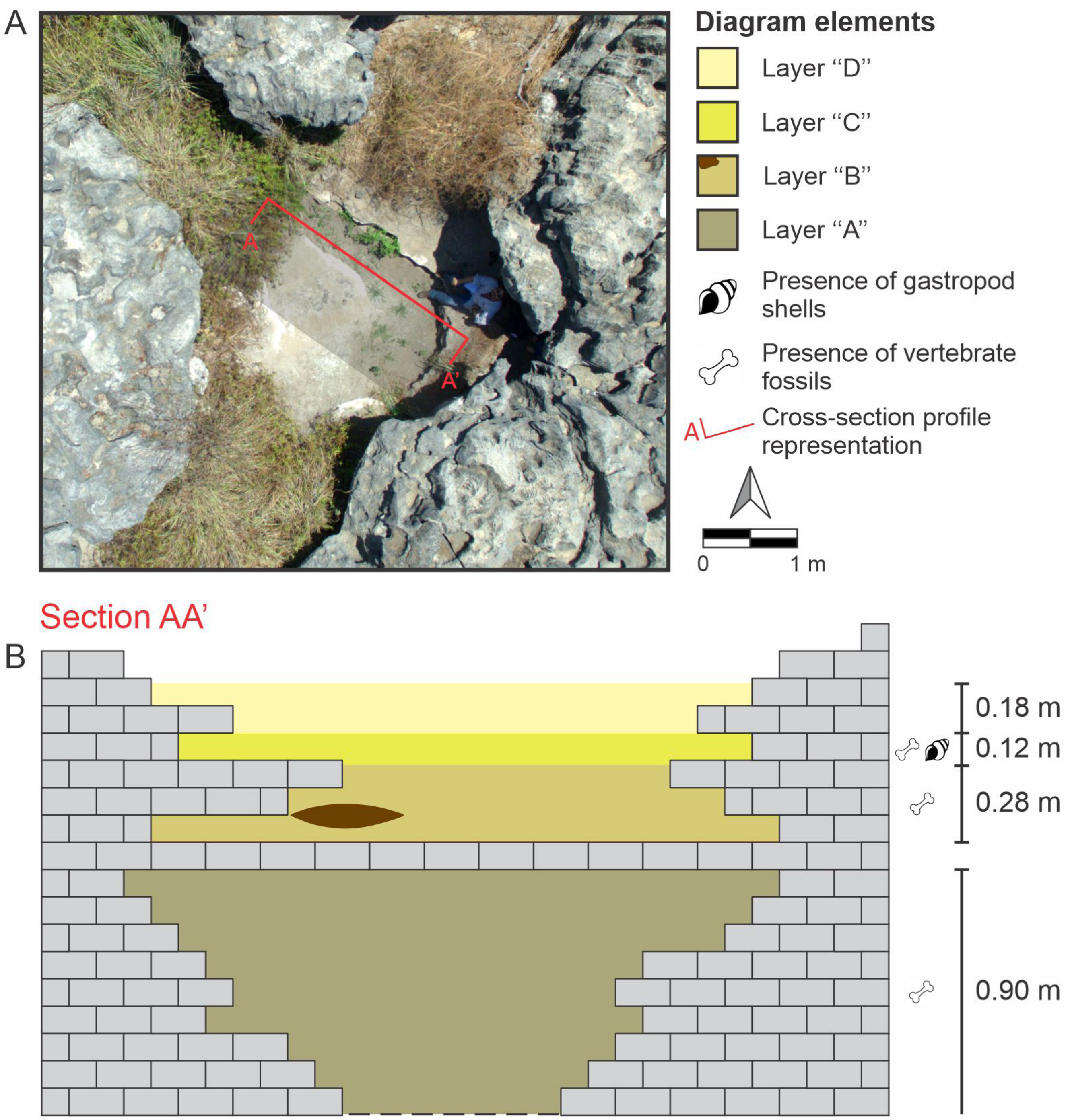

Figure 2. Diagram of sedimentary layers in the Quaternary deposit of the Araras Ravine. Apodi/RN. **A,** aerial image of the Araras Ravine indicating the cutting profile represented by the diagram; **B,** diagram of the sedimentary layers.

depth of up to 2.5 m (Santos, 2001). The fossils were collected from a lower depression (Santos, 2001), with no available sedimentological information.

MATERIAL AND METHODS

The material belongs to the Lajedo de Soledade Museum, but it is temporarily housed in the Paleontological Collection of the Paleontology Laboratory (**LABPALEO**) at the Faculty of Geology of Universidade do Estado do Rio de Janeiro (**UERJ**) in Rio de Janeiro/RJ and at the Museu Câmara Cascudo of the Universidade Federal do Rio Grande do Norte (MCC/UFRN) in Natal/RN. The collected materials underwent a screening process, during which only skeletal elements belonging to mammals, excluding small rodents and marsupials, were selected. Highly fragmented elements (difficult to identify) were excluded from the analysis. From this screening, 121 fossil specimens were chosen, consisting of postcranial bone fragments, teeth, and osteoderms of mammals from different layers filling the sedimentary deposit of the Araras and the Leon Ravines.

Bone terminology and anatomical identification followed specialized literature (*e.g.*, Paula-Couto, 1979; Williams *et al.*, 1989; Kardong, 2016; Konig & Liebich, 2016; Klaczko *et al.*, 2019; Dyce *et al.*, 2019 Brandão & Hingst-Zaher, 2021). Comparisons were made with extant and fossil materials deposited in the Mastozoological Collection of the Department of Vertebrates at the Museu Nacional/Universidade Federal do Rio de Janeiro (**MN/UFRJ**), the collection of the Museu de Ciências Naturais (**MCL**) of Pontifícia Universidade Católica de Minas Gerais (**PUC/Minas**), the collection of the Museu de Ciências Naturais of the Secretaria do Meio Ambiente e Infraestrutura of Rio Grande do Sul (**MCN/SEMA-RS**), and the collection of the Museu de História Natural of Taubaté Dr. Herculano Alvarenga (**MHNT**).

Dental terminology followed Hershkovitz (1982) and Scherer (2009) for Artiodactyla Owen, 1848, and Cirilli *et al.* (2020) for Perissodactyla Owen, 1848. Terminology for the osteoderms of Cingulata Illiger, 1811, followed Oliveira *et al.* (2014) and Krmpotic *et al.* (2015).

SYSTEMATIC PALEONTOLOGY

Order CARNIVORA Bowdich, 1821
Suborder CANIFORMIA Kretzoi, 1943
Superfamily CANOIDEA Simpson, 1831
Family CANIDAE Fischer, 1817

Cerdocyon Smith, 1839

Cerdocyon thous (Linnaeus, 1766)
(Figure 3A)

Material. MLS 371 (Figure 3A) and MLS 372, cervical vertebrae.
Provenance. Layer C, Araras Ravine, Lajedo de Soledade, Apodi/RN.
Remarks. The morphology and size of the vertebral elements indicate a small-sized canid. There are six different small-sized canids found in Brazil, which include *Atelocynus microtis* (Sclater, 1883), *C. thous*, *Lycalopex gymnocercus* (Fischer, 1814), *Lycalopex vetulus* (Lund, 1842), *Chrysocyon brachyurus* (Illiger, 1815), and *Speothos venaticus* (Lund, 1842) (Wilson & Reeder, 2005). The specimens were morphologically compared with four extant small-sized canid species: *C. thous*, *L. gymnocercus*, *L. vetulus*, and *S. venaticus*. The cervical vertebrae studied have partially or fully destroyed transverse processes, making it impossible to compare these structures. In dorsal view, the vertebrae have a subtriangular shape, becoming narrower near the cranial articular surface, as in *C. thous*, while in *L. gymnocercus*, *L. vetulus*, and *S. venaticus*, the vertebrae have a rectangular shape. Furthermore, in the dorsal view, the caudal end of the vertebra has a slightly recessed appearance compared to the species *L. gymnocercus*, *L. vetulus*, and *S. venaticus* but similar to *C. thous*. Based on the morphological comparisons made, it is possible to assign the specimens to the species *C. thous*.

Suborder FELIFORMIA Kretzoi, 1945
Superfamily FELOIDEA Simpson, 1931
Family FELIDAE Fischer von Waldheim, 1817
Subfamily FELINAE Fischer von Waldheim, 1817

Leopardus Gray, 1842

Leopardus tigrinus (Schreber, 1775)
(Figure 3E–F)

Material. MLS 373, left humerus (Figure 3E); MLS 374, left radius; MLS 375, left ulna (Figure 3F).
Provenance. Layer B, Araras Ravine, Lajedo de Soledade, Apodi/RN.
Remarks. The size and morphology of the described specimens are consistent with those of a small feline. South American felids are currently divided into at least three groups: the Ocelot lineage (Pecon Slattery *et al.*, 1994; Masuda *et al.*, 1996; Pecon Slattery & O'Brien, 1998), which includes medium to small-sized felids such as *Leopardus pardalis* (Linnaeus, 1758) and *L. tigrinus*; and the *Puma* Jardine, 1834, which includes *Puma concolor* (Linnaeus, 1771) and *Puma yagouaroundi* (É. Geoffroy Saint-Hilaire, 1803) (Pecon Slattery & O'Brien, 1998; Johnson *et al.*, 2006); and the genus *Panthera* Oken, 1816, with only one representative on the continent, *Panthera onca* (Linnaeus, 1758) (Chimento *et al.*, 2014). The genus *Smilodon* Lund, 1842 includes extinct large felids belonging to the subfamily Machairodontinae Gill, 1872, with at least two species for South America: *Smilodon populator* Lund 1842 and *S. fatalis* (Leidy, 1869), the former with occurrences in the Northeast region, including Lajedo de Soledade (Porpino *et al.*, 2004).

Figure 3. Carnivora. **A,** *Cerdocyon thous*, MLS 371, cervical vertebra in dorsal view; **B,** *Panthera onca*, MLS 394, right dentary fragment in vestibular view; **C-D**, *Puma concolor*, **C,** MLS 385, right humerus in anterior view, and **D,** right ulna in lateral view; *Leopardus tigrinus*, **E,** MLS 373, left humerus in anterior view, and **F,** MLS 375, left ulna in medial view. Scale bars = 20 mm.

The fossil specimens were morphologically compared to three felids, *L. pardalis*, *L. tigrinus*, *P. yagouaroundi*.

The proximal portion and a large part of the lateral supracondylar crest of the humerus are missing. The trochlea and capitulum are similar in proportions, as seen in *Leopardus tigrinus*, but different from *L. pardalis*, which has a less-developed trochlea than the capitulum. In *Puma yagouaroundi*, the trochlea is much more developed than the capitulum. The capitulum is cylindrical, like in *L. tigrinus* and *L. pardalis*, while in *P. yagouaroundi*, the capitulum is spherical. The trochlear crest is semicircular, as in *L. tigrinus* and *P. yagouaroundi*, differing from *L. pardalis*, which has a straight crest. The constriction separating the trochlea from the capitulum is not well defined, similar to *L. tigrinus* and

P. yagouaroundi, whereas in *L. pardalis* it is well defined. The supracondylar crest is well developed, similar to *L. tigrinus* and *L. pardalis*. In *P. yagouaroundi*, the crest is less developed. The lateral epicondyle projects laterally, differing only from *P. yagouaroundi*, which has a continuous lateral edge compared to the supracondylar crest. The medial epicondyle has a smaller proportion, as in *L. tigrinus*, different from *P. yagouaroundi*, in which it is slightly prominent, and *L. pardalis*, in which it is well developed. The olecranon fossa is slightly developed and perforated, like in *L. tigrinus*.

The radius is fragmented, with the distal portion missing. The neck is shorter compared to *P. yagouaroundi*, being more similar to *Leopardus pardalis* and *L. tigrinus*. The bicipital tuberosity is elongated and elliptical, as in *L. pardalis* and *L. tigrinus*, while in *Puma yagouaroundi* it is reniform and shorter. The medial insertion of the collateral ligament is shallow, as in *L. tigrinus*, in contrast to *P. yagouaroundi*, which has a well-defined insertion, and *L. pardalis*, where it is deep. The capitular eminence is acute, as in *L. tigrinus*, *L. pardalis*, and *P. yagouaroundi*. In the proximal view, the central fossa has a distinct shape, as in *L. tigrinus*, but different from *P. yagouaroundi*, which is reniform, and *L. pardalis*, which is circular.

The ulna did not preserve the distal portion. The lateral edge is higher than the medial, and the insertion of the anconeal muscle is more cranially and proximally projected compared to the triceps muscle insertion, as in *Leopardus pardalis* and *L. tigrinus*, contrasting with *Puma yagouaroundi*. The cranial crest is wider, as in *L. pardalis* and *L. tigrinus*. Based on their morphological characteristics described in the literature and the comparisons made, the described specimens can be identified as *L. tigrinus*.

Puma Jardine, 1834

Puma concolor (Linnaeus, 1771)
(Figure 3C-D)

Material. MLS 376, MLS 377, MLS 378, MLS 379, MLS 380, MLS 381, MLS 382, lumbar vertebrae; MLS 383, sacrum; MLS 384, left ilium; MLS 385 and MLS 386, right and left humeri, respectively; MLS 387 and MLS 388, right radii; MLS 389 and MLS 390, right and left ulnae, respectively; MLS 391, left third metacarpal; MLS 392 and MLS 393, right and left femora, respectively.

Provenance. Layer B, Araras Ravine, Lajedo de Soledade, Apodi/RN.

Remarks. The morphological characteristics and size of the skeletal elements showed similarities with a felid of the genus *Puma*. In addition to literature-based comparisons among *Puma* species, comparisons were also made with *Leopardus pardalis* and *Panthera onca* to better support the morphological assignment of the skeletal elements to the genus *Puma*.

The two humeri are incomplete, with the proximal portion missing. They have the trochlea projected distally in relation to the capitulum, as in *Puma concolor* and *P. yagouaroundi*, but more so than in *Leopardus pardalis* and *Panthera onca*, the trochlear crest is straight, as in *P. concolor* and *L. pardalis*. Although poorly developed, *Panthera onca* also has a straight crest, and *P. yagouaroundi* has a circular crest. The capitulum is semispherical, similar to *P. concolor* and *P. yagouaroundi*, while in the other felids, it is cylindrical. The supracondylar crest is not very developed, like in *P. concolor*, whereas in *P. yagouaroundi* and *L. pardalis*, it is well developed, and in *P. onca*, the crest is highly developed, forming a platform. The lateral epicondyle projects laterally markedly, as in *P. concolor* and *L. pardalis*. In *P. yagouaroundi*, the lateral margin is continuous with the supracondylar crest, while in *P. onca*, this distinction is challenging due to the extensive development of the supracondylar crest. The olecranon fossa is well developed and ellipsoidal, resembling *P. concolor* and *P. yagouaroundi*, contrasting with *P. onca* and *L. pardalis*. The coronoid fossa is more developed than the radial fossa, as in *P. concolor*. In *P. yagouaroundi*, the opposite occurs, whereas in *P. onca*, the facets are less developed, and in *L. pardalis*, the facets have the same proportion.

The two specimens of right radius are fragments, with MLS 387 being a fragment of the proximal portion and MLS 388 being a fragment of the distal portion. The proximal part of the radius exhibits a short and reniform bicipital tuberosity, as in *Puma concolor* and *P. yagouaroundi*. In *Leopardus pardalis*, it is more elongated and elliptical, while in *Panthera onca*, it is rectangular. The medial insertion of the collateral ligament occurs proximally and medially to the bicipital tuberosity, as in *P. concolor*. In *L. pardalis*, it appears at the same position, although it is very deep, while in *P. yagouaroundi*, the insertion is located proximally to the bicipital tuberosity. The capitular eminence is not very prominent, as in *P. concolor*, unlike the other felids compared here, which have a more developed capitular eminence.

The ulnae are fragmented, with MLS 390 preserving only the proximal portion and MLS 389 preserving the proximal portion and part of the diaphysis. They have the medial edge higher than the lateral edge, as in *Puma concolor* and *P. yagouaroundi*, contrasting with *Leopardus pardalis* and *Panthera onca*, where the opposite occurs. The insertion points of the triceps and aconeus muscles is at the same level as in *P. concolor*. In *L. pardalis* and *P. onca* it is similarly located, though it is more deeply embedded. In contrast, in *P. yagouaroundi*, the insertion is located proximal and medially to the bicipital tuberosity, and in *P. onca*, it is absent. The coronoid crest is less prominent, as in *P. concolor*, unlike the other felids compared here, which have a more developed coronoid crest.

The femora are fragmented, with only the proximal portion preserved. They have a less proximally projecting head than the greater trochanter, as in *Puma concolor* and *Panthera onca*. However, in the latter, the greater trochanter and the head form an obtuse angle. In *P. yagouaroundi*, the head and the greater trochanter are at the same level, while in *Leopardus pardalis*, the head is more proximally projected in relation to the greater trochanter. The trochanteric fossa is well defined, as in *P. concolor*, *P. yagouaroundi*, and *P. onca*, while in *L. pardalis*, the fossa is divided into two regions by the oblique medial crest, with the proximal fossa being deep and the distal one shallow.

The other previously mentioned specimens that were not discussed here exhibit similar shapes and sizes as the skeletal elements of *Puma concolor* from the Mastozoological collection of the Vertebrate Department of the Museu Nacional/Universidade Federal do Rio de Janeiro and the Paleomastozoology collection of PUC/Minas. Based on the morphological analysis, which relied on the literature and conducted comparisons, the fossil specimens could be attributed to the species *P. concolor*.

Subfamily PANTHERINAE Pocock, 1917

Panthera, Oken, 1816

Panthera onca (Linnaeus, 1758)
(Figure 3B)

Material. MLS 394, dentary fragment (Figure 3B); MLS 100 and MLS 395, left calcanei.
Provenance. Layers B and C, Araras Ravine and Leon Ravine, Lajedo de Soledade, Apodi/RN.
Remarks. The sizes of the alveoli in the dentary fragment, especially that of the canine, indicate a large carnivore. The families Canidae (*e.g.*, *Protocyon troglodytes* (Lund, 1838)), Ursidae (*e.g.*, *Arctotherium brasiliense* (Lund, 1839)), and Felidae (*e.g.*, *Puma concolor*, *P. onca*, and *Smilodon populator*) have Quaternary representatives with large proportions, compatible with the size of the dentary fragment and its alveoli. However, the pair of alveoli indicate a double-rooted tooth, observed only in Felidae. In Machairodontinae, the P_3, when present, has a single root, and the P_4 has a double root, but the diastema is much longer compared to the specimen MLS 394. The length of the alveoli is greater compared to *P. concolor* and similar species.

The calcanei are incomplete, preserving only the most proximal portion. The specimens are smaller and robust compared to *Smilodon populator* but larger than small felines such as *Leopardus tigrinus*, *L. pardalis*, and *Puma yagouaroundi*. In the anterior view, the ectal facet is more elongated, like *Panthera onca*, while in *P. concolor*, it is shorter. The medial process is less prominent compared to *P. concolor*. A lateral projection is observed in *P. concolor* but not in the elements described here. In summary, the characteristics observed here allow us to attribute the described elements to the species *P. onca*.

Felidae indet.

Material. MLS 396, MLS 397, MLS 398, MLS 399, metapodials; MLS 400, phalanx.
Provenance. Layers A, B, and C, Araras Ravine, Lajedo de Soledade, Apodi/RN.
Remarks. Compared to other carnivores, MLS 396, MLS 397, MLS 398, MLS 399, and MLS 400 are slender, indicating a cursorial carnivore, such as a canid or felid. The metapodials correspond to fragments of the distal portion and part of the diaphysis, with specimens MLS 396 and MLS 399 having larger proportions. The phalanx is also fragmented, comprising the distal portion and part of the body. They feature an arched body, convex dorsally and face, and concave palmarly. Canids have straight diaphysis, while felids have slightly arched ones, consistent with the analyzed material. The head of the metapodial is rounded, like felids, and different from canids, which have a straight head. The sesamoid crest is poorly developed, as in felids, while canids have a well-developed crest (Morales-Mejía & Arroyo-Cabrales, 2012). The observed l characteristics allow attributing the specimens to the Felidae family, although it is not feasible to identify them below this taxonomic level.

Order ARTIODACTYLA Owen, 1848
Family CERVIDAE Goldfuss, 1820

Mazama Rafinesque, 1817

Mazama sp.
(Figure 4A–C)

Material. MLS 401, left M_3 (Figure 4A); MLS 149, right lower molar; MLS 235, MLS 402, MLS 403, MLS 404, left lower molars; MLS 405, right horn (Figure 4C); MLS 406, left humerus (Figure 4B); MLS 407, left radius; MLS 427 and MLS 428, metapodials; MLS 408, MLS 409, MLS 410, MLS 411, MLS 412, middle phalanges; MLS 413, MLS 414, MLS 415, MLS 566, distal phalanges; MLS 369, 416, and 417, right astragalus; MLS 370, left astragalus.
Provenance. Layers A, B, and C, Araras Ravine and Leon Ravine, Lajedo de Soledade, Apodi/RN.
Remarks. In South America, the Cervidae family is currently represented by at least twelve genera, both extinct and extant: *Mazama*, *Odocoileus* Rafinesque, 1832, *Ozotoceros* Ameghino, 1891, *Blastocerus* Wagner, 1844, *Pudu* Gray, 1852, *Hippocamelus* Leuckart, 1816, *Antifer* Ameghino, 1889, *Epieurycerus* Ameghino, 1889, *Morenelaphus* Carette, 1923, *Paraceros* Ameghino, 1889, *Agalmaceros* Hoffstetter, 1952, and *Charitoceros* Hoffstetter, 1963 (Grubb, 2005). Among these, *Odocoileus*, *Blastocerus*, *Ozotoceros*, *Morenelaphus*, and *Mazama* occur in Brazil, with the first four being large animals (Azevedo *et al*., 2021; Rotti *et al*., 2021).

The fused epiphyses, proportions, and wear on the dental specimens described indicate adult, small-sized cervids, with at least one having simple antlers. Among the genera recorded in Brazil, only *Mazama* has small size, small, simple antlers, postcranial elements, and dental proportions like those studied here. Five species of this genus are found in Brazil: *M. gouazoubira* (G. Fischer, 1814), *M. nemorivaga* (F. Cuvier, 1817), *M. americana* (Erxleben, 1777), *M. nana* (Hensel, 1872), and *M. bororo* Duarte, 1996 (Merino & Rossi, 2010).

Comparisons with materials attributed to *Mazama americana* and *M. gouazoubira* showed that the molars

Figure 4. Artiodactyla. *Mazama* sp., **A,** MLS 401, left M_3 in occlusal view; **B,** MLS 406, left humerus in anterior view; **C,** MLS 405, right horn in anterior view; **D,** Cervidae indet., MLS 418, right upper molar; **E,** *Palaeolama major*, MLS 430, right M_3 in occlusal view. Scale bars = 10 mm.

are more like the latter, primarily due to the absence of the endostyles/ectostyle, which is present only in *M. americana*. The dimensions also appear similar to those of the latter species. However, for a more accurate specific identification, it is necessary to conduct a morphological comparison with the other species in the *Mazama* genus. Therefore, we identify the specimens as *Mazama* sp.

Cervidae indet.
(Figure 4D)

Material. MLS 418, right upper molar; MLS 419 and MLS 420, left upper molars; MLS 421, left P_4; MLS 422, right P_3; MLS 423, right lower molar; MLS 424 and MLS 425, left lower molars; MLS 426, metapodial.

Provenance. Layers B and C, Araras Ravine, Lajedo de Soledade, Apodi/RN.

Remarks. The upper molars are selenodont, with all structures preserved, exhibiting significant wear. They all feature an elongated lingual loph, oriented labio-lingually. The interlophular styles are well developed, and the talon and trigon basins have a “half-moon” shape. The lower teeth are heavily worn to the point where the fossettids are absent. General characteristics include slightly V-shaped vestibular lophids and underdeveloped stylids. The metapodial corresponds to a small portion of the distal end, preserving only the abaxial and axial condyles of the metapodial IV. Despite being a small fragment, its size is significant when compared to small deer species.

The morphology of the described specimens suggests they belong to cervids. The wear on the dental specimens possibly indicates that they are senile animals, with proportions larger than contemporary individuals of the genus *Mazama*. The lack of studies addressing the dental morphology of cervids, and the high level of dental wear hinder a more precise comparison. Therefore, we identify the species only at the family level.

Suborder TYLOPODA Illiger, 1811
Family CAMELIDAE Gray, 1821
Subfamily CAMELINAE Gray, 1821

Palaeolama Gervais, 1867

Palaeolama major Liais, 1872
(Figure 4E)

Material. MLS 429, MLS 430 (Figure 4D), and MLS 431, right M_3; MLS 432, left M_3; MLS 433, left lower molar.
Provenance. Layers A, B, and C, Araras Ravine, Lajedo de Soledade, Apodi/RN.
Remarks. The morphological characteristics and size of the specimens show similarities with members of the Camelidae family. In South America, there are five genera within the Lamini Tribe, namely: *Palaeolama*, with an occurrence from the Middle to Late Pleistocene; *Hemiauchenia* Gervais & Ameghino, 1880, with records from the Late Pliocene to Late Pleistocene; *Lama* Cuvier, 1800, with occurrences from the Late Pliocene to the present; *Vicugna* Lesson, 1842, from the Middle Pleistocene to the present; and *Eulamaops* Ameghino, 1889, exclusive to the end of the Pleistocene (Mckenna & Bell, 1997; Scherer, 2009).

The lower molars have a buccal lophids V-shaped, and the parastylid and protostylid with little development, analogous to the lower molars of *Palaeolama*. They differ from *Hemiauchenia*, which has a U-shaped buccal lophids and well-developed parastylid and protostylid (Scherer, 2009). They also differ from *Lama*, which has a rounded buccal lophids and well-developed parastylid and protostylid (Scherer, 2009). The genus *Vicugna* has narrower molars, with an average width of the third molar of about 9 mm (see Scherer, 2009 – tab. 67, p. 246–247), while the studied specimens have a width ranging from 12.35 to 15.22 mm. As for the genus *Eulamaops*, it is known from a single occurrence from the Late Pleistocene in the Pampean region of Argentina (Scherer, 2009), making comparisons currently impossible. Based on the abovementioned characteristics, we attribute the specimens to the genus *Palaeolama*.

The genus *Palaeolama* comprises two South American species: *P. major*, with an occurrence mainly in northeastern Brazil and other scattered records in the Pampean region of Argentina, Venezuela, Uruguay, and other regions of Brazil, and *Palaeolama weddelli* Gervais, 1855, with records in southern Bolivia and Ecuador (Scherer, 2009). *Palaeolama niedae* Guérin & Faure (1999), described from a Pleistocene deposit in the Serra da Capivara, northeastern Brazil, is a synonym of *P. major* (Scherer, 2009).

Among the valid species, *Palaeolama weddelli* differs from *P. major* by having shorter postcranial bones and larger teeth (Scherer, 2009). The third molars, MLS 429, MLS 430, MLS 431, and MLS 432 have lengths ranging from 28.29 to 29.67 mm, while *P. weddelli* has lengths ranging from 32.6 to 34.4 mm (see Scherer, 2009 – tab. 25, p. 160–163). The result of the morphometric comparison allows us to assign the studied specimens to *P. major*.

Camelidae indet.

Material. MLS 434 and MLS 435, phalanges.
Provenance. Layers A and B, Araras Ravine, Lajedo de Soledade, Apodi/RN.
Remarks. The specimens exhibit characteristics similar to the proximal phalanges of camelids, such as the rough plantar surface of the phalanges (Pascual *et al*., 1966; Scherer, 2009), but they are represented only by the proximal portion. Phalanges are challenging to identify due to the limited variation among taxa (Scherer, 2009). The fragmented condition of the phalanges prevents size comparison, which would be the only tool for more specific identification. Therefore, both specimens are attributed here to Camelidae indet.

Order PERISSODACTYLA Owen, 1848
Family EQUIDAE Gray, 1821
Subfamily EQUINAE Gray, 1821

Hippidion Owen, 1869

Hippidion principale Lund, 1846
(Figure 5A)

Material. MLS 475 (Figure 5A) and MLS 476, lower right teeth; MLS 477, lower left tooth.
Provenance. Layers A and B, Araras Ravine, Lajedo de Soledade, Apodi/RN.
Remarks. The occlusal morphology and hypsodont condition of the teeth exhibit the same characteristics observed in individuals of the Family Equidae. Only two species of Equidae are described for the Quaternary of Northeast Brazil, *Equus* (*Amerhippus*) *neogeus* (Lund, 1840) and *H. principale* (Alberdi *et al*., 2003; Alberdi & Prado, 2004; Machado, 2018; Machado & Avilla, 2019). The rounded shape of the vestibular lophids, a small isthmus, and the significant development of the linguoflexid are characteristics that occur in *H. principale* (Paula-Couto, 1979). These characteristics differ from *E. neogeus*, which has flattened, nearly straight vestibular lophids, the metaconid and metastylid widely united, forming a figure resembling a double knot, and the

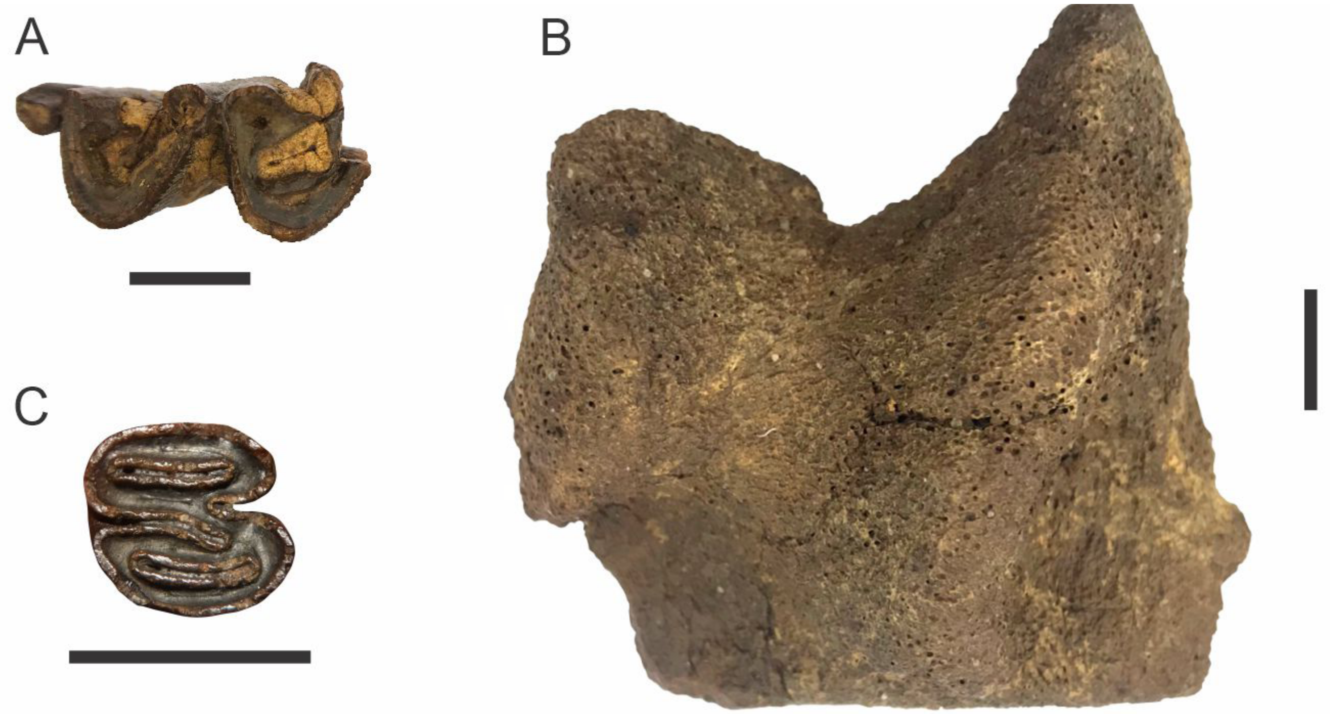

Figure 5. Perissodactyla and Rodentia. **A,** *Hippidion principale*, MLS 475, right lower tooth in occlusal view; **B,** Equidae indet., MLS 478, right astragalus in dorsal view; **C,** *Cuniculus* sp., MLS 367, left M_1 in occlusal view. Scale bars = 10 mm.

ectoflexid poorly developed, with the presence of a cabalian fold (Paula-Couto, 1979). Thus, based on the similarities mentioned, the specimens described in this study are attributed to *H. principale*.

Equidae indet.
(Figure 5B)

Material. MLS 478, right astragalus (Figure 5B).
Provenance. Layer A, Araras Ravine, Lajedo de Soledade, Apodi/RN.
Remarks. The specimen is fragmented, with a significant portion of the lateral region missing and a considerably altered surface. The dorsal surface preserves part of the trochlea, mainly the medial trochlear crest, which is separated from the lateral trochlear crest by a synovial fossa. The mediolateral orientation of the trochlear crests, combined with the flat surface of the astragalus head, are characteristics that allow attributing the specimen to an individual of the family Equidae (König & Liebich, 2021, p. 262). However, due to the preservation state of the specimen, a generic attribution is not feasible.

Order RODENTIA Bowdich, 1821
Family CUNICULIDAE Miller & Gidley, 1918

Cuniculus Brisson, 1762

Cuniculus sp.
(Figure 5C)

Material. MLS 367, left M_1 (Figure 5C).
Provenance. Leon Ravine, Lajedo de Soledade, Apodi/RN.
Remarks. The genus *Cuniculus* encompasses at least three species: *Cuniculus paca* (Linnaeus, 1766) and *C. taczanowskii* (Stolzmann, 1865), which are extant species, and *C. rugiceps* Lund, 1837, an extinct species (Mayer *et al*., 2016).

The anterofossetid and posterofossetid exhibit an elongated and elliptical shape in the studied element. Between these structures, there is the hypoflexid, which is shorter and does not reach the tooth's midline, and the paraflexid, which is longer and extends beyond the tooth's midline, as seen in species of the genus *Cuniculus* (Mayer *et al*., 2016).

No evident differences are found in the morphology of the teeth among species of the genus *Cuniculus*. The only means of distinction among the species is their size, with *C. rugiceps* being proportionally larger than the other two species (Mayer *et al*., 2016). Due to the absence of distinctive morphological characteristics and the fact that it is only an isolated tooth, we identified the specimen as *Cuniculus* sp.

Superorder XENARTHRA Cope, 1889
Order CINGULATA Illiger, 1811
Family CHLAMYPHORIDAE Pocock, 1924
Subfamily EUPHRACTINAE Pocock, 1924

Euphractus Wagler, 1830

Euphractus sexcinctus (Linnaeus, 1758)
(Figure 6A, D)

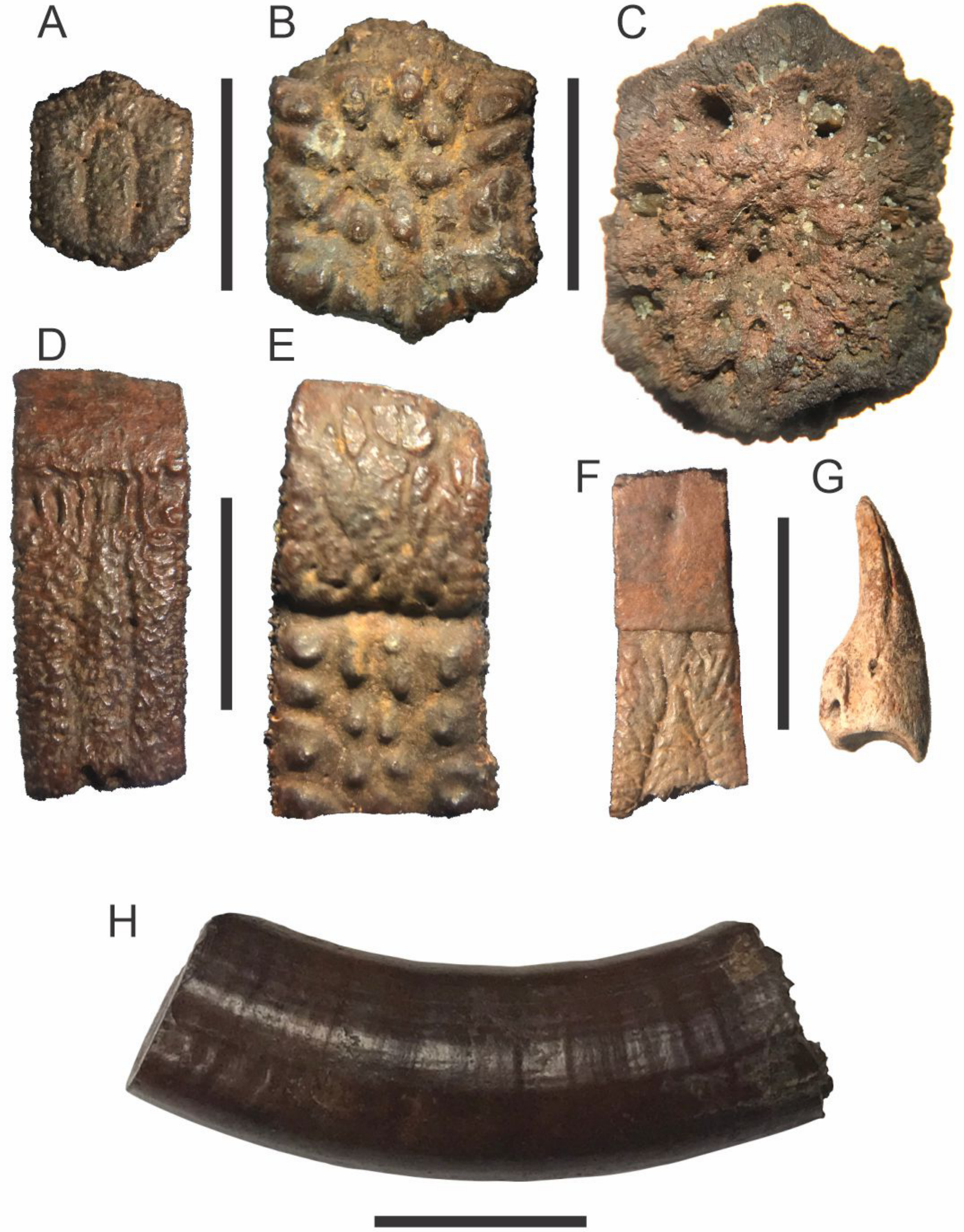

Figure 6. Xenarthra. *Euphractus sexcinctus*, **A,** MLS 437, fixed osteoderm in dorsal view, **D,** MLS 446, mobile osteoderm in dorsal view; *Tolypeutes* cf. *T. tricinctus*, **B,** MLS 452, fixed osteoderm in dorsal view, **E,** MLS 457, mobile osteoderm in dorsal view; **C,** *Glyptotherium* sp., MLS 469, osteoderm in dorsal view; **F,** *Dasypus novemcinctus*, MLS 460, mobile osteoderm in dorsal view; **G,** Cingulata indet., MLS 474, distal phalanx in medial view (); **H,** Megalonychidae indet., MLS 144, left upper fourth molariform in posterior view. Scale bars = 2.5 mm.

Material. MLS 436, caudal vertebra; MLS 437 (Figure 6A), MLS 438, MLS 439, MLS 440, MLS 441, MLS 442, MLS 443, and MLS 444, fixed osteoderms of the scapular or pelvic shield; MLS 445, MLS 446 (Figure 6D), MLS 447, MLS 448, and MLS 449, osteoderms of the mobile band.

Provenance. Layers B and C, Araras Ravine, Lajedo de Soledade, Apodi/RN.

Remarks. According to the proposal by Delsuc *et al.* (2016), there are two main families within Cingulata: Dasypodidae Gray, 1821 and Chlamyphoridae Pocock, 1924. Dasypodidae includes the subfamily Dasypodinae Gray, 1821, with the genus *Dasypus* Linnaeus, 1758. Meanwhile, Chlamyphoridae encompasses the following subfamilies: Euphractinae, with the genera *Euphractus*, *Chaetophractus* Fitzinger, 1871, and *Zaedyus* Ameghino, 1889; Subfamily Chlamyphorinae Pocock, 1924, with the genera *Chlamyphorus* Harlan, 1825, and *Calyptophractus* Fitzinger, 1871; Subfamily Tolypeutinae Gray, 1865, with the genera *Priodontes* F. Cuvier, 1825, *Tolypeutes* Illiger, 1811, and *Cabassous* McMurtie, 1831. These subfamilies primarily consist of small, extant animals. In addition, according to this proposal, the extinct subfamily Glyptodontinae Gray, 1869 is nested within Chlamyphoridae.

The caudal vertebra only exhibits remnants of the cranial and caudal articular processes, with the transverse process being poorly developed and extending across the vertebral body but not surpassing the cranial and caudal ends, a feature observed only in the distalmost vertebrae of the genus *Euphractus*.

In contrast, the genus *Dasypus* has a highly developed cranial articular process compared to *Euphractus* , with an elongated transverse process extending cranially . The genus *Tolypeutes* possesses well-developed transverse and articular processes . *Cabassous* has a more robust caudal vertebra with a poorly developed transverse process that does not extend across the vertebral body.

The fixed osteoderm displays an elongated ellipsoidal central figure in the anteroposterior axis, like in *Euphractus*, differing from *Dasypus*, which often has a shorter, rounder central figure. *Cabassous* and *Priodontes* have a single figure with a smooth concavity, while *Tolypeutes* lacks a clearly defined central figure.

The mobile band osteoderms are elongated, resembling *Euphractus*, *Dasypus*, and *Tolypeutes*, but different from *Cabassous* and *Priodontes*, which have shorter osteoderms. They exhibit a relatively extensive transverse depression with a rugged appearance, like the mobile osteoderms of *Euphractus*.

In contrast, *Dasypus*, *Cabassous*, *Priodontes*, and *Tolypeutes* have a transition region with a shorter extent . The central figure is elongated , as in *Euphractus* , while *Cabassous* and *Priodontes* have a less elongated central figure formed by a shallow depression. *Dasypus* has a triangular central figure.

The specimens exhibit distinct characteristics in line with those of *Euphractus*. As only one species represents this genus, we attribute these elements to *E. sexcinctus*.

Subfamily GLYPTODONTINAE Gray 1869

Glyptotherium Osborn, 1903

Glyptotherium sp.
(Figure 6C)

Material. MLS 469 (Figure 6C) and MLS 470, osteoderms.

Provenance. Layers B and C, Araras Ravine, Lajedo de Soledade, Apodi/RN.

Remarks. Both osteoderms exhibit surface wear on the external side, which hinders the observation of details of peripheral figures and grooves. However, it is possible to discern the rosette-like ornamental pattern present in *Glyptotherium* Osborn, 1903 (Oliveira *et al*., 2010).

The central figure is visible and has a subcircular shape with a slight concavity. Specimen MLS 469 shows five large foramina, while specimen MLS 470 exhibits three, both within the range observed in *Glyptotherium*. A rosette pattern is also present in osteoderms from the regions near the lateral and posterior edge of the carapace of *Panochthus* Burmeister, 1866 and most osteoderms of *Hoplophorus* Lund, 1838; both genera are also recorded in the Quaternary deposits of northeastern Brazil (Porpino *et al*., 2010a, b; 2014). Nonetheless, in *Panochthus,* the peripheral figures are proportionally much smaller than the main one, compared to *Glyptotherium* (see Porpino *et al*., 2014). *Hoplophorus*, in turn, has much smaller and thinner osteoderms in contrast to *Glyptotherium* (See Oliveira *et al*., 2010; Porpino *et al*., 2014). There is no clear differentiation among the osteoderms of *Glyptotherium* species, so it is more prudent to identify them at the genus level only (Oliveira *et al*., 2010).

Subfamily TOLYPEUTINAE Pocock, 1924

Tolypeutes Illiger, 1811

Tolypeutes cf. *T. tricinctus* (Linnaeus, 1758)
(Figure 6B, E)

Material. MLS 450, MLS 451, MLS 452 (Figure 6B), MLS 453, MLS 454, MLS 455, MLS 456, MLS 561, MLS 562, MLS 563, and MLS 564, fixed osteoderms of the scapular or pelvic shield; MLS 457 (Figure 6E), MLS 458, and MLS 459, osteoderms of the mobile band.

Provenance. Layers A, B, and C, Araras Ravine, Lajedo de Soledade, Apodi/RN.

Remarks. The fixed osteoderms have tubercles distributed over the dorsal surface and on the caudal portion of the mobile osteoderms. Grooves are absent, and the cranial portion of the mobile osteoderms is very rough. This combination of distinctive characteristics is found only in the genus *Tolypeutes*. Within the genus *Tolypeutes*, there are two known species: *T. matacus* (Desmarest, 1804), found in Bolivia, the Central-West region of Brazil, the Gran Chaco Province in

Paraguay, and Argentina; and *T. tricinctus*, occurring in the Northeast region of Brazil (Gardner, 2007).

The osteoderms described here are similar in size to those of *Tolypeutes tricinctus*, which would allow us to attribute the elements to this species. However, to confirm this assignment, a morphometric comparison with osteoderms from *T. matacus* would be necessary. Therefore, at this moment, the osteoderms are attributed to *Tolypeutes* cf. *T. tricinctus*.

Family DASYPODIDAE Gray, 1821
Subfamily DASYPODINAE Gray, 1821

Dasypus Linnaeus, 1758

Dasypus novemcinctus Linnaeus, 1758
(Figure 6F)

Material. MLS 460 (Figure 6F), MLS 461, MLS 462, MLS 463, MLS 464, MLS 465, MLS 466, MLS 467, and MLS 468, osteoderms of the mobile band.

Provenance. Layers B and C, Araras Ravine, Lajedo de Soledade, Apodi/RN.

Remarks. All specimens studied are fragments of osteoderms from the mobile band of the dorsal shield. The cranial surface of the osteoderms is smooth and thin, a characteristic observed in the mobile band osteoderms of *Dasypus*. These osteoderms differ from those of *Cabassous*, *Priodontes*, and *Euphractus*, which lack this elongated region and are more robust. In *Tolypeutes*, the surface is tuberous, differing from the osteoderms described here. The studied osteoderms have a slightly rough caudal surface, forming a triangular figure delimited by the main grooves, a feature typical of *Dasypus* osteoderms. In contrast, *Euphractu*s osteoderms have an elliptical central figure, *Tolypeutes* lacks a well-defined central figure, and *Cabassous* and *Priodontes* have a single figure formed by a smooth concavity. Based on these characteristics, the analyzed material can be attributed to *Dasypus*.

Among the *Dasypus* species, only two occur in the Northeast region of Brazil: *D. septemcinctus* Linnaeus, 1758, which is smaller and found in Maranhão, Pará, Minas Gerais, Mato Grosso, São Paulo, Paraná, Rio Grande do Sul, the southern regions of Argentina, and Bolivia; and *D. novemcinctus*, which is larger and has a broader distribution across South America (Gardner, 2007). The width of the studied osteoderms is similar to that of *D. novemcinctus*, allowing us to associate them with this species.

Cingulata indet.
(Figure 6G)

Material. MLS 471, molariform; MLS 472, MLS 473, and MLS 474 (Figure 6G), distal phalanges.

Provenance. Layers B and C, Araras Ravine, Lajedo de Soledade, Apodi/RN.

Remarks. The distal phalanges of Dasypodidae and Chlamyphoridae can vary in size and morphology within the same individual, making identification challenging. Additionally, the molariform lacks sufficient characteristics for species identification, leading us to categorize it as Cingulata undetermined.

Order PILOSA Flower, 1883
Family MEGALONYCHIDAE Gervais, 1855

Megalonychidae indet.
(Figure 6H)

Material. MLS 565, lower canine; MLS 144, left upper fourth molariform (Figure 6H).

Provenance. Layer C, Araras Ravine and Leon Ravine, Lajedo de Soledade, Apodi/RN.

Remarks. The proportions of the analyzed specimens suggest they belong to the family Megalonychidae, as they are similar to individuals within this family and considerably smaller than those found in other families, except Nothrotheriidae.. In Soth America, Megalonychidae includes at least three species: *Ahytherium aureum* Cartelle, De Iullis, Pujos, 2008, *Australonyx aquae* De Iullis, Pujos, Cartelle, 2009, and *Megistonyx oreobios* McDonald, Rincón, Gaudin, 2013.

However, both the lower canine and the upper fourth molariform are incomplete, lacking the corresponding occlusal surface. The index found between mesiodistal and buccolingual measurements is 0.73 for the canine and 0.57 for the molariform (the index of the fourth molariform is not indicative of species differentiation.) The index of the canine is similar to that of *Australonyx aquae* according to Costa *et al*. (2023). Nevertheless, due to the isolated and fragmented nature of the teeth, it is more prudent to identify them only at the family level.

BIOSTRATIGRAPHIC ASPECTS

The biostratigraphic aspects of Araras Ravine are described below and is illustrated in the Figure 7:

Layer "A," the deepest fossil-bearing layer, contains two species representing the Pleistocene megafauna: *Palaeolama major*, *Hippidion principale*, *Mazama* sp., a small deer, and *Tolypeutes* cf. *T. tricinctus*, a small living cingulatan.

Layer "B," the intermediate fossil-bearing layer, features the occurrence of *Leopardus tigrinus*, *Puma concolor*, *Panthera onca*, *Mazama* sp., *Palaeolama major*, *Hippidion principale*, *Euphractus sexcinctus*, *Glyptotherium* sp., *Tolypeutes* cf. *T. tricinctus*, and *Dasypus novemcinctus*.

Layer "C," the fossil-bearing layer closest to the surface, contains *Cerdocyon thous*, *Panthera onca*, *Mazama* sp., *Palaeolama major*, *Euphractus sexcinctus*, *Glyptotherium* sp., *Tolypeutes* cf. *T. tricinctus*, *Dasypus novemcinctus*, and Megalonychidae indet.

Leon Ravine does not have layer separation; however, we can incorporate the following taxa into the faunal association of Leon Ravine: *P. onca*, *Mazama* sp., *Cuniculus* sp., and Megalonychidae indet.

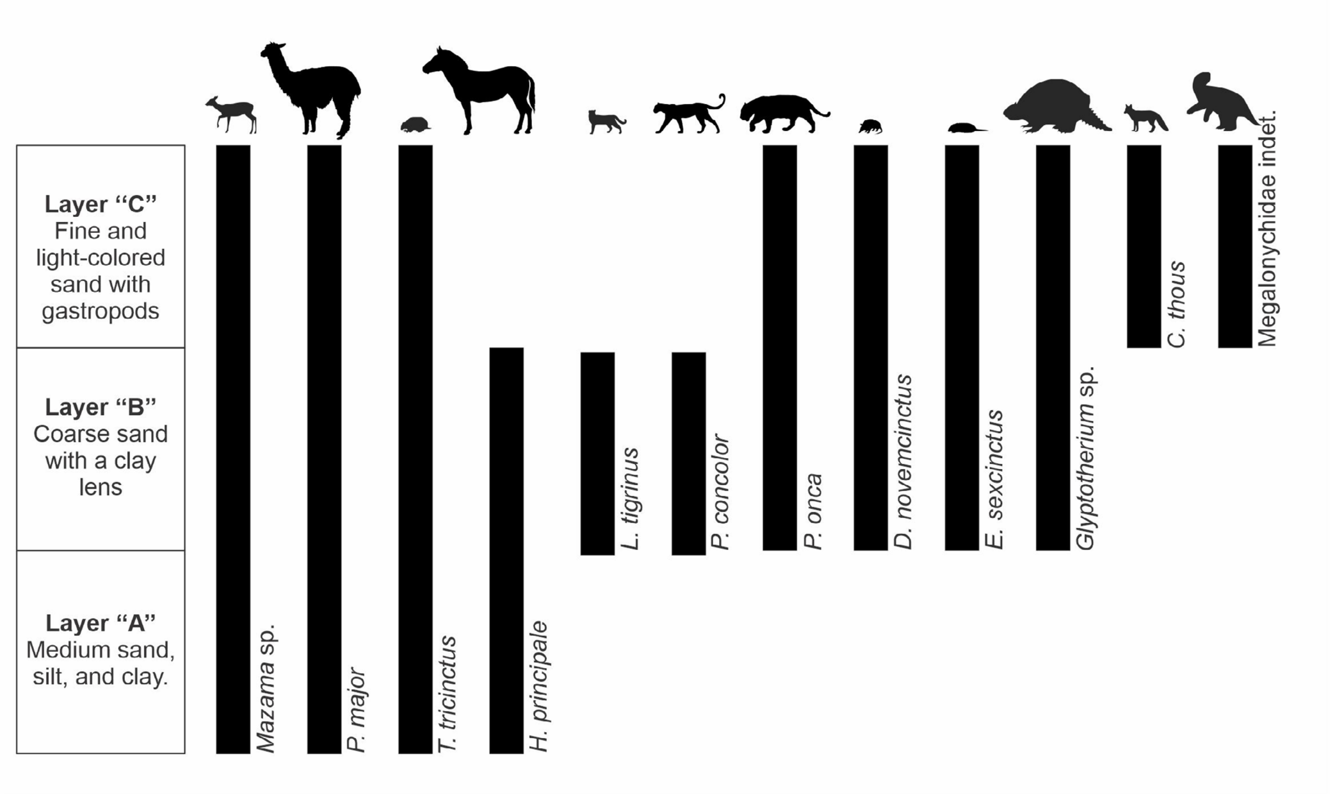

Figure 7. Distribution of taxa by layer.

DISCUSSION

The fossils collected at Araras Ravine are relatively small compared to those collected in natural tanks. This size discrepancy could be attributed to various factors such as taphonomic processes and the methods used for collection (Porpino *et al*., 2004), low sedimentation rates, or the early stage of ravine development at the time of deposition, when the fissure would still be narrow (Santos, 2001).

The identified taxa provide important paleoenvironmental information for Lajedo de Soledade. Layer "A" contains two extinct and two extant mammal taxa: *Hippidion principale*, a horse of open plains that frequently frequented denser areas (Alberdi *et al*., 2003; Bernardes *et al*., 2013); *Palaeolama major*, which despite its wide distribution in the Americas, serves as an indicator of open environments, based on robust paleoenvironmental studies (*e.g*., Silva, 2009; Marcolino, 2011; Rocha-dos-Santos *et al*., 2017; Eltink *et al*., 2020); *T*. cf. *T. tricinctus*, an endemic species in the Caatinga associated with deciduous forests (Gardner, 2007); and *Mazama* sp., a genus of small deer with a wide distribution (Reis *et al*., 2011).

Layer "B" shows an association of the taxa found in Layer A and the occurrence of other taxa, such as *Leopardus tigrinus*, *Puma concolor*, and *Panthera onca*, three carnivores with broad occurrences in different biomes (Reis *et al*., 2011; Nascimento & Feijó, 2017); *Euphractus sexcinctus* is known to inhabit savanna environments and forest edges; (Gardner, 2007); and *Dasypus novemcinctus*, a highly adaptable species found across various habitats from forests to savannas (Gardner, 2007).

In Layer "C," the same taxa as in Layer B are present, including *Panthera onca*, *Mazama* sp., *Palaeolama major*, *Euphractus sexcinctus*, *Glyptotherium* sp., *Tolypeutes*. cf. *T. tricinctus*, and *Dasypus novemcinctus*. However, a small canid taxon, *Cerdocyon thous*, is unique to this layer. This small canid is widely distributed in South America (Emmons & Feers, 1997).

The paleoecology of the extinct taxa found in Araras Ravine differs from the current environmental conditions in the vicinity of Lajedo de Soledade, where the hyperxerophytic caatinga predominates, mainly composed of tree and shrub species with a broader distribution in the landscape (Oliveira *et al*., 2021). However, despite this disparity, extinct and endemic caatinga taxa occur in the same sedimentary layers, indicating that the biostratigraphy may not correspond to a chronological sequence.

The taxa identified in the faunal association of Leon Ravine have a wide geographical distribution, which limits their informative value, except for *Cuniculus* sp. This taxon, although widely distributed, typically inhabits forested areas but can also be found in other biomes such as the Caatinga, particularly close to small watercourses like streams (Reis *et al*., 2011). It's worth noting that *Cuniculus* sp. is not currently found in the state of Rio Grande do Norte (Leal *et al*., 2003).

FINAL REMARKS

The mammal taxa identified, their paleoecology/ecology, and their vertical distribution throughout the layers of Araras Ravine suggest the presence of at least two distinct environments in the Lajedo de Soledade region during the Quaternary: (i) an open environment associated with denser areas likely resembling Cerrado vegetation, and (ii) a drier environment similar to the current Caatinga. The faunal association of Leon Ravine includes *Panthera onca*, *Mazama* sp., *Cuniculus* sp., and Megalonychidae indet. The presence of *Cuniculus* sp. in Leon Ravine represents a historical record of this genus for the state of Rio Grande do Norte, suggesting that the paleoenvironment consisted of open areas with forested environments, possibly with a higher number of small water bodies. However, to better understand the relationship between the ravines and any potential environmental transition, geochronological and isotopic studies of the material studied here, along with further collections, are necessary.

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