

# Cauca: megafaunal and felid fossils (Mammalia) from a Pleistocene site in northwest Venezuela

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## Abstract

Numerous surveys and three excavation and surface collection field seasons resulted in the discovery of numerous megafaunal remains and that of a medium-sized felid in a new site located on the coastal plain of the Gulf of Venezuela, in Western Falcón State. The faunal assemblage is represented by South American natives such as megatheres (cf. *Eremotherium laurillardi*), an indeterminate mylodontid and a glyptodont (probably related to *Glyptotherium*) and Nearctic representatives such as gomphotheres (*Notiomastodon platensis*), equids (*Equus* sp.) and a feline (Felidae cf. *Leopardus pardalis*), providing novel information for the distribution of some of these mammals. Radiocarbon indicates that this deposit is at least 40,000 years old. Lithic artefacts of a kind reported for other Pleistocene sites in the region document the presence of humans in Cauca, but as these cultural remains were found on the surface, their association with the fauna is uncertain.

## Key Words

Carnivora, cf. *Leopardus pardalis*, *Eremotherium*, *Equus*, Megaherbivores, Mylodontidae, *Notiomastodon*, South America

## Introduction

The north-western region of Venezuela (specifically the Falcón State; Figs 1, 2) is characterised by a semi-arid landscape in which multiple sites preserve rich fossil deposits. The Urumaco sedimentary sequence (ca. 23–1 Ma) preserves the largest succession of strata with vertebrate remains that exemplify the faunal changes of the last 23 Ma (Aguilera 2004; Linares 2004; Sánchez-Villagra et al. 2010; Carrillo-Briceño et al. 2021). In the same region, numerous sites of archaeological significance preserve megafaunal (taxa with a body mass greater than or equal to 44 kg) and cultural remains of the Late Pleistocene and the Early Holocene (e.g. Royo y Gómez (1959, 1960); Bryan et al. (1978); Ochsenius and Gruhn (1979); Aguilera (2006); Carrillo-Briceño (2015); Carlini et al. (2022); amongst others). Compared to other parts of Venezuela, the northwest region has a great Pleistocene fossiliferous record with abundant remains of reptiles, birds and especially mammals (Royo y Gómez 1960; Bocquentin-Villanueva 1979, 1982; Ochsenius 1980; Aguilera 2006; Prevosti and Rincón 2007; Rincón and White 2007; Carlini et al. 2008; Carrillo-Briceño et al. 2008a; Carlini and Zurita 2010; Chávez-Aponte and Carrillo-Briceño 2012; Ruiz-Ramoni et al. 2013, 2022; Carrillo-Briceño 2015; Rincón et al. 2021; Reyes-Céspedes et al. 2023; amongst others; see Fig. 2).

In the Falcón State, various types of evidence indicate the co-existence of early South American humans with now-extinct fauna and inferred interactions between humans and megaherbivores documented at the Muaco, Taima-Taima and Cucuruchú sites (Cruxent 1970; Bryan et al. 1978; Ochsenius and Gruhn 1979; Oliver and Alexander 2003; Carrillo-Briceño 2015; Carlini et al. 2022). In the excavations carried out at these sites, projectiles and other artefacts produced with bone and lithic materials were reported, in some cases proposed in direct association with the remains of megafauna (Rouse and Cruxent 1963; Cruxent 1967, 1979; Ochsenius and Gruhn 1979). Since the last excavations carried out at the Taima-Taima site in the 1990s (Aguilera 2006; Carrillo-Briceño 2015), no other systematic excavations at Pleistocene sites in the Falcón State have been carried out. In the present contribution, we provide palaeontological evidence from a new site assigned by its content and radiocarbon dating to the Late Pleistocene, which we have named “Cauca”. This new locality presents an association of extinct mammals and evidence of lithic artefacts near the excavations is also reported (e.g. Jaimes et al. (2024a)).

## Geographic and geological context

The site, Cauca ( $11^{\circ}18'51''\text{N}$ ,  $70^{\circ}17'41''\text{W}$ ), was so named because of its proximity to the homonymous fishing village, in the coastal area of the Gulf of Venezuela. It is located approximately 14.6 km northwest of the Town

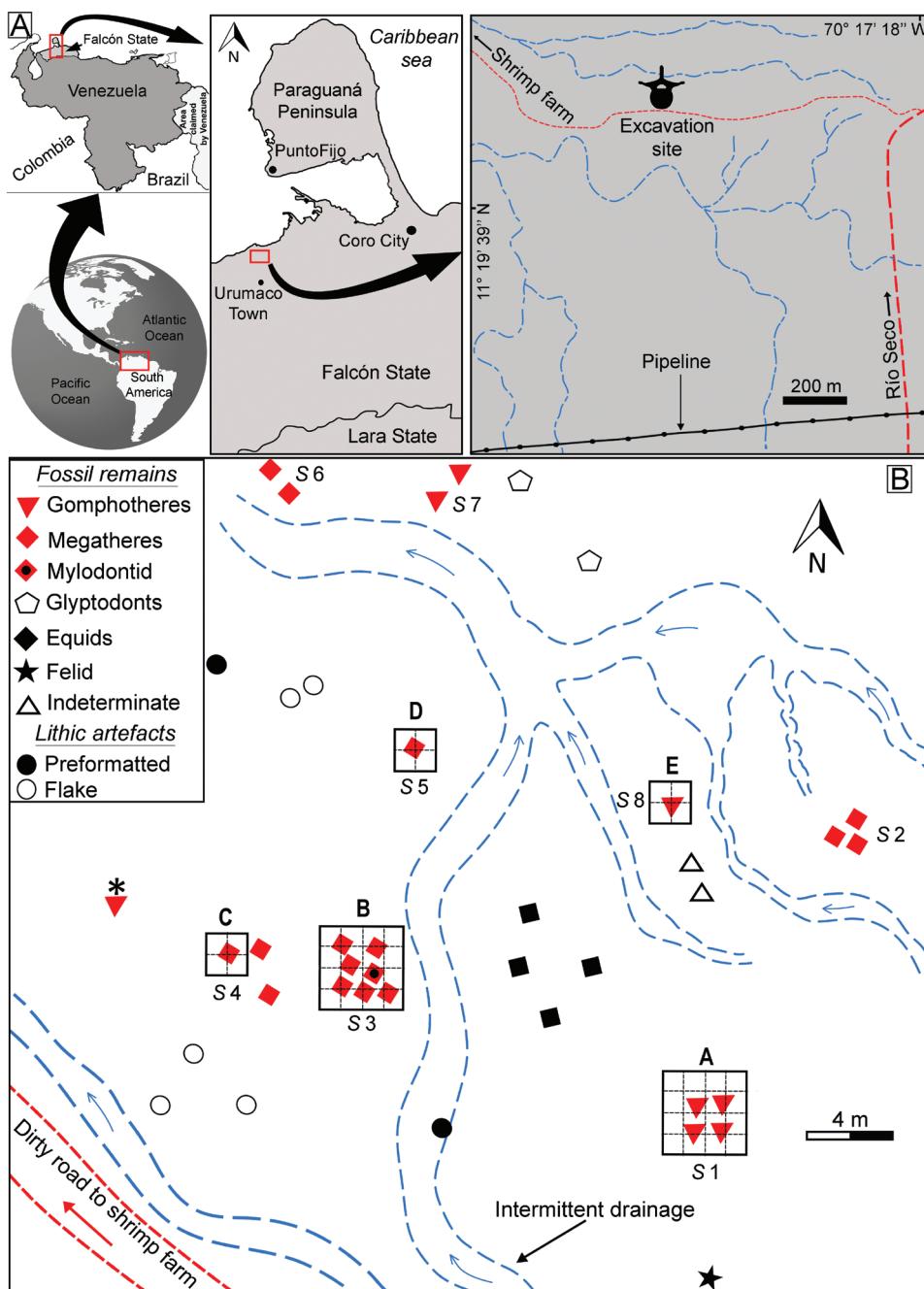
of Urumaco, Urumaco Municipality, following the dirt road that connects Urumaco with the hamlets of Cauca and Río Seco (Fig. 1). The site is on the western coastal plain about 2.3 km south of the coastal zone and approximately 12 metres above sea level. Currently, this plain is influenced by the trade winds (“vientos alisios”), whose incidence generates a semi-arid or arid, seasonal climate with prolonged periods of water deficit, with rainfall that ranges between 200 and 600 mm annually, average temperatures of  $30^{\circ}\text{C}$  and a predominantly xerophytic vegetation (Matteucci et al. 1999).

The area is affected by an intermittent runoff system, generating laminar erosion of the sediments. The geology is represented by a not formally defined sedimentary unit, characterised mainly by facies of unconsolidated fine to coarse sands of light brown to ochre colour, with underlying coastal palaeodunes. The level of oxidation of the sand and clay layers carrying the bone assemblages suggests that Cauca was probably deposited in a low-energy more humid environment, contrasting with the environmental conditions currently present in the area. For now, there is no precise evidence of whether this deposition environment was a permanent or intermittent body of water. The coastal plains of Falcón State were subject to a negative water balance during the Late Pleistocene (Ochsenius 1980) and the Cauca site could have offered attractive water resources for animals with swamp patch areas. An example of archaeological sites, such as Muaco, Taima-Taima and Cucuruchú, which were deposited in sedimentary environments influenced by the action of resurgent springs, offer an oasis that may have attracted animals during dry periods (Cruxent 1970; Ochsenius and Gruhn 1979; Ochsenius 1980).

## Excavations at the Cauca site

The fossiliferous site covers an area of approximately  $1600\text{ m}^2$ , where eight groupings of bone remains have been identified emerging on the surface (Figs 1B, 3). The first reports from this locality were made by one of the authors (R.S.) from the Palaeontology Department of the Alcaldía Bolivariana del Municipio Urumaco, in January 2004. During a survey of the site on 16 November 2019, several of the authors (J.D.C.B., A.J. and R.S.) collected from surface partial lithic projectiles and other preformatted artefacts in the vicinity of the Cauca site (see Jaimes et al. (2024a)). Thanks to the support and legal authorisation from the Alcaldía Bolivariana del Municipio Urumaco and the Instituto del Patrimonio Cultural de Venezuela (permits N° 00019-01/31/2020, 00110-04/09/2021, 00178-07/14/2021 and 00522-08/18/2022) the first systematic excavations were planned at the Cauca site.

To date, three excavation field seasons have been carried out between 2021 and 2022, totalling five work areas. These excavations were under the direction of A.J. and R.S., excavating only the outcropping bone groupings defined as 1, 3–5 and 8 (see Fig. 1B). The five

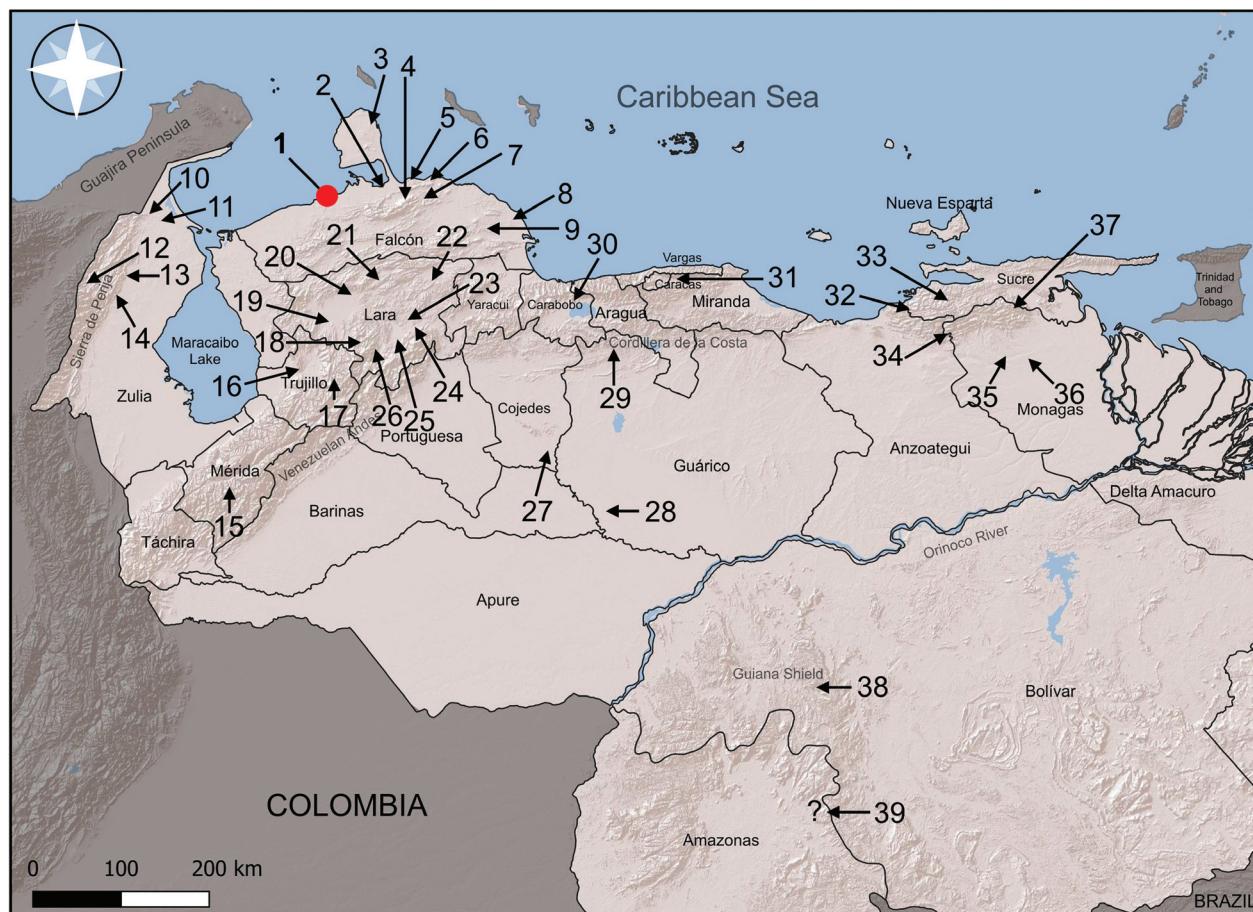


**Figure 1.** Geographic location of the Cauca site (A) and the excavation area (B). The different bone groupings are referred to as “S” and the excavations as “A–E”. The M2 isolated from a juvenile *Notiomastodon platensis* (AMU-CURS-1045) is referred to with a triangle and \*. Lithic artefacts referred to here are illustrated in Fig. 9.

excavations include: 1) Cauca “A”, carried out between 3 and 4 August 2021, with a  $4 \times 4$  m grid (Fig. 4B); 2) Cauca “B”, carried out between 4 and 26 October 2021, with a  $4 \times 4$  m grid (Fig. 4B), and 3) Cauca “C”, “D” and “E” carried out between 3 and 20 November 2022, and all with  $2 \times 2$  m grids (Figs 1B, 4B).

The depth of all excavations did not exceed 40 cm because that is the thickness of the bearing layer (e.g. Fig. 4B, C). There is no evidence of fossil under/below this layer. The stratigraphy of the site, based on the five excavations and from the top or surface to the excavated base, is characterised by at least three well-defined

layers. The first is the surface layer, about 5 cm thick and composed of unconsolidated sediments that include pellets and other small clasts that are transported by rain runoff and wind action that occurs from east to west. The second layer varies between 20 and 35 cm thick, composed of fine silt-clayey sands, heterogeneous, compact, and well-defined with colours between light brown and ochre, with evidence of oxidation. In Cauca “D”, specifically grid “C”, the sediments showed a greater clay composition, which could be related to its accumulation in the lowest deposition area in the northern section of the site. The deposit of this second layer may have occurred in



**Figure 2.** Map of Quaternary fossil mammal sites in Venezuela. Falcón State; 1) Cauca; 2) Coro; 3) La Ciénega, Pueblo Nuevo; 4) Cueva del Cerro La Chapa; 5) Muaco; 6) Taima-Taima; 7) Quebrada Cucuruchú; 8) Cueva el Zumbador; 9) Cueva del Miedo. Zulia State; 10) Minas de Guasare-Socuy; 11) El Mene de Inciarte; 12) Cerro Pintado; 13) Cueva de los Huesos; 14) Sierra de Perijá. Mérida State; 15) Llano el Anís. Trujillo State; 16) Agua Viva; 17) Los Guamos. Lara State; 18) La Hundición; 19) El Vano; 20) Carora; 21) Quebrada de Guadalupe; 22) La Cruz, Guardagallos, La Represa, Quebrada del Totumo, Las Faldas, Las Veras, La Rueza; 23) Campo Alegre, Urama; 24) San Miguel; 25) Quíbor; 26) Barbacoas. Cojedes State; 27) Zanja de Lira. Guárico State; 28) Camaguán; 29) San Juan de los Morros; Carabobo State; 30) Río Las Tunitas, Río Los Guayos y Río Guacara. Miranda State; 31) Cueva de Iglesitas. Sucre State; 32) Cueva de los Escorpiones; 33) Caiguire Abajo, Cumanacoa. Monagas State; 34) Mundo Nuevo; 35) El Breal de Orocuá (ORS 16 and ORS 20); 36) Maturín; 37) Cueva del Guácharo. Bolívar State; 38) Minas de Guaniamo. Amazonas State; 39) Sierra de Maigualida (\*D.R.R., pers. obs.).

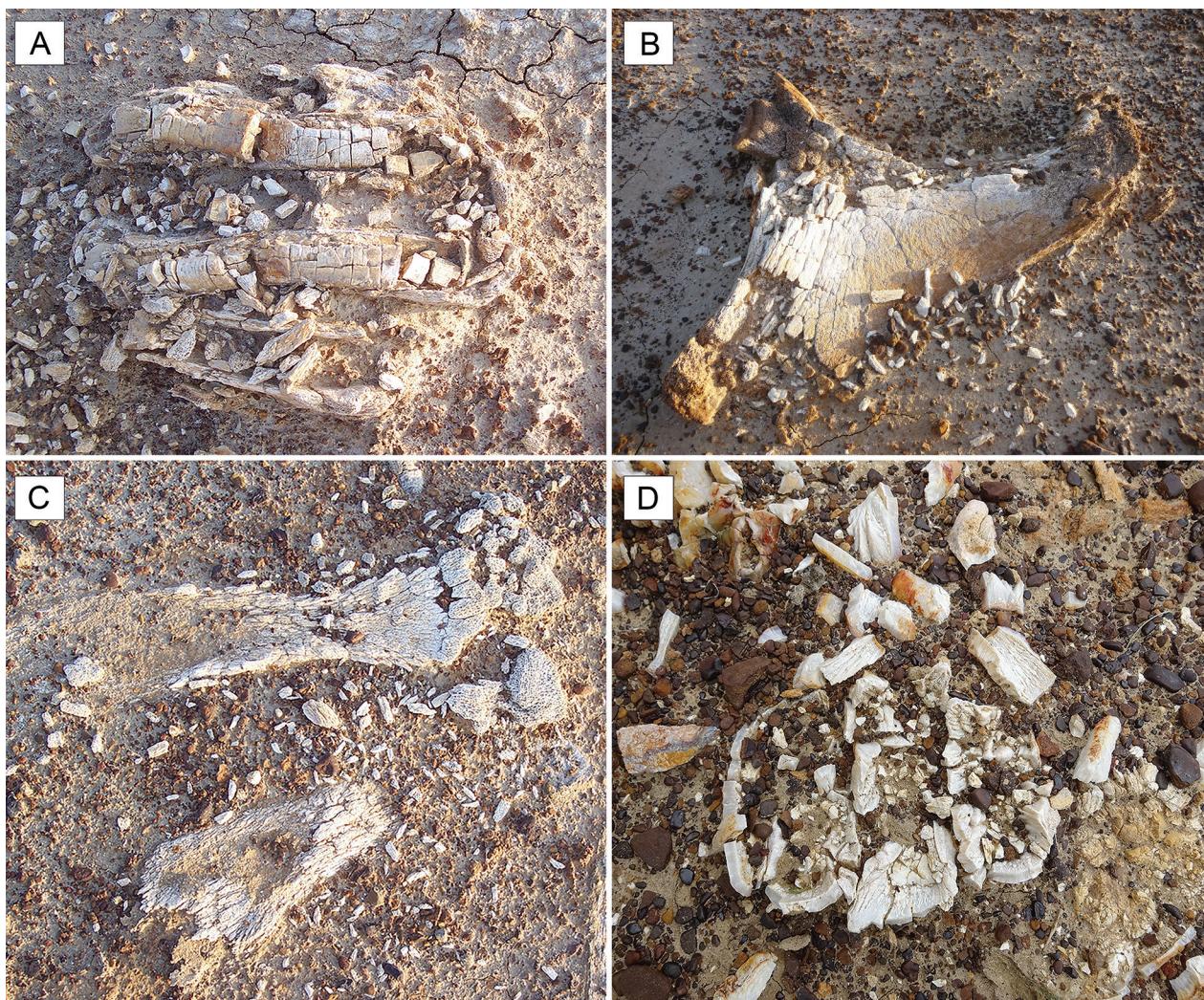
a water-saturated, or intermittent, very low-energy environment, favoured by the low inclination of the terrain ( $\sim 10^\circ$ ). This second layer is the carrier of the bone remains and it could have had a greater thickness, which was likely eroded by laminar erosion, explaining the large amount of fossil bones exposed on the surface. The third layer, or the basal part, is characterised by an ancient relief of slightly more consolidated dark and oxidised sands, in which no remains of vertebrates or other micro/macrofossil organisms have been found.

Most of the bone and dental remains identified on the surface in different surveys (pre-excavation) were practically disintegrated or in a state of fragmentation that did not allow any type of surface rescue (Fig. 3A–C). Possibly, this was because of its exposure to environmental factors for decades before the first survey at the site. In pre-excavation activities, only the relatively complete crown of an M2 molar from a gomphothere and

fragments of equid teeth were recovered on the surface by the authors (J.D.C.B., R.S.) in 2013.

## Referred materials and methods

A total of 41 cranial and postcranial elements of fossil mammals were collected in the Cauca site and deposited in the palaeontological collection of Alcaldía Bolivariana del Municipio Urumaco (AMU-CURS). All fossils outcropping on the surface and in the excavations were treated in situ with consolidation of the Paraloid B72 type diluted to 10% in thinner solvent. Given the high degree of deterioration of the fossil elements, only the remains in the best state of preservation were recovered and transported in plaster jackets (e.g. Fig. 4D). The restoration and preparation of the fossil specimens was carried out in the palaeontology laboratory of the Urumaco Museum.



**Figure 3.** Remains of fossil vertebrates emerging on the surface at the Cauca site. Skull (A), pelvis (B) and appendicular elements (C) of megatheriid *Eremotherium*. A, C. correspond to unexcavated S2 (see Fig. 1B). Upper molars (D) of gomphoteriid *Notiomastodon platensis*, with the root completely eroded, associated with the mandible AMU-CURS-1269 from Cauca “A” (Fig. 1B).

The taxonomic identification involved an extensive bibliographic review and comparisons with fossil and extant specimens housed in: Argentina [Centro Regional de Investigaciones y Transferencia Tecnológica de La Rioja (CRILAR); Museo Argentino de Ciencias Naturales “Bernardino Rivadavia” (MACN); Museo de La Plata (MP)], France [Muséum national d’Histoire naturelle, Paris (MNHN)], México [Instituto Nacional de Antropología e Historia (INAH)], Switzerland [Natural History Museum of Basel (NMB); Palaeontological Institute of the University of Zurich (PIMUZ)] and Venezuela [Centro de Investigaciones Antropológicas, Arqueológicas y Paleontológicas (CIAAP) de la Universidad Experimental Francisco de Miranda (UNEFM), Falcón; Museo de Ciencias de Caracas (MCNC); Museo Geológico Royo y Gómez de la Universidad Central de Venezuela (UCV); Fundación La Salle de Ciencias Naturales, San Carlos, Cojedes State]. Additionally, the material was compared with images shared by collaborators and available on the web (e.g. [www.boneid.net](http://www.boneid.net)).

Most of the fossiliferous localities presented on the map in Fig. 2 are based on the following references: Schaub (1935); Nectario María (1937, 1941); Simpson (1939); Von der Osten (1947); Royo y Gómez (1960); Bocquentin-Villanueva (1979, 1982); Ochsenius (1980); Linares (1983); Linares and Bruni (1993); Odreman (1997); Aguilera (2006); Rincón et al. (2006, 2021); Prevosti and Rincón (2007); Rincón and White (2007); Carrillo-Briceño et al. (2008a, 2016); Chávez-Aponte et al. (2008a, 2008b); Chávez-Aponte and Carrillo-Briceño (2012); Ruiz-Ramoni et al. (2013, 2022); Carrillo-Briceño (2015); Solórzano et al. (2015); Steadman et al. (2015); Ruiz-Ramoni (2016); Meneses and Gordones (2021); Chávez-Aponte (2022); Jaimes et al. (2024b) and references therein. Names of localities referred to with (\*) in Fig. 2 are mentioned here for the first time.

Anatomical and measurement abbreviations. (**mf**) lower molariforms, (**Mf**) upper molariforms, (**m**) lower molar, (**M**) upper molar, (**Tl**) total length.



**Figure 4.** Excavations at the Cauca site. Cauca “A” (A), Cauca “B” (B), and Cauca “E” (C), showing the defence of *Notiomastodon platensis* (AMU-CURS-1359) *in situ*. Mandible of *N. platensis* in plaster jacket in Cauca “A” (D). Cauca “D” with remains (tibia and ribs) of cf. *Eremotherium laurillardi* (E).

### Radiocarbon dating of the Cauca site

Two dental fossil samples were selected for radiocarbon dating (Table 1). The dated material comes from a *Notiomastodon platensis* mandible (AMU-CURS-1269) found in excavation Cauca “A” and an isolated tooth of *Equus* sp. (AMU-CURS-1365), found in the vicinity of the latter (Fig. 1B). Both specimens correspond

stratigraphically to the most superficial or exposed part of what we recognise here as the second layer.

In the absence of bone collagen, tooth enamel was selected from these two fossils. The enamel surface was cleaned and the dentine was removed with a dremel to isolate the enamel from the rest of the dental tissue. The enamel (approx. 2 g) was then ground using a steel mortar and pestle, followed by grinding in an agate mortar to a

**Table 1.** Measured and calibrated  $^{14}\text{C}$  ages of the fossil samples from Cauca.

| Sample id                     | species                        | $^{14}\text{C}$ age | Error | Target ID | Cal BP (95.4% proba) |
|-------------------------------|--------------------------------|---------------------|-------|-----------|----------------------|
| Cauca 3-23-2<br>AMU-CURS-1269 | <i>Notiomastodon platensis</i> | 33750               | 350   | 5545.1.1  | 39584 37540          |
| Cauca 4-21<br>AMU-CURS-1365   | <i>Equus</i> sp.               | 37050               | 500   | 5547.1.1  | 42310 41175          |

particle size of < 100 microns. The powder was then further ground using a McCrone Microniser Retsch following the methodology described in Wood et al. (2016). Briefly, this approach enables better separation of crystallite clusters and increases the efficiency of the acetic acid pre-treatment aimed at removing diagenetic carbonates. To achieve this, the powder was ground three times for 10 min, with a 5 min pause between each stage to avoid heating. For some samples, part of the hand-milled fraction (< 100 microns) was retained for comparison with the conventional pre-treatment approach. The resulting powder was pre-treated under light vacuum for 20 h with a solution of 1 N acetic acid (1 ml acetic acid for approx. 50 mg powder). The extraction yields were comprised between 70–80%. The pre-treated powder was then rinsed with milliQ water and dried at 50 °C in an oven. About 250 mg of powder was then reacted under vacuum with orthophosphoric acid at 70 °C for around 20 min. The  $\text{CO}_2$  released was then separated cryogenically from the water produced and chemically purified, thanks to several passages through a trap filled with a copper-silver wool mixture. The  $\text{CO}_2$  gas was then reduced in the presence of hydrogen and iron to produce graphite. Samples were then pressed into targets and  $^{14}\text{C}$  ages were measured on the compact AMS ECHoMicadas (Archéozoologie, Archéobotanique, Sociétés, Pratiques et Environnements, Equipe SAPOA, France).

## Results

### Faunistic assemblage

Five mammal taxa are reported here, including three xenarthrans, one proboscidean, an equid and a felid. Other fragmentary and no diagnostic elements are referred to here as indeterminate mammals.

**Xenartha Cope, 1889**

**Phyllophaga Owen, 1842**

**†Megatheriidae Gray, 1821**

**†Eremotherium Spillmann, 1948**

**†cf. *Eremotherium laurillardi* (Lund, 1842)**

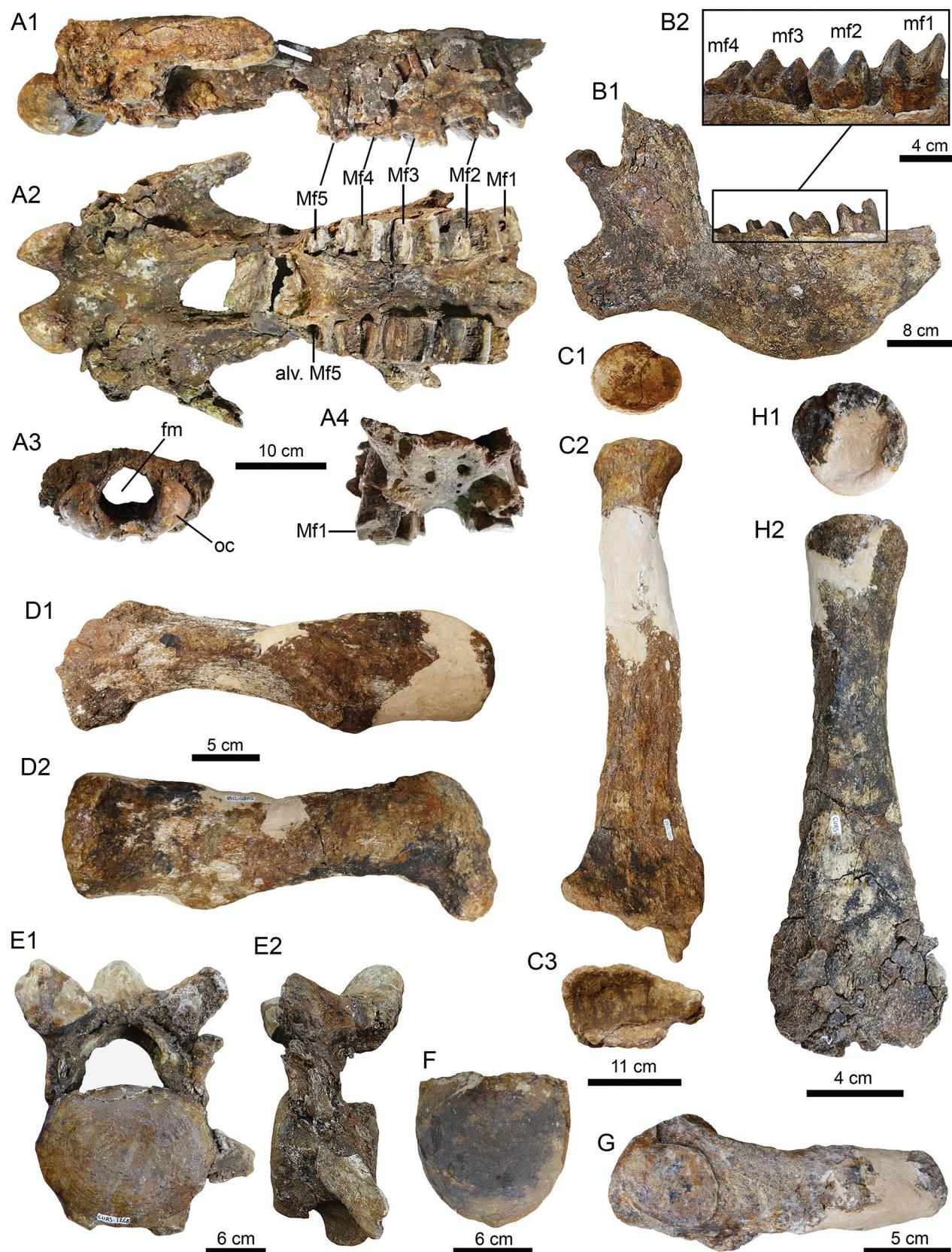
Fig. 5

**Referred material.** Remains of *Eremotherium* cf. *E. laurillardi* have been recovered at the Cauca site in bone groupings 2–6, with only groupings 3–5 being excavated (Fig. 1B). Fourteen cranial and postcranial remains that include a right hemi-mandible (with mf 1 to 4), skull (with right Mf 1 to 5 and left Mf 2 to 4), right clavicle, right radius, presumably left navicular, cuneiform, IV left

metatarsal, a worn element that we presume corresponds to a scaphoid, fragment of pelvis with acetabulum and part of the pubic ramus and five incomplete vertebrae, from excavation Cauca “B” (Fig. 4B) and assigned to catalogue number AMU-CURS-1268. A probable right tibia (AMU-CURS-sn) and seven rib fragments were found in Cauca “D”. The other cranial and postcranial elements identified in Cauca “C” and unexcavated groupings 2 and 6 were not collected due to their poor state of preservation, being in some cases disintegrated (Fig. 3A–C).

**Descriptions.** The 14 disarticulated cranial and postcranial elements recovered in Cauca “B” most probably belong to the same individual (AMU-CURS-1268). The cranial material is composed of only the skull (AMU-CURS-1268a) (Fig. 5A1–A4) and the right hemi-mandible (AMU-CURS-1268b) (Fig. 5B1, B2). The skull has a TL of 580 mm and preserves only the palatal section, since part of the cranial vault, nasal bones and part of the maxilla bones were destroyed by erosive processes. The palatal section is relatively well preserved, with both the right Mf1–Mf5 and the left series Mf2–4 and the alveolus of left Mf1 and Mf5. The hemi-mandible has a TL of 450 mm, preserving the four molariforms mf1–mf4 (Fig. 5B2). This hemi-mandible has a convex ventral margin and projects downwards at the level of the first molars, forming a moderate mandibular protuberance. The molariforms preserved in the skull and hemi-mandible are of quadrangular section with crowns characterised by two transverse and parallel ridges, separated by a “V”-shaped valley. Measurements of the molariforms are presented in Table 2. Associated with these cranial remains were recovered the right clavicle with a TL of 240 mm (AMU-CURS-1268c; Fig. 5D1, D2), complete right radius with a TL of 700 mm (AMU-CURS-1268d; Fig. 5C1–C3), presumably left navicular (AMU-CURS-1268e), cuneiform (AMU-CURS-1268f), IV left metatarsal (AMU-CURS-1268g; Fig. 5G), a worn element that we presume corresponds to a scaphoid (AMU-CURS-1268h), fragment of pelvis with the acetabulum and part of the pubic ramus (AMU-CURS-1268i) and five incomplete vertebrae (AMU-CURS-1268j–n; Fig. 5E1–F). Other small, fragmented and indeterminate bone elements were observed during the excavation and presumably could be associated with the same individual.

In Cauca “C”, only a few remains of postcranial elements of an *Eremotherium*, were found emerging on the surface. These were identified as vertebrae, ribs, pelvis fragments and other small indeterminate fragments. However, the poor state of preservation and disintegration in some cases, did not allow their recovery. Due to the proximity of these materials to the individual collected in Cauca “B”, a possible association amongst them is not ruled out here. In Cauca “D”, an association of seven fragments of ribs



**Figure 5.** Megatheres (A1–G) and mylodontids (H1, H2) from the Cauca site. A1–A4. Skull of cf. *Eremotherium laurillardi* (AMU-CURS-1268a) in right lateral, ventral, posterior and anteroventral view; B1, B2. Right hemi-mandible (AMU-CURS-1268b) in right lateral view; C1–C3. Right radius (AMU-CURS-1268d) in proximal, dorsal and distal view; D1, D2. Right clavicle (AMU-CURS-1268c); E1, E2. Thoracic vertebra (AMU-CURS-1268j) in anterior and left lateral view; F. Thoracic or lumbar vertebral centrum (AMU-CURS-1268k) in anterior view; G. Left IV metatarsal (AMU-CURS-1268g); H1, H2. cf. Mylodontidae, proximal and dorsal right radius (AMU-CURS-1363). Abbreviations: (alv.) alveolus, (fm) foramen magnum, (mf) lower molariform, (Mf) upper molariform, (oc) occipital condyle.

**Table 2.** Dental measurements of cf. *Eremotherium laurillardi* (AMU-CURS-1269a, b) collected at the Cauca site. Abbreviations: upper molariform (Mf), lower molariform (mf), right (d), left (i). (\*): incomplete or missing pieces. Measures in millimeters.

|        | Mfr1 | Mfr2 | Mfr3 | Mfr4 | Mfr5* | Mfl1 | Mfl2 | Mfl3 | Mfl4 | Mfl5* | mfr1 | mfr2 | mfr3 | mfr4 |
|--------|------|------|------|------|-------|------|------|------|------|-------|------|------|------|------|
| Long   | 25   | 35   | 35   | 35   | 20    | 25   | 35   | 35   | 37   | 20    | 40   | 40   | 40   | 30   |
| Width  | 36   | 50   | 47   | 40   | 25    | 35   | 45   | 47   | 40   | 15    | 44   | 45   | 42   | 40   |
| Height | 40   | 32   | 22   | 10   | 5     | 10   | 10   | 27   | 20   | —     | 40   | 30   | 10   | 10   |

and a right tibia were recovered, also in a poor state of preservation (Fig. 4E). This bone accumulation is located about 8 m north of the Cauca “B” individual, so a possible association with the latter would not be unlikely.

Bone grouping 2 (Fig. 1B) was not excavated due to the partial or total disintegration in very little scraps of bones of the outcropping materials. However, a skull in a state of fragmentation (Fig. 3A) still offers evidence that allows us to identify this association as a second specimen of *Eremotherium*. In bone grouping 6 (not excavated) to the northwest of Cauca “D”, a humerus of *Eremotherium* was also identified, but its poor state of preservation prevented collection or conservation *in situ*.

**Remarks.** The ground sloth *Eremotherium laurillardi* distributed from south-eastern USA to Brazil, is the only species of the genus known from the Late Pleistocene in the Americas (Cartelle and De Iuliis 1995). The taxonomic validity of *Eremotherium rusconi* Schaub, 1935, another species from the Late Pleistocene of South America, is questionable (Cartelle and De Iuliis 1995; Faure et al. 2014; Cartelle et al. 2015).

Remains referable to *Eremotherium* are common and widely referred to in the Pleistocene fossil record of Venezuela (e.g. Schaub (1935); Simpson (1939); Nectario Maria (1941); Aguilera (2006); Carrillo-Briceño (2015); Carrillo-Briceño et al. (2016); Chávez-Aponte (2022) and references therein); specific taxonomic assignments of many of these specimens are still uncertain and should be clarified.

Remains assigned to cf. *Eremotherium laurillardi* have been reported in Venezuelan territory in palaeontological and archaeological sites ranging from sea level (e.g. Muaco, Taima-Taima and Cucuruchú; see Aguilera (2006); Carrillo-Briceño (2015); J.D.C.B pers. obs. (2022)), to mountain areas above 1200 m (e.g. El Vano; Jaimes et al. (2024b)).

The cranial and postcranial materials of *Eremotherium* collected from Cauca likely belong to an adult individual. The assignment of these specimens to the genus *Eremotherium* is based on the Hypsodontic index (HI) known for ground sloths. According to Bargo et al. (2006), HI is an element that is quantified by using the depth of the mandible (DM) (below the third molariform tooth) divided by the length of the molariform tooth row (LTR). In the right hemimandible collected in Cauca “B” (AMU-CURS-1268b), the DM is 140 mm and the LTR is 180 mm, with a resulting IH equal to 0.77, a value that coincides with *Eremotherium* whose range oscillates between 0.73 and 0.83 (De Iuliis 1996; Bargo et al. 2006). Based on the taxonomic validity of the Late Pleistocene *Eremotherium* species suggested by Cartelle and De Iuliis (1995) and Cartelle et al. (2015), we tentatively suggest assigning the specimens collected at the Cauca site as cf. *Eremotherium laurillardi*.

## †Mylodontidae Gill, 1872

### cf. Mylodontidae

Fig. 5

**Referred material.** The right radius (AMU-CURS-1363) collected in Cauca “B” (Fig. 4B).

**Descriptions.** The AMU-CURS-1363 radius is incomplete in its distal part and has a TI of 430 mm (Fig. 5H1, H2). This specimen differs in dimensions and morphology with reference to the left radius of cf. *Eremotherium laurillardi* (AMU-CURS-1268d; Fig. 5C1–C3) found in the same excavation. AMU-CURS-1363 is proportionally thicker and shorter compared to Megatheriidae and Megalonichyidae (e.g. McAfee (2007)), being narrow at the proximal end and laterally expanded at the distal end, which is fragmented and deteriorated. The proximal articular head is concave, narrow, and semicircular with a maximum diameter of 40 mm. The axes are relatively straight, and a prominent laterally expanded pronator ridge is not observed, as occurs in Scelidotherinae and some Lestodontinae. These characteristics lead us to consider AMU-CURS-1363 as belonging likely to a mylodontid (Mylodontinae) indet.

**Remarks.** The incompleteness and state of preservation of AMU-CURS-1363 does not allow for a more precise taxonomic determination. Mylodontid remains reported for the Late Pleistocene of Falcón State come from the Muaco and Taima-Taima sites and some of these have been referred to as *Glossotherium tropicorum* Hoffstetter, 1952, by Bocquentin-Villanueva (1979), Aguilera (2006) and Carrillo-Briceño (2015); although De Iuliis et al. (2017) noted that those specimens from Falcón appear to be distinct from the *G. tropicorum* material known from Ecuador and Peru. A taxonomic re-evaluation of the *Glossotherium* materials found in Falcón, as well as in other regions of Venezuela (Carrillo-Briceño 2015; Chávez-Aponte 2022), would be relevant for new clues about the stratigraphic range and geographic distribution of the three valid species of *Glossotherium* recognised for the Pleistocene of South America (see Cartelle et al. (2019)).

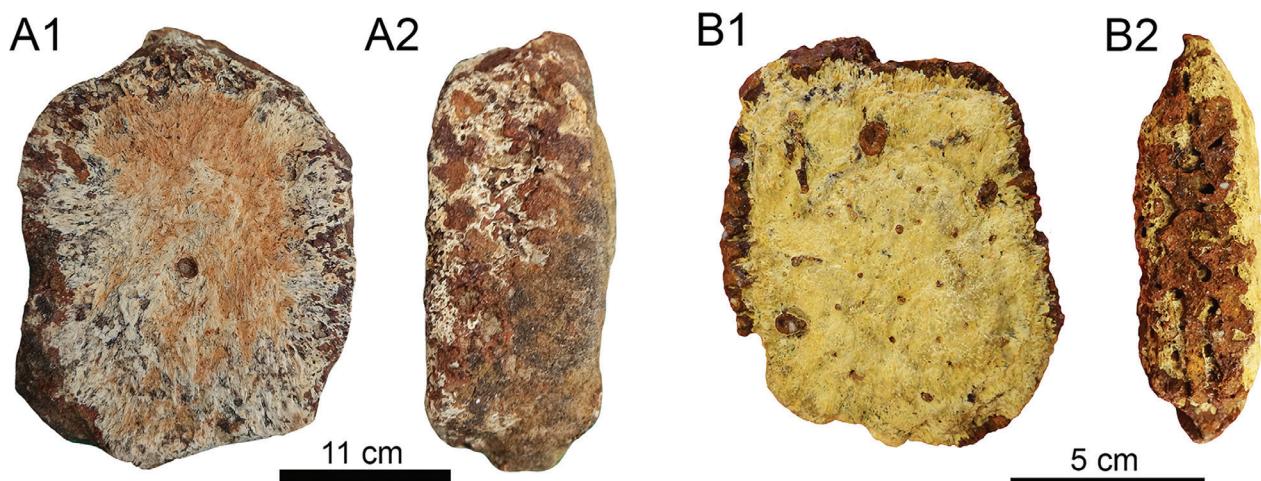
## Cingulata Illiger, 1811

### †Glyptodontidae Gray, 1869

### †Glyptodontidae indet.

Fig. 6

**Referred material.** Two isolated osteoderms (AMU-CURS-1047 and -1360) were collected on the surface at the Cauca site (Fig. 1B).



**Figure 6.** Indeterminate Glyptodontidae osteoderms from Cauca site. **A1, A2.** AMU-CURS-1047; **B1, B2.** AMU-CURS-1360; both in external and transversal view.

**Descriptions.** Both isolated osteoderms are from the shell. AMU-CURS-1047 has a Tl of 47 mm and is eroded on both the internal and external faces, which does not allow the identification of the ornamentation pattern (Fig. 6A1, A2). AMU-CURS-1360 possibly corresponds to an osteoderm from the anterior lateral region of the shell and this has a Tl of 31 mm; it is also eroded on the inner face, and partially preserving the ornamentation of the outer face with a central figure of irregular polygonal shape, preserving some foramina that could belong to hair follicles and surrounded by a groove (Fig. 6B1, B2).

**Remarks.** The state of preservation of these two osteoderms does not allow a more precise taxonomic determination than Glyptodontidae, Glyptodontinae. However, these osteoderms could belong to the genus *Glyptotherium*, widely known in the Late Pleistocene of the Falcón State, especially at the sites of Muaco and Taima-Taima (Carlini et al. 2008, 2022). A recent report suggests that these *Glyptotherium*-related armadillos had a broader distribution in what is now Venezuela during the Late Pleistocene, with reports including mountain areas above 1200 m altitude (see Jaimes et al. (2024b)).

#### Proboscidea Illiger, 1811

†*Gomphotheriidae* Hay, 1922

†*Notiomastodon* Cabrera, 1929

†*Notiomastodon platensis* (Ameghino, 1888)

Fig. 7

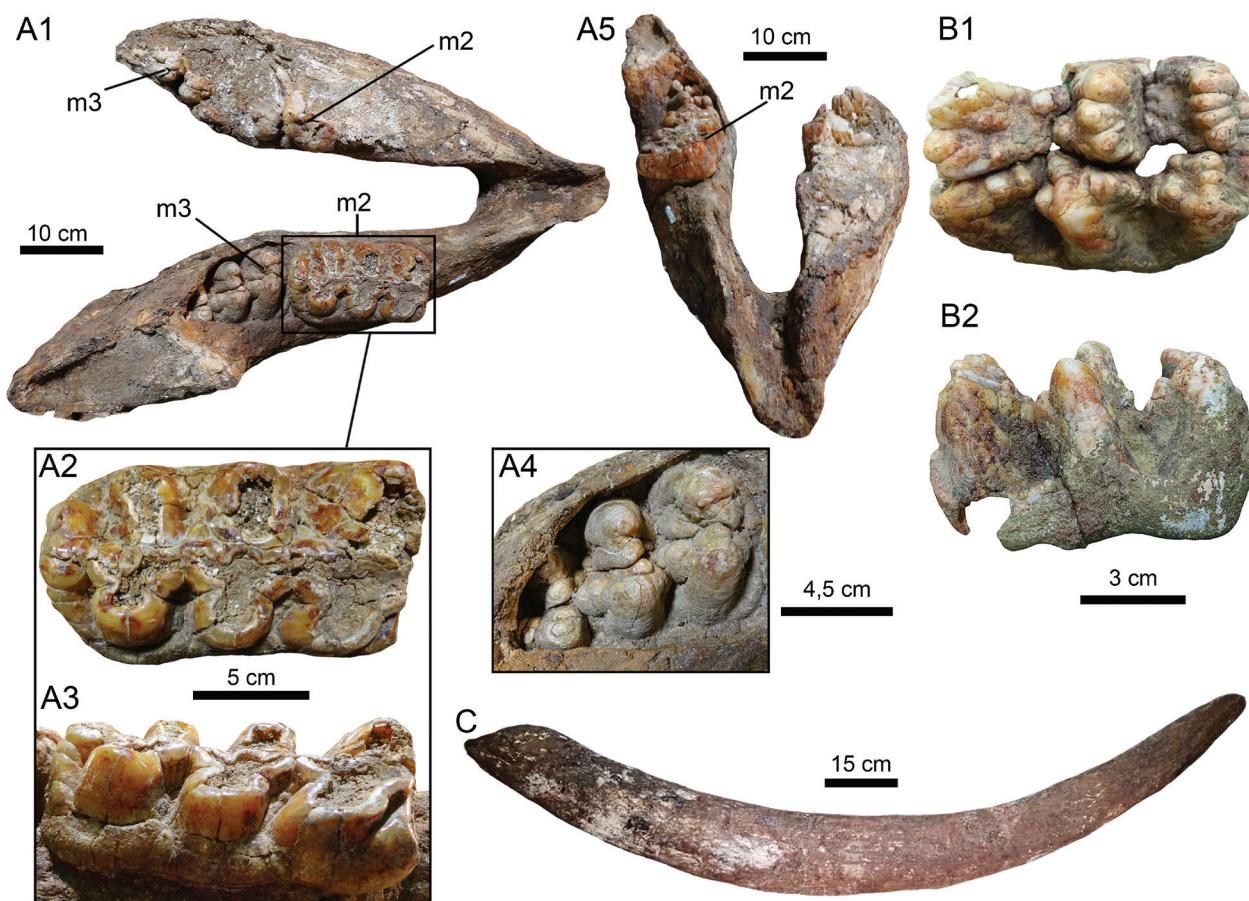
**Referred material.** A mandible (Fig. 7A1), the proximal part of a humerus and the distal end of the radius with what appears to be parts of very deteriorated carpals and metacarpals, all assigned as AMU-CURS-1269 and collected from Cauca “A” (Fig. 4A). An isolated M2 (AMU-CURS-1045) collected about 5 m northwest of Cauca “C” (Fig. 1B) and a complete and isolated tusk (AMU-CURS-1359) (Fig. 7C) from Cauca “E” (Fig. 4C).

Other dental and postcranial fragments (see below) in a very poor state of preservation could not be collected.

**Descriptions.** The mandible AMU-CURS-1269 (Fig. 7A1) preserves the complete right m2 (Fig. 7A1–A3, A5) and erupted m3 (Fig. 7A1, A4) and erupted left m2 and m3 in a fragmentary state (Fig. 7A1, A5). Part of the mandibular ramus and condylar processes are not preserved. The right m2 is a bunodont and trilophodont molar with a well-defined heel and cingulum (Fig. 7A2, A3); it is 150 mm in Tl. This molar presents a wear state of “3” (following Mothé et al. (2010)), which suggests that it could correspond to a subadult/adult individual. Abundant fragments referring to upper molars M2–M3 of the same individual were recovered on the mandibular remains (Fig. 3D). A small portion of a tusk was also found a few centimetres from the specimen, which was not collected due to the high degree of disintegration. Of the postcranial remains associated with the lower jaw, the proximal part of a right humerus is only preserved in the posterior section and what appears to be the distal end of the radius with carpal and metacarpal fragments are in a very poor state of preservation.

The isolated tusk AMU-CURS-1359 (Fig. 7C), whose position on the skull is undetermined, measures about 1700 mm long and could belong to an adult. It is curved, although it shows no apparent natural twist and lacks an enamel band. The tusk lies about 14 m north of the Cauca “A” site and its association with the jaw and the other elements is uncertain. Near the collection site of this tusk and on the surface, some fragmented and indeterminate postcranial bones were observed.

A few metres northeast of the Cauca “D” and “E” excavations, a tusk and bone fragments were found emerging on the surface. However, these were not collected due to the poor state of preservation (grouping 7; Fig. 1B). In addition, small fragments of gomphotherid molars were scattered on the surface of the site, possibly because of transport by runoff. A possible upper left M2 (AMU-CURS-1045) not worn and with ~ 96 mm in Tl



**Figure 7.** *Notiomastodon platensis* remains from Cauca site. **A1, A5.** Dorsal and anterodorsal views of the mandible (AMU-CURS-1269); **A2, A3.** Occlusal and labial views of preserved right m2 and (A4), occlusal view of m3; **B1, B2.** Occlusal and lateral view of M2 (AMU-CURS-1045). **C.** lateral view of tusk (AMU-CURS-1359).

(Fig. 7B1, B2), was collected a few metres northeast of excavation “C”, suggesting the probable presence of a juvenile individual at the site. On the other hand, we do not have any evidence that allows us to associate the cranial and dental remains found in Cauca “A”, with the other gomphothere elements reported herein, resulting in an uncertain number of adult individuals present at the site.

**Remarks.** In recent times, consensus has emerged suggesting the validity of only two genera of gomphotheres in the southern continent, *Cuvieronius hyodon* Fischer, 1814 and *Notiomastodon platensis* (= *Stegomastodon platensis*) (e.g. Mothé et al. (2012, 2013, 2017a); Alberdi and Prado (2022)). The stratigraphic and geographic distribution, as well as the diagnostic features that have been used to differentiate both genera, which are based on the skull and mandibular symphysis morphology and upper tusk and molars, are discussed in detail by Mothé et al. (2016, 2017a, 2017b), Alberdi and Prado (2022) and Carrillo-Briceño et al. (2023).

Based on the taxonomic differences mentioned above and used to differentiate both genera of gomphotheres in South America, we assigned the better-preserved specimens referred to in this section to *N. platensis*. This assignment is supported by: 1) the double to

single clover wear pattern present in the right m2 of the AMU-CURS-1269 (Fig. 7A2), which resembles the pattern present in molars with advanced wear state in *N. platensis* (e.g. Mothé et al. (2012, 2013, 2017a) and references therein); 2) the robustness, curved shape and lack of twist and enamel bands in the tusk AMU-CURS-1359 (Fig. 7C), which contrast with the shape and morphology of the *C. hyodon* tusk (Mothé et al. 2012, 2013; Mothé and Avilla 2015); and 3) a jaw with no trace of lower tusks; meanwhile, *C. hyodon* presents a pair of lower incisors or its corresponding vestigial alveoli (Mothé and Avilla 2015). By analogy, we believe the other remains of gomphotheres found at the Cauca site (e.g. tooth fragments and probably postcranial elements), and with a poor state of preservation (for example these from grouping 7) could also belong to *N. platensis*.

Abundant specimens of gomphotheres have been reported for several locations in the Falcón State and other sites in Venezuela (Carrillo-Briceño et al. 2008a, 2008b; Chávez-Aponte et al. 2008; Carrillo-Briceño 2012, 2015); however, their taxonomic assignment should be re-evaluated. The gomphothere remains collected from the palaeontological/archaeological sites of Muaco, Taima-Taima and Cucuruchú in Falcón State, should be assigned to *N. platensis* (e.g. J.D.C.B., pers. obs. (2022)).

**Perissodactyla Owen, 1848****Equidae Gray, 1821*****Equus* Linnaeus, 1758*****Equus* sp. and Equidae indet.**

Fig. 8

**Referred material.** The equid material corresponds to isolated dental elements collected on the surface of the second layer (Fig. 1B) and is represented by a complete m3 (AMU-CURS-1365) and another five molar fragments (AMU-CURS-523: n = 2, and AMU-CURS-1046: n = 3).

**Descriptions.** The left m3 AMU-CURS-1365 is almost complete, only missing part of the mesial surface (Fig. 8A1). The occlusal surface of the m3 is relatively well preserved with a length of 28 mm and it is characterised by a subtriangular protoconid, an oval hypoconid, a metaconid and metastylid forming a more rounded double knot, an oval postflexid and the presence of a well-defined pli caballinid fold. The rest of the five fragments could belong to both upper and lower molars; however, the poor state of preservation of these prevents a more detailed taxonomic identification.

**Remarks.** The occlusal pattern, present in the m3 with a subtriangular protoconid, an oval hypoconid and the presence of a pli caballinid fold, can likely be associated more with *Equus* than *Hippidion* Owen, 1869 (see Prado and Alberdi (2017); Carrillo-Briceño et al. (2023) and references therein). The poor state of preservation of the other dental elements does not allow them to be assigned beyond Equidae for now.

For the Pleistocene of Falcón State, equid remains assigned to *Equus neogeus* Lund, 1840 and *Equus santaelenae* Spillmann, 1938, have been reported for the sites of Muaco, Taima-Taima, Cucuruchú and Quebrada Ocando (Royo and Gómez 1960; Aguilera 2006; Rincón et al. 2006). Other reports of fossil equids from Venezuela have also been referred to by Rincón et al. (2006) and Carrillo-Briceño (2015).

Prado and Alberdi (2017), based on an extensive review of the morphological and morphometric characters of cranial and postcranial elements of fossil horses from South America, recognise only three species as valid (e.g. *E. andium*, *E. insulatus* and *E. neogeous*). Machado and Avilla (2019) questioned the diagnoses and taxonomic validity of the three valid species proposed by Alberdi and Prado (2017), suggesting the possibility of a single *Equus* species of South America which should be recognised as *E. neogeous*. In the case of our specimens, only the m3 AMU-CURS-1365 is likely associated here with *Equus*; despite this, until now, as there is no consensus on the taxonomy of the valid *Equus* species of South America and the lack of more diagnostic characters in our specimen, it is appropriate to keep this assignment tentatively as *Equus* sp.

**Carnivora Bowdich, 1821****Felidae Fischer, 1817****Felinae Fischer, 1817****cf. *Leopardus pardalis* (Linnaeus, 1758)**

Fig. 8

**Referred material.** A right astragalus (AMU-CU-RS-1361; Fig. 8B1–B3). This specimen was collected, exposed on the surface about six metres south of the Cauca “A” excavation (Fig. 1B) and we believe that it also comes from the upper part of the second layer that has been affected by laminar erosion. The preservation of the astragalus is good, except for partial erosion of the fibular facet and the distal end of the lateral lip of the trochlea that is broken.

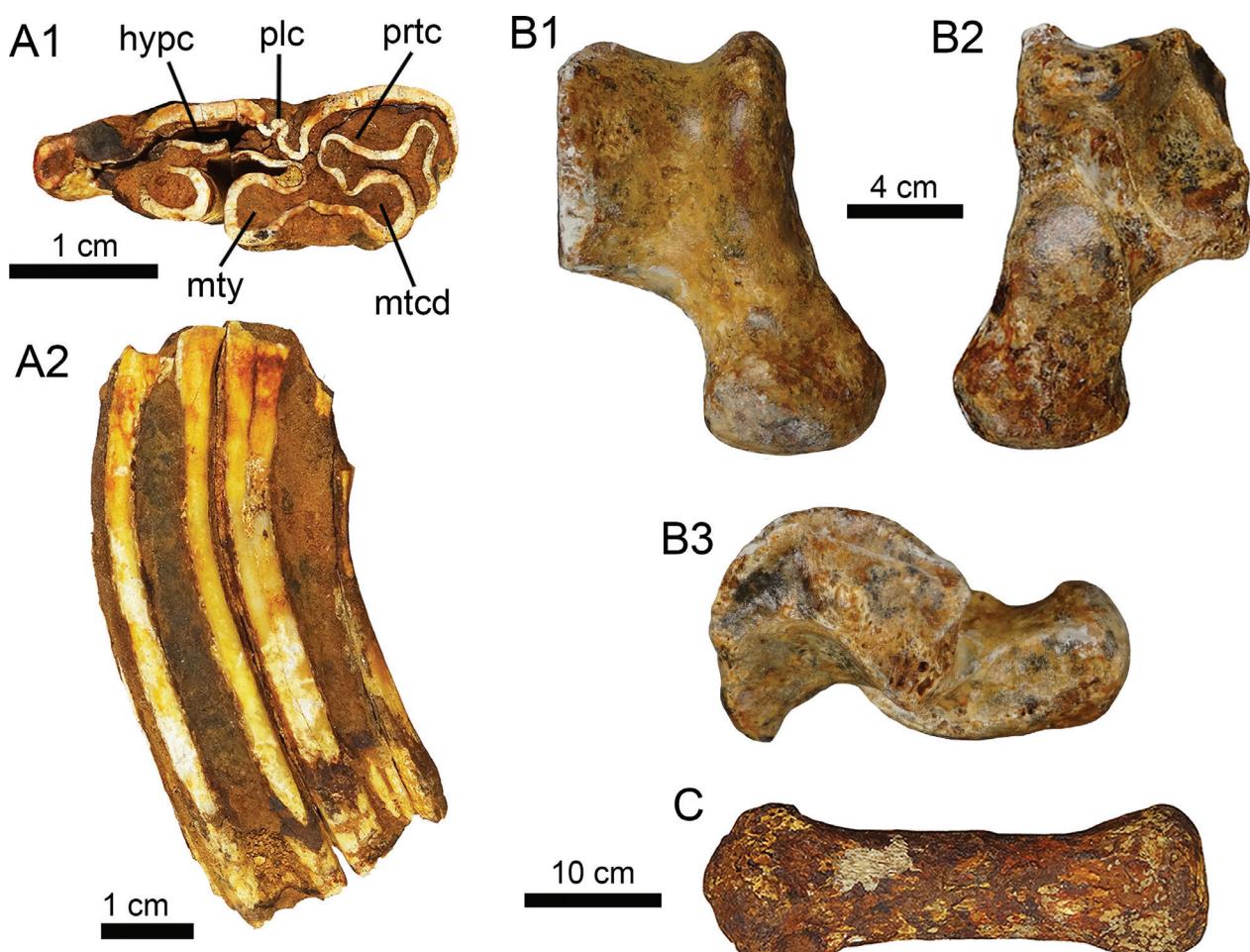
**Description.** AMU-CURS-1361 has a maximum length of 23.23 mm and a maximum width at the trochlea of 12.59 mm, which corresponds to a medium-sized mammal. The astragalus head is projected distally, but its media border is more displaced medially than the trochlea. The head is wide and, in the distal view, it has an elliptical shape that is slightly inclined medially. The trochlea is well-marked, with a sharp medial lip and a laterally inclined lateral lip. It differs from that of canids in that the trochlea is less excavated, the head is less inclined and not subtriangular in shape in the distal view. Canids have a bony shelf distal to the trochlea that connects with the neck of the head, which is not present in the AMU-CURS-1361, in felids and other carnivorans. Other carnivorans, like procyonids and mustelids, have a different astragalus shape, with a flatter trochlea and a wider and rounded head that is more medially directed. Although we did not observe diagnostic features at the genus level in the context of medium-sized felines in the astragalus, AMU-CURS-1361 exhibits a morphology resembling *Leopardus pardalis* and *Lynx rufus* Schreber, 1777.

**Remarks.** We note some differences between AMU-CURS-1361 and *Lynx rufus*. In the revised specimens of the bobcat (INAH 7776; NMB 6111; and one at BonelD.net), the head of the astragalus is proportionally shorter and the distal border of the sustentacular facet is interrupted by a sharp incision. These features were also observed in some individuals of *Leopardus pardalis* (e.g. MACN-Ma 30866), while in other *Le. pardalis*, this facet contacts the navicular facet (e.g. MACN-Ma 27888, 30695 and 30698). Thus, based on the size and shape of the astragalus, AMU-CURS-1361 has a greater morphological affinity with *Le. pardalis* than with *Ly. rufus*, but given the small size of the comparison sample, it is not possible to make a more precise taxonomic conclusion.

**Mammalia indet.**

Fig. 8

**Note.** A bone of the foot of an indeterminate mammal (Fig. 8C) with a Tl of 30 mm (AMU-CURS-1362) was collected on the surface about three metres north of



**Figure 8.** Equids, felids, and indeterminate mammals from Cauca site. **A1, A2.** Left m3 of *Equus* sp. (AMU-CURS-1365) in occlusal and labial view; **B1–B3.** Right astragalus of cf. *Leopardus pardalis* (AMU-CURS-1361) in dorsal, plantar and lateral view; **C.** A bone of the foot of an indeterminate mammal (AMU-CURS-1362). Abbreviations: (hypc) hypoconid, (mtcd) metaconid, (mty) metastyliid, (plc) pli caballini fold, (prtc) protoconid.

Cauca “A”. The state of preservation of the specimen is poor and it lacks diagnostic elements that do not allow a more precise taxonomic determination.

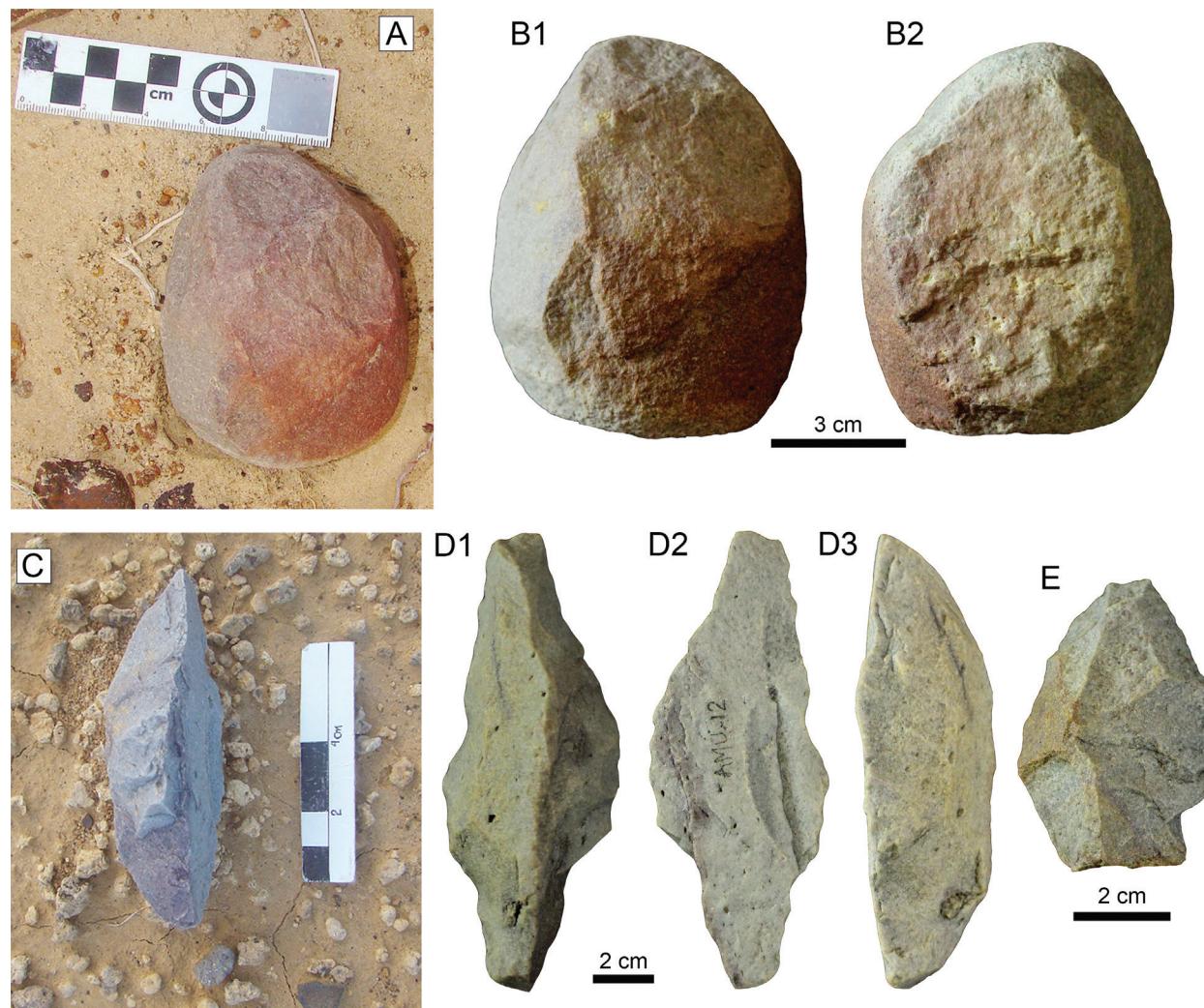
#### Dating of the Cauca Site

Radiocarbon age of  $33750 \pm 350$  and  $37050 \pm 500$  BP were obtained from teeth of *Notiomastodon platensis* and *Equus* sp., respectively. Results were then calibrated using OxCal 4.4 (Bronk Ramsey 2009) and indicate that the *Notiomastodon* is 37.5–39.5 ka cal. BP and that the *Equus* is 41.3–42.3 ka cal. BP. These dates are amongst the oldest dates ever produced on bioapatite (see Cherkinsky (2009)) and are close to the limit of the radiocarbon dating technique. It is important to note here that these are minimum ages because diagenesis makes bioapatite samples look younger due to carbon isotope exchange between soil dissolved carbonates and bone carbonate (Zazzo and Saliège 2011; Zazzo 2014). It is, thus, very likely that these samples are older than 40 ka.

#### Lithic artefacts and early human evidence in the area

Preformatted lithic artefacts, on the surface and without evidence of discrete accumulations, were in the adjacent areas of the Cauca “B–D” excavations (Fig. 1B). None of these artefacts was recovered in direct association with the bone materials in the fossil-bearing stratum or layer. These artefacts are represented by a chopper (AMU-12-1; Fig. 9A–B2), a planoconvex scraper (AMU-12; Fig. 9C–D3) and three flakes or lithic debris (AMU-12-2; Fig. 9E).

Between 100 and 150 m northeast of the Cauca excavation site, we have found a relatively flat area with the presence of abundant preformatted lithic artefacts on the surface. The carrier layer corresponds to unconsolidated fine to coarse sand facies of light brown and ochre colour that underlie palaeodunes. This area and its surroundings have been prospected by members of our team since 2019 and, in it, we have collected at least three different typologies of lithic projectiles that include El Jobo, Clovis and Fish Tail technologies, amongst other lithic artefacts (Jaimes et al. 2024a). However, so far, we do not have



**Figure 9.** Lithic artefacts found in the vicinity of the excavations at the Cauca site (see Fig. 1B). **A, C.** *in situ* artefacts. Chopper (AMU-12-1; **B1, B2**), planoconvex scraper (AMU-12; **D1–D3**) and flake (AMU-12-2; **E**).

precise evidence that allows us to put this diversity of lithic technologies around the Cauca site in a chronological and stratigraphic context or in any relationship with the megafauna reported for the place.

According to Jaimes et al. (2024a), the contemporaneity of these three projectile typologies in the surroundings of Cauca in such a small area remains an uncertainty and their presence there could probably be due to erosion/laminar washing of the most overlying layers which may have generated decanting and mixing of artefacts corresponding to different antiquities. There is no doubt that the site of Cauca and its surroundings have been subjected to these processes of laminar erosion and this could be inferred by the flat characteristics of the terrain and the almost null evidence of transportation shown by both the fossils and the lithic artefacts (Jaimes et al. 2024a).

## Discussion

Prospecting and excavations in Cauca have resulted in a varied association of fossil mammals represented by South American natives, such as megatheres (cf. *Eremotherium*

*laurillardi*), an indeterminate mylodontid and a glyptodont (probably related to *Glyptotherium*) and Nearctic representatives, such as gomphotheres (*Notiomastodon platensis*), equids (*Equus* sp.) and a feline (*Felidae* cf. *Leopardus pardalis*), expanding the geographic distribution of some taxa.

Megaherbivores reported for the Cauca site such as megatheres, glyptodontids, gomphotheres and equids, have also been widely referred to in the Pleistocene fossil record of Venezuela, with distributions that cover a large part of the national territory, from sea level to almost 2000 m above sea level and even south of the Orinoco River (see Linares and Bruni (1993); Carrillo-Briceño et al. (2008a, 2008b); Carrillo-Briceño (2015); Chávez-Aponte (2022); see Fig. 2). The sympatry amongst megaherbivores in Cauca (i.e. *Notiomastodon* and *Eremotherium*) also characterises other sites in Venezuela, including some in the Cordillera de Mérida (Simpson 1939), the basin of Lake Valencia (Del Valle and Salazar 2009) and the sites of Taima-Taima, Muaco and Cucuruchú in Falcón State (Royo y Gómez 1959, 1960; Ochsenius and Gruhn 1979; Bocquentin-Villanueva 1982; Aguilera 2006; Carrillo-Briceño 2015).

The only medium-sized predator recovered so far at the locality corresponds to a material classified as Felidae cf. *Leopardus pardalis*. Records are scarce for medium-sized felids in the northern neotropics, which is why the report of cf. *Leopardus pardalis* in Cauca is notable, as this taxon was previously undocumented in north-western Venezuela. Royo y Gómez (1960) mentioned the presence of “*Felis (Lynx) cf. rufus?*” in the locality of Muaco and acknowledged that, despite this lineage not having been recognised in South America, the collected material (N°. 24 on the author’s published list) exhibits similarities. Later, the identification presented by Royo y Gómez was questioned by Marshall et al. (1984) because the author did not present figures or descriptions of the studied fossil felid. Unfortunately, the current location of this material is unknown (D.R.R., pers. obs.), so this record cannot be confirmed and likely does not correspond to the *Lynx* genus. A left P3 and a lumbar vertebra from the Late Pleistocene El Mene de Inciarte locality in Eastern Venezuela were referred to cf. *Leopardus* sp. (Ruiz-Ramoni 2016). The P3 could correspond to a deciduous tooth of an undetermined feline and the study of the vertebra’s morphology further questioned this allocation to *Leopardus* (D.R.R., pers. obs.). Finally, Linares (1998) mentioned “remains” of *Le. pardalis* in archaeological sites (Pre-Columbian Age) on Margarita Island, the Eastern Cordillera and the Central Cordillera, but this taxonomic assignation was not justified and the specimens were not figured (see Prevosti and Forasiepi (2018)).

Currently, the medium-sized felines in the north of South America region are *Le. pardalis*, *Le. tigrinus*, *Le. wiedii* and *Herpailurus yagouaroundi* (Linares 1998; Sánchez and Lew 2012; Boher et al. 2023; Ruiz-García et al. 2023). The ocelot, or cunaguaro, *Le. pardalis* has a large distribution during the present (see Paviolo et al. (2015)) and during the Late Pleistocene (see Werdelin (1985); Seymour (1999); Prevosti and Forasiepi (2018); Prevosti et al. (2021); Manzuetti et al. (2023)) which is congruent with its presence in Venezuela deposition of Cauca sediments. On the other hand, the current distribution of *Ly. rufus* is limited to the northern half of México to Canada (Larivière and Walton 1997) and there are no fossils or living records of this genus in South America.

On the other hand, the sedimentary characteristics of some Late Pleistocene archaeological sites, such as Muaco and Taima-Taima (Ochsenius and Gruhn 1979; Carlini et al. 2022) and El Vano, in the Andean region of Venezuela (Jaimes 2003, 2005; Jaimes et al. 2024b), suggest that these sites were deposited in environments characterised by bodies of water that attracted animals. Specifically, Muaco and Taima-Taima have been referred to as resurgent springs, offering an oasis during dry periods (Ochsenius and Gruhn 1979; Ochsenius 1980). At the Cauca site, the bone remains are concentrated in a defined area (Fig. 1B) and the sedimentary conditions allow us to infer that the site was deposited in a humid, probably low-energy environment. However, the high degree of alteration and degradation of the site due to its exposure to extant (epidiagenetic) weathering is a limitation that

prevents us from inferring more precise evidence about possible extension and permeance/seasonality of the body of water. During the Late Pleistocene, the coastal plains of the Falcón State were subject to a negative water balance (Ochsenius 1980) and the ancient body of water in Cauca could have offered attractive water resources for the fauna that roamed in the area. The extension of these coastal plains in the region was greater than at present because of the glaciations and the consequent variations in sea level that occurred along the coastal zone. These now submerged plains extended from western Falcón to the Guajira Peninsula (see fig. 8 in Carrillo-Briceño (2015)), offering natural corridors that facilitated faunal and human movements along the Caribbean coast.

### Age of the Cauca site

The bioapatite dating of two fossil remains from Cauca provided an age of at least 40,000 cal. BP. In contrast, a biochronological approach of the site using identified fossil taxa does not offer a more precise age due to a wide chronological record for these taxa. For example: 1) Late Pleistocene for *Eremotherium laurillardi* (Cartelle and De Iuliis 1995), 2) Pliocene (~ 3.8 Ma, only for North America)—Late Pleistocene (for South America) for *Glyptotherium* (Carlini and Zurita 2010; Gillette et al. 2016; Zurita et al. 2018), 3) Early Pleistocene (1.2–0.4 Ma)—Late Pleistocene (~ 11,770 years BP) for *N. platensis* (Alberdi and Prado 2022) and 4) Middle Pleistocene (~ 2 Ma)—Early Holocene (~ 8,000 years BP) for *Equus* (MacFadden 2013; Prado and Alberdi 2017; Villavicencio et al. 2019).

### Taphonomic aspects and potential human-megafauna interactions at the Cauca site

Fossil bone elements emerging on the surface at the Cauca site were categorised within conservation stage “5” on the scale of Behrensmeyer (1978) (i.e. as the bone is fragile and breaks easily, it may lose the original shape of the bone). These materials could not be collected or identified in most cases due to their degree of fragmentation or total or partial disintegration (e.g. Fig. 3A–C). In contrast, the elements of the excavated groupings (not exposed) present a conservation stage of “3 to 4”, on the scale of Behrensmeyer (1978). These specimens have a thick fibrous surface, rough texture, large and small splinters that tend to break off when the bone is moved. Weathering has penetrated the internal cavities. The cracks are open and chipped with rounded edges and, in some cases, there is an incursion of sediment and biological activity (plant roots). These taphonomic preservation conditions limit the identification of micro modifications of animal or anthropogenic origin on the bone surface. Some specimens recovered from excavations are fractured or incomplete, where the missing part was exposed on the surface and eroded.

The factors that influenced the arrangement, alteration and disarticulation of the bones could be related to natural processes (meteoric and animal action) or human action (Fernández-Jalvo and Andrews 2016). At the Cauca site, indirect evidence of disarticulation was observed. An example is the postcranial remains of a probable adult individual assigned as cf. *E. laurillardi* and identified in excavation groupings 3 (Cauca “B”), 4 (Cauca “C”) and 5 (Cauca “D”) (Fig. 1B). In Cauca “B”, only the skull, right hemi-mandible, and a few other postcranial elements of the individual (see the faunal assemblage section) were identified. Other remains that probably belong to the same individual from Cauca “B” are found scattered between Cauca “C” and “D”. In Cauca “C”, a badly deteriorated fragment of the pelvis and other fragments of ribs and vertebrae were identified less than six metres west of Cauca “B”. In Cauca “D”, about 12 m north of Cauca “B”, a grouping of fragments of disarticulated ribs and a right tibia were recovered (Fig. 4E). These ribs show high fragmentation, with an arrangement pattern where some are on top of others and very close to the tibia.

At the Cauca site, large, compact and dense postcranial elements such as humeri and femurs of large megaherbivores (e.g. *Eremotherium* or *mylodontids*, *Notiomastodon*), both on the surface and in excavated groupings 1–5 (Cauca “A–D”), are scarce. Some examples are the tibia reported in Cauca “C”, the humerus in very poor condition observed in grouping 6 and what appear to be fragments of large bones destroyed amongst the remains of the *Eremotherium* identified in unexcavated grouping 2 (Fig. 3C). Gravitational dispersion models of large mammal carcasses in deposition environments with inclinations greater than 20° and subjected to hydraulic forces of 152 cm/s, considered a high rate (Voorhies 1969), are easier to disperse, starting with phalanges, ribs, teeth and jaw, while the last to be transferred from the place of death would be the skull. Although gravitational dispersion can organise and select bones for transport, others tend to anchor especially in clay environments with a lower inclination and subject to lower rates of hydraulic currents (Fernández-Jalvo and Andrews 2016). However, the spatial arrangement of the bone elements of the probable same individual from the cf. *Eremotherium laurillardi* in Cauca “B–D” breaks with the natural anatomical pattern that could be expected in high-energy deposition environments. The same could be inferred from the remains of *Notiomastodon platensis* from Cauca “A” and the tusk found in Cauca “E” if there is a possible relationship between them. Despite this, we do not rule out the possibility that most of the large bones and other cranial and postcranial elements have been eroded and destroyed before or after the biostratinomic and fossil-diagenetic processes. As mentioned above, many fossils that remain on the surface have suffered fragmentation and disintegration due to the direct action of meteoric processes (e.g. very dry environment with concentrated rain) once they were exposed due to the erosion of the carrier layer and a clear example is the unexcavated grouping 2 (Fig. 3A, C).

The greatest disadvantage present when identifying potential evidence of direct action by animals (predators and scavengers) or humans in the skeletal remains of the Cauca site, as well as in their distribution pattern, includes: 1) the poor state of preservation of the remains, which limits the identification of micro modifications of anthropogenic origin on the surface of the bones, 2) absence of direct association of lithic artefacts and the remains of fossil fauna and 3) the high degree of exposure of the site to the external agents (e.g. laminar erosion) that, for years or decades, has eroded and degraded its sedimentary context. This last limitation prevents us from putting into stratigraphic context the few preformatted lithic instruments found in the vicinity of excavations B–D (Fig. 9). The origin of the pruning layer of these artefacts is uncertain and its association with the site’s megafauna is speculative and cannot be ratified, especially if the radiocarbon ages obtained for the site (40,000 cal. BP.) are taken into consideration. The latter would contrast with new cultural evidence for the American continent with ranges within the Last Glacial Maximum (LMG) (e.g. Pansani et al. (2023)).

The presence of lithic artefacts in adjacent areas of the excavations and surroundings of the Cauca site, with different lithic typologies, such as El Jobo, Clovis and Fish Tail (Jaimes et al. 2024a), undoubtedly sheds new light on technologies and distribution of the artefacts used by the megafauna hunters who roamed the region at the end of the Pleistocene. However, the lack of a chronological and stratigraphic context of the layers carrying the lithic also prevents a secure association with the megafauna of the Cauca site. The only known sites with an association of megafauna and humans from the Late Pleistocene of Venezuela (with dating), are Muaco, Cucuruchú, Taima-Taima and El Vano (see Cruxent (1970); Bryan (1973); Carrillo-Briceño (2015); Carlini et al. (2022)). In Taima-Taima (Bryan et al. 1978; Haynes 2023) and El Vano (Jaimes 1998, 1999, 2003, 2005; Jaimes et al. 2024b), there is evidence of hunting/butchering of gomphotherids (*Notiomastodon platensis*) and megatheres (cf. *Eremotherium laurillardi*), respectively, are evident. At both sites, lithic points associated with the Jobo typology were found in association with the bone remains (Cruxent 1967, 1970, 1979; Bryan et al. 1978; Jaimes 1998, 2003, 2005). Meneses and Gordones (2021) recently suggested the existence of early human presence alongside megafauna (*Notiomastodon* sp.) at the El Llano del Anís site in Mérida State (Fig. 2). However, the absence of precise dating, comprehensive palaeontological examinations of the site’s fossil material and substantial evidence of human involvement in the bone remains pose limitations in interpreting the site.

## Conclusions

Despite thorough investigations into the Pleistocene mammals of South America, significant knowledge gaps persist, particularly in the northern region of the continent.

In this contribution, we report the first fossil records of mammals from the new coastal locality called Cauca in Falcón State, with the objective of revaluing this region in the context of the evolution of fauna in the continent. The fossil assemblage from the Cauca site is characterised by at least five megaherbivores that includes the terrestrial sloths cf. *Eremotherium laurillardi*, an indeterminate mylodontid, a glyptodont probably related to *Glyptotherium*, the proboscidean *Notiomastodon platensis* and the equid *Equus* sp. The only medium-sized taxon corresponds to a predator, identified here as Felidae cf. *Leopardus pardalis* and its report is notable due to the undocumented fossil record of this taxon in north-western Venezuela and the region. The bioapatite dating of two fossil remains from Cauca provided an age of at least 40,000 years old.

Lithic artefacts of a kind reported in the vicinity of the Cauca excavation and in other adjacent Pleistocene sites (Jaimes et al. 2024a), document the presence of humans in the region, but as these cultural remains were found on the surface, their association with the fossil fauna is uncertain.

Cauca is part of the Coro coastal plain that has been interpreted as one of the natural corridors that allowed the expansion of territories by different species during the Pleistocene, associated with the Great American Biotic Interchange (Webb 1978, 1991). Cauca, like sites such as Muaco, Taima-Taima, Cucuruchú and El Vano, has records of the existence of faunas subsequently extinct following environmental transformation in which probably both climate change and humans played a synergistic role (see Barnosky et al. (2016); Metcalf et al. (2016); MacPhee (2018)).

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