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A Fossil Bone of a Giant Ground Sloth from the Last Millennium of the Pleistocene: New Data from Salto Department, Uruguay

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Abstract

During the Pleistocene-Holocene transition at ~10.0 uncalibrated, or ~11.7 calibrated kya, the Americas were undoubtedly inhabited by humans from north to south ends. The groups living in that time had cultural and adaptive differences in terms of subsistence and technological pursuits. Particularly in the southern cone of South America, archaeological remains witnessed hunter-gatherers living at ~11.0 - 10.0 uncalibrated kya. They mostly used the so-called “fishtail,” or just “Fell” points, a widespread Paleo-American marker. Despite that, they exploited different faunal species, including extant and extinct fauna. At the Salto Department in the northwestern region of Uruguay, on the Itaperibí Grande creek shore, archaeological remains of bones and stones were recovered. One of the most remarkable is a fragmented fossil femur of *Lestodon armatus*, a mega-mammal giant ground sloth. In its anterior face, this specimen shows diverse kinds of marks. However, no clear association among the findings was documented. Then, in order to check the possible relationship between the bone and the artifacts, the specimen was subjected to radiocarbon dating and it was analyzed in detail from a taphonomic perspective to evaluate the origin of the marks. The radiocarbon assay indicates that the specimen belongs to the last millennium of the Pleistocene. The date is relevant as it is one of the few assays obtained on a sample from that time. The taphonomic study revealed that the marks were not produced by human activity, hence, its primary relationship with the stone artifacts is uncertain. Despite that, these data make an important contribution to the knowledge about the fauna contemporaneously living with the earliest hunt-

er-gatherer that were foraging the regional landscape during one of the colonization events that populated the southern cone of South America.

Keywords

Fossil Bone, *Lestodon armatus*, Taphonomy, Radiocarbon Date, Late Pleistocene, South America

1. Introduction

Diverse lines of investigations indicate that the human colonization of the Americas occurred during the Late Pleistocene, but in a time that is subject to debate (Meltzer, 2009; 2013). However, growing archaeological evidence suggests that this process occurred at ~14,000 - 15,000 uncalibrated radiocarbon years before present or ~14.0 - 15.0 kya (Waters et al., 2011, 2018; Dillehay et al., 2017; Davis et al., 2017, 2019; among others), and probably earlier (Ardelean et al., 2020). From a planetary point of view, during the last millennium of the Pleistocene and its transition to the Holocene at ~10.0 uncalibrated, or ~11.7 calibrated kya (Walker et al., 2009, 2012, 2018; Gibbard & Head, 2010; Head & Gibbard, 2015) significant environmental and socio-cultural phenomena took place (e.g. Strauss et al., 1996; Dolukhanov, 1997; Acosta et al., 2018; Strauss 2018; among many others). Specially during the time of the Younger Dryas (Lothrop et al., 2011), the Americas were undoubtedly inhabited by hunter-gatherer groups in its entire territory from north to south ends (Lanata et al., 2008; Graf, 2013; Nami, 2014, 2020; Potter et al., 2018). The evidence provided by the archaeological record shows that there were cultural and adaptive differences in terms of subsistence and technological pursuits (Dillehay, 2009; Meltzer, 2009; Politis et al., 2008; 2019; Nami, 2014, 2019; Chichkoyan et al., 2017). Particularly in the southern cone of South America, the archaeological remains attest that foragers living ~11.0 - 10.0 uncalibrated kya used the “fishtail,” “Fell’s cave,” or “Fell” points (FP), a widespread Paleo-American (PA) marker. Probably originated in eastern North America (Nami, 2020), this distinctive lithic artifact had an extraordinary dispersion from Mesoamerica to the southern tip of South America (Bell, 1965; Bird & Cooke, 1978; Mayer-Oakes, 1986; García-Barcena, 1980; Ranere & Cooke, 2003; Nami, 2014, 2020). In spite of sharing similar projectile point shapes, the subsistence of the human groups using FPs in the southern cone exploited different faunal species, some of them now living, but also others that are now extinct (Salemme & Miotti, 2008, Nami, 2014, 2019; Politis et al., 2019).

Located in northwestern Uruguay, the *Museo de Arqueología y Ciencias Naturales* (Salto city) conducted various field-work activities over the last decades. Among the remarkable results was the discovery of several archaeological and paleontological sites. As a contribution to the knowledge of the regional past, the

finding of a significant fossil is reported, which was found useful to know about issues related to the coeval fauna of the early hunter-gatherers living during the terminal Pleistocene at Salto Department (**Figure 1**).

2. The Paleontological Finding and General Remarks

Conducted for different purposes, the field-work allowed the discovery of archaeological and paleontological remains on the shore of the Itaperibí Grande Creek (31°19'09"S, 57°34'53"W). Belonging to the drainage basin of the Uruguay River, this watercourse, born in the Daymán hills, flows westerly in the reservoir formed by the Salto Grande dam on the Uruguay River. On its shore, and eroded from its banks, a number of archaeological and paleontological remains were found. The latter includes several extinct taxa; among them, two bones stood out because of their different kinds of marks on their surfaces. One of the most noticeable is the specimen reported in this paper, a fragmented fossil femur of *Lestodon armatus* (Xenarthra, Mammalia). The *Lestodon armatus* is an extinct species of megafaunal ground sloth that inhabited South America (e.g. Deschamps et al., 2000, Czerwonogora, 2010; Fariña et al., 2014, Ubilla et al., 2016; among others). *Lestodon* is placed as a member of the Mylodontinae monophyletic group.

According to the last phylogenetic study (Boscaini et al., 2019), it was a bulk-feeding mega-mammal, measuring ~4.5 meters from nose to tail tip (**Figure 2**) and estimated to have weighed over 2 tons (Fariña et al., 2014). Remains of this kind of ground sloth were found in the Pleistocene deposits of Venezuela, Brazil, Bolivia, Paraguay, Argentina and Uruguay (Czerwonogora, 2010; Fariña et al., 2014), but some records date back to the Early Pliocene in Argentina (Deschamps et al., 2000). Particularly in northern Uruguay, the *Lestodon armatus* bones come from the Sopas Formation, a Late Pleistocene continental unit

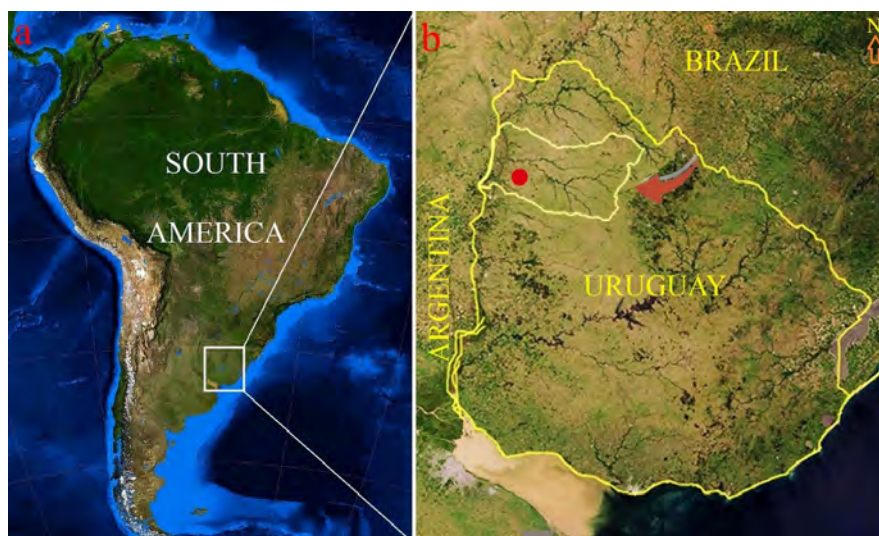


Figure 1. (a) Map of South America and the location of the Uruguay Republic denoted with a rectangle, (b) Salto Department within Uruguay indicated with an arrow and the Itaperibí creek showed with a red circle. Modified after NASA and Google Maps.

including trace fossils, woods, fresh-water mollusks, and as illustrated in **Figure 3**, vertebrates with mammals as the predominant taxa (Ubilla et al., 2016, Table 4).



Figure 2. Mounted skeleton of *Lestodon armatus* displayed at the Paleontological Museum “Fray Manuel de Torres in the city of San Pedro (Buenos Aires, Argentina). (a). Frontal view, (b). Lateral view. The oval indicates the position of the femur studied here (Photos taken by K. V. Chichkoyan).



Figure 3. Late Pleistocene faunal composition of the Pampean region (region extended among Argentina, Uruguay and Brazil): *Glyptodon*, *Megatherium*, *Equus* and *Prosbocidea*. Drawing performed by Mauricio Antón (after Belinchón et al. 2009).

At present, no clear associations between the findings have been documented. Then, in order to check the possible associations between the bones and the artifacts, one of the fossil remains was subject to radiocarbon dating and it was analyzed in detail from a taphonomic point of view so as to evaluate the marks origins. The results of this research are as follows.

3. Taphonomic Observations

This analysis was performed to describe the general state of the analyzed specimen and to identify possible anthropical intervention. As a discipline, taphonomy helps to detect and interpret the various agents affecting the living organisms following death (Lyman, 1994; Fernández-Jalvo & Andrews, 2016). In this case, the most important agents to describe this fossil femur are:

1) *Fresh and post-depositional fractures*: bones can fracture just after an animal death or long after its skeleton gets exposed (Fernández-Jalvo & Andrews, 2016). In the first case, the bone is still fresh and plastic. Therefore, borders will tend to be smooth, rounded, or curved. In the second case, the bone is already dry and lacks most of the collagen that tempers the impacts. As a consequence, borders will tend to be irregular and rough, with straight angles (Fernández-Jalvo & Andrews, 2016).

2) *Trampling*: Abrasion of sediments over bones, given the movement of animals and/or humans, may generate lines and scratches (Lyman, 1994; Domínguez-Rodrigo et al., 2009). These are characterized by being randomly oriented and shallow, producing a general polishing and microabrasion over the bone surface (Olsen & Shipman, 1988; Domínguez-Rodrigo et al., 2009). Nevertheless, they may also have straight orientation and have symmetrical or asymmetrical grooves, depending on the particle size and orientation (Domínguez-Rodrigo et al., 2009).

3) *Weathering*: Atmospheric conditions may produce changes in the surface of exposed bones. The sun, wind, or contrasting temperatures may result in cracking, exfoliation, flaking, splintering, and in later stages, the decomposition. A total or partial burial may affect parts of the same bone in different ways (Fernández-Jalvo & Andrews, 2016).

4) *Ancient cut marks and recent marks*: Cut marks are generally characterized by being elongated/straight and narrow linear incisions (Lyman, 1994; Fisher Jr., 1995; Domínguez-Rodrigo et al., 2009), with V-shape walls and internal microstriations (Lyman, 1994; Fisher Jr., 1995; Fernández-Jalvo & Andrews, 2016). They will tend to be present as patches or clusters of marks with parallel or similar orientation (Merritt, 2015) and to be related with specific anatomical position (Lyman, 1994; Domínguez-Rodrigo et al., 2009). Ancient cut marks can be differentiated from recent ones (generally done during excavation or manipulation), as fresh marks will have a lighter color than the surrounding surface (Fisher Jr., 1995).

Based on the characteristics mentioned above, in general, the analyzed femur

fragment is in a good state of preservation. We detected different types of agents but no one related to an anthropic intervention. The presence of irregular and rough borders in the diaphysis indicates that the bone was fractured when the skeleton was exposed. The lighter borders of the anterior face (**Figure 4(a)**) are more recent than the posterior ones (**Figure 4(a')**), as the different coloration indicates fractures that were not subject to similar burial effects. Superficial, superpose, and non-oriented marks distributed along the shaft can be related to trampling activity (**Figure 4(b)**). The general polished aspect can also be related to this agent. Some cracking grooves along the long axis of the bone might have been produced by some surface exposure, at least in this area, producing this weathering effect (**Figure 4(c)**). Four diagonal (three large and one short), straight and parallel marks were also detected (**Figure 4(d)**). They have a lighter color than the rest of the bone, showing a recent exposure of the sub-cortical surface and indicating their recent origin, as it happened with the afore-described post-depositional fracture. These marks were made with the horseshoe of the horse the person who discovered this bone was riding. Besides, over the articular surface, two pre-depositional straight U-shape lines were detected (**Figure 4(e)**). Nevertheless, their orientation, lack of internal microstriations, and morphology dismiss an anthropogenic origin. So far, the origin of these marks is still unclear. They might be either the product of trampling, surface exposure, or even anatomical features of this species.

4. Radiocarbon Dating

To obtain its precise age, a small portion of the previously described femur was taken out for radiocarbon dating. The sample was submitted and processed by

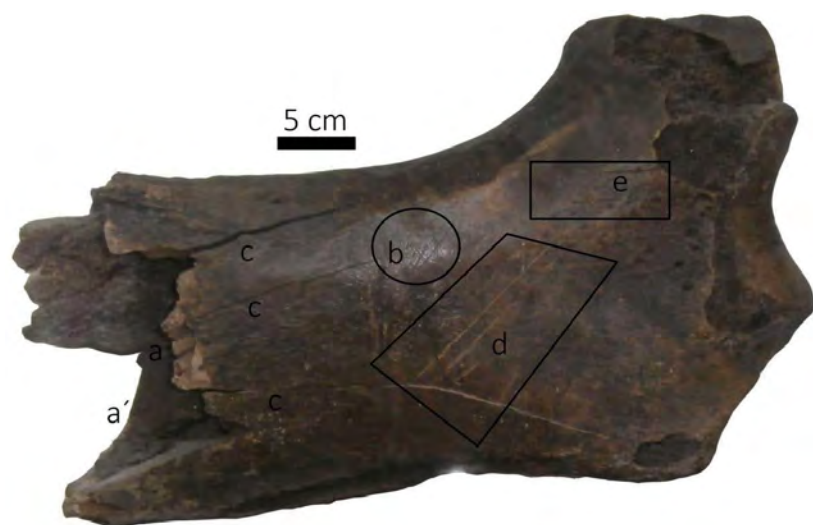


Figure 4. Anterior-distal view of *Lestodon armatus* fossil bone with the indication of the taphonomic agents described in the text: (a). Fresh post-depositional fracture, (a'). Ancient post-depositional fracture, (b). Trampling, (c). Weathering grooves, (d). Horseshoe's marks, (e). Unidentified ancient marks (Image credits H. G. Nami and K. V. Chichkoyan).

analyzing the extracted collagen with alkali by Beta Analytic Inc. (Miami, Florida, USA). The C/N ratio of 3.3 indicates good collagen preservation as it is in the range of 2.9 to 3.6 that is considered reliable (De Niro, 1985; Ambrose, 1990). Using the AMS method, a Conventional Radiocarbon Age of 10820 ± 40 BP ^{14}C yr BP (Beta - 469089) was obtained. This date was corrected by using the BetaCal 3.21 program based on the probability method developed by Bronk Ramsey (2009), and the ShCal 13 curve for the southern hemisphere (Hogg et al., 2013). **Table 1** shows the results of the calibrated ages with 68.2% and 95.4% probability, and **Figure 5**, the calibrated age histogram.

Few direct taxon dates were obtained from this species inhabiting the Pampean and Uruguayan plains. In Argentina, an early assay of 16440 ± 320 ^{14}C yr BP was from the Pehuén-Có locality, situated in the Atlantic coast (Aramayo et al., 2005). Figini and colleagues (1998) reported a standard date of 10710 ± 90 ^{14}C yr BP (LP-152) over a *Pseudolestodon* bone from Tapalqué creek. Earliest ages, on several *Lestodon* bones of circa 30,000 yr BP are from the Vizcaíno creek site, located in the southern area of Uruguay (Czerwonogora et al., 2011). Specially, the Tapalqué creek date is almost contemporary with the one presented here. Remarkably, these dates show coeval populations of this taxon along the plains of Uruguay and Argentina, and coexisting with the first human population inhabiting this landscape.

Table 1. Range of calibrated ages for the Itaperibí creek date.

Uncalibrated age	68.2% probability		95.4% probability	
Years BP	Years BC	Years BP	Years BC	Years BP
$10,820 \pm 40$	10,773 - 10,736	12,722 - 12,685	10,794 - 10,717	12,743 - 12,666

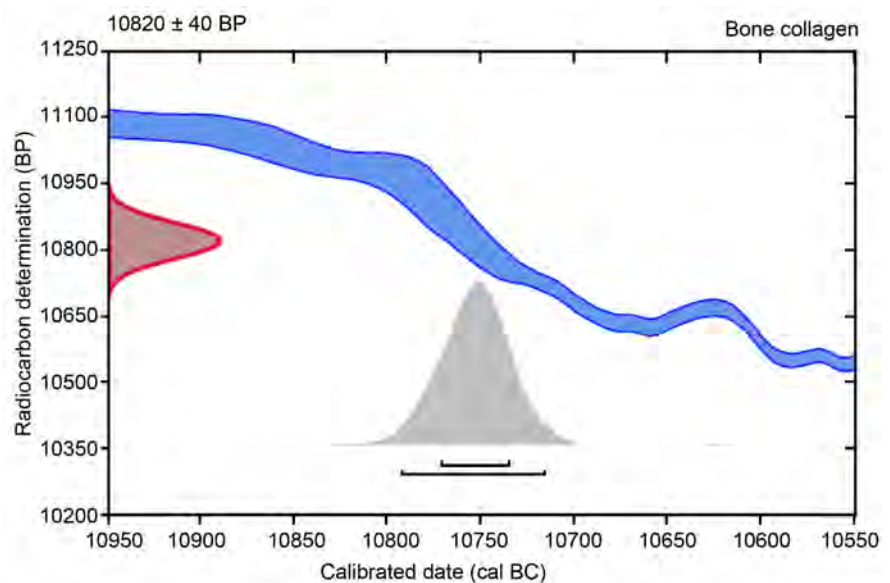


Figure 5. Plot showing the AMS date of $10,820 \pm 40$ BP ^{14}C yr BP (Beta - 469089) for the Itaperibí Grande creek, as well as the 95.4% and 68.2% probability calibrated age ranges and the ShCal13 curve for the southern hemisphere (from Beta Analytic Inc.).

The laboratory report also presents the first carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotope values for *Lestodon* during the last millennium of the Pleistocene: -14.7 $\delta^{13}\text{C}$ and 9.9 $\delta^{15}\text{N}$. $\delta^{13}\text{C}$ value is more enriched (less negative) than the ones reported for the Vizcaíno creek, while $\delta^{15}\text{N}$ is very similar (Czerwonogora et al., 2011). Intermediate $\delta^{13}\text{C}$ and high $\delta^{15}\text{N}$ values might be related with grasses and some shrubs/trees vegetation in a predominant arid/semi-arid environment, as reflected in other isotopic studies of the Pampean region (Czerwonogora et al., 2011; Bocherens et al., 2016, 2017; Loponte & Corriale, 2019), although more information is necessary to correctly interpret these results.

5. Concluding Remarks

To sum up, new data obtained from the *Lestodon* fossil bone from northwestern Uruguay have led to a more in-depth understanding of several topics. The taphonomic study demonstrated that the marks were not produced by human activity, and hence its primary relationship with the stone artifacts is uncertain. The radiocarbon date and isotope values are relevant because it is one of the few assays obtained directly on a sample from *Lestodon armatus* with age spanning the last millennium of the Pleistocene. Besides, it primarily belongs to the FPs' timeframe in South America in general, and the southern cone in particular (e.g., Jackson et al., 2007; Nami, 2007, 2017, 2019; Maggard & Dillehay, 2011; Prates et al., 2013; Nami & Stanford, 2016; Nuñez et al., 1994; Waters et al., 2015; Yataco Capcha & Nami, 2016). Consequently, the information presented is not only significant from a paleontological point of view, but also from an archaeological and anthropological perspective. From the former, it is one of the few taxon dates belonging to this time for this extinct animal in the area. It also agrees with the fact that several South American giant ground sloths died out during the Late Pleistocene-Early Holocene extinction, an event that eliminated most large mammals in the Americas (e.g. Barnosky et al., 2004; Haynes, 2009; Prescott et al., 2012). The precise timing of this event during the terminal Pleistocene, and the onset of the Holocene is poorly understood in South America, primarily due to a lack of radiometric dates on taxa (Prevosti & Schubert, 2013). Then, the data presented here shed light on this matter. More interestingly, it agrees with additional ages obtained in other species of extinct fauna in the Uruguayan territory (Meneghin & Sánchez, 2009; Ubilla et al., 2018). Archaeologically, it absolutely matches with radiocarbon assays for the earliest regional human occupations (Miller, 1987, Meneghin, 2004, Suárez, 2017; Nami, 2017; Nami et al., 2018), suggesting in this way that at least this kind of mega-mammals was coeval with Paleo South Americans hunter-gatherers living in the region. Extremely important were the isotopic values. They contributed to the analysis and knowledge of the environment these foragers lived in. The date also agrees with the remarkable record of FPs existing in Southern Brazil, NE Argentina, and Uruguay (e.g. Bosch et al., 1980, Nami, 2013, 2017, 2020; Loponte et al., 2015, 2016; Loponte & Carbonera, 2017; among others), whose examples are illustrated in **Figure 6**. It is worth mentioning that nearby the Itaperibí Grande creek, it is



Figure 6. Illustrative examples of Fell points from southern Brazil ((a)-(d)), northeastern Argentina ((e)-(j)), and Uruguay ((k)-(s)), mainly from the Salto department ((k), (m)-(o)) and the Negro River drainage basin ((p)-(s)). They came from the following sites, localities and/or provinces: (a) Jusante UHE Salto Caixas I site; (b) Irani River; (c) Jaguaruna 11 site; (d) Montenegro site; (e) El Dorado, and (f) Puerto Esperanza, Misiones province; (g)-(h) nearby Monte Caseros, and (i) Santa Lucía site, Corrientes province, (j) Colonia Santa Eloísa, Federación, Entre Ríos province, (k) Barranca Pelada del Arapey, (l) Puntas del Queguay, Paysandú department, and (m)-(o) Boicúa creek, Salto Department; (p) San Gregorio de Polanco, (q) unknown site from the Tres Arboles creek basin, (r)-(s) Rincón del Bonete dam area, Photo credits: (r)-(s) U. Meneghin; (g)-(h), (k)-(m), (o)-(q) H. G. Nami. The remaining were modified after: (a)-(c) Loponte et al. 2015: **Figure 3**, **Figure 5** and **Figure 6**; (d) da Silva Lopes and Nami 2011: **Figure 1**); (e)-(f) Loponte & Carbonera 2017: **Figure 4**; (j) Capeletti 2011; (i) Serrano 1932: Lam. XV, 11; (n) Cordero 1960. Note: (n)-(o) not in scale.

claimed that other types of projectile points belonging to different “techno-complexes” overlap the time of the FPs from other South American areas (Suárez, 2017). However, needless to say, that this data must be taken with caution in light of alluvial geo-archaeology and site formation processes (Nami, 2013, Feathers & Nami, 2018), principally in the Uruguay River (Pouey Vidal, 2018). Finally, due to the scarcity of this sort of finds, its discovery deserves attention, mainly because it makes an important contribution to the knowledge about the fauna contemporaneously living with the earliest hunter-gatherers that were foraging the regional landscape during the last millennium of the Pleistocene.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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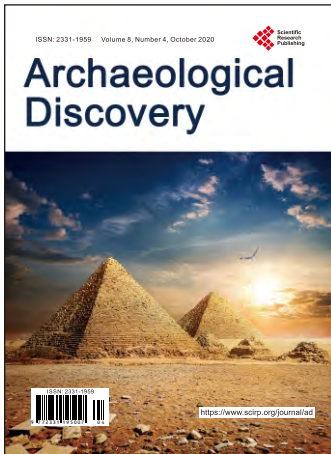
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