



Human Palaeontology and Prehistory

The exploitation of megafauna during the earliest peopling of the Americas: An examination of nineteenth-century fossil collections



L'exploitation de la mégafaune pendant le premier peuplement américain : valorisation des collections de fossiles anciennes

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ABSTRACT

This paper describes human-modified bones originally from the Pampas region, and that form part of nineteenth-century fossil collections of native fauna. We describe the morphological and configurational features of the marks, relate them to the various stages in the butchering process, and discuss access type. An examination of various different American sites is used to interpret this evidence at a coarse-grained level. Although these collections are more biased than current archaeological materials with regard to their sedimentary origin and previous handling, the application of modern technology has allowed us to obtain new data. Therefore, despite their complex history, these artefacts can be incorporated into the broader body of modern archaeological research. This type of study adds new value to our historic heritage and underscores its usefulness in modern enquiries, in this case, related to the topic of how *Homo sapiens* interacted with the native fauna in the southern Cone of South America.

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R É S U M É

Le matériel de cette étude comprend les collections de fossiles découverts au XIX^e siècle dans la Pampa argentine et se composent de spécimens de faunes endémiques conservées dans plusieurs musées d'Argentine et d'Europe. Une révision taphonomique globale a permis de mettre en évidence des traces d'activité humaine sur plusieurs ossements. Les caractères morphologiques et la configuration de ces traces permettent de les attribuer

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à des étapes du processus de boucherie. Ces collections fossiles souffrent, plus que tout autre matériel archéologique, de nombreux biais liés à leur origine sédimentaire et à leur historique. Néanmoins, les observations microscopiques et l'étude des traces à partir des données de scanner surfaciques ont permis d'argumenter et de confirmer ces interprétations. Malgré leur histoire compliquée, ces collections peuvent ainsi être intégrées à un corpus archéologique et étudiées selon ce nouvel axe de recherche. Ce type d'étude permet de revaloriser un patrimoine historique en montrant l'intérêt de ces collections dans des problématiques actuelles telles que la question de l'interaction d'*Homo sapiens* avec les mégafaunes endémiques du cône austral d'Amérique du Sud.

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1. Introduction

Unlike on other continents, anatomically modern humans were the first and only *Homo* species that dispersed from high latitudes to lower ones and again to higher latitudes in the Americas (Lanata, 2011). Although these first populations used a diverse array of resources in the different paleoenvironments (Lanata, 2011), their exploitation of native megafauna has been one of the most widely debated topics. The arrival of humans coincides with the extinction of this native fauna and the paleoenvironmental changes that affected them during the Late Pleistocene-Early Holocene. Thus, humans, climate and/or a combination of these would have driven these animals to extinction (Barnosky et al., 2004; Borrero, 2009; Cione et al., 2009; Graham and Lundelius, 1984; Grayson and Meltzer, 2015; Hubbe et al., 2013; Lanata, 2011; Martin, 1973; Monjeau et al., 2015; Surovell et al., 2016; among others). Archaeologically, it is difficult to prove the extent of the human influence. One of the main problems is the scarcity of early archaeological sites and the weak association or absence of cut marks. This would suggest a human influence that was minor and opportunistic (Arribas et al., 2001; Borrero, 2009; Grayson and Meltzer, 2015; Hubbe et al., 2013). However, from a paleontological point of view, humans were an important biological factor that affected this native community (Cione et al., 2009).

Cut marks are the most direct way to analyse the past exploitation of fauna by humans, but the megamammal species tend to have few such marks because their size, skin and the periosteum mean that their bones are not easily modified (Crader, 1983; Yravedra et al., 2011; Haynes and Klimowicz, 2015). Additionally, in the case of the Americas, the density of early sites would have been lower than on other continents due to the recent arrival of humans (Surovell and Grund, 2012). Preservation processes, the construction of cities, and even early uncontrolled excavation have all contributed to the loss of this type of data (Fucks and Deschamps, 2008; Surovell and Grund, 2012).

In relation to this last point, the megamammal collections currently housed in many natural science museums stem from major fossil trafficking operations that took place between Argentina and Europe in the 19th century (Podgorny, 2011). The revision of these collections in search of evidence of biological intervention (both human and carnivore) constitutes an alternative method for uncovering new information. Museum collections are one of the most

important means of preserving information about past and present life, and fossil collections, which are archives of past diversity, are especially valuable (de Renzi, 2002; Suarez and Tsutsui, 2004). The study of this information currently contributes to a wide range of disciplines, including palaeontology, genetics, biology and even the study of global climate change. Furthermore, the incorporation of this information into new studies can save money and time (Suarez and Tsutsui, 2004). Within this context, fossil collections can be very useful in the field of archaeology, and the revision of different paleontological and historical collections has yielded new data due to the discovery of human and carnivore biological intervention (Chichkoyan et al., 2015; Dowd and Carden, 2016; Labarca, 2003; Martín, 2008; Perez et al., 2005; Prous, 1986; Redmond et al., 2012; Saunders, 2007; Saunders and Daeschler, 1994). The revision of some of the collections mentioned in this paper has already revealed the presence of cut-marked bones (see details in Toledo, 2009). Thus, the components of these historical collections are a tool that can potentially provide new data to help us better understand human behaviour with regard to past fauna communities at a regional level.

The biggest drawback with this kind of record is the lack of context information (Turvey and Cooper, 2009) because archaeology is a context-dependent discipline (Schiffer, 1983). Fossil collections are an artificial selection filtered by biostratigraphy, fossilization, excavation, merchandising and restoration processes. The first two filters are common with past and present collections of materials. In general, paleontological and archaeological records are biased representations of the living past because natural and/or anthropic actions have dispersed, destroyed and modified primary deposits (Schiffer, 1983). But they have also undergone historical-cultural selection (Turvey and Cooper, 2009), as they are the result of what excavators deemed worthy of rescue, what was offered by commercial sponsors and what museums wanted to buy (de Renzi, 2002; Podgorny, 2011; Turvey and Cooper, 2009). Collectors often attempted to complete specimens with bones from different individuals, and museums generally wanted the largest and most complete skeletons (de Renzi, 2002; Podgorny, 2011). For all of these reasons, 19th-century fossil collections represent a more biased record than materials collected today.

That being said, a weak context does not necessarily equal a complete lack of information. The advancement in these last decades of our ability to interpret bone

modifications (Fariña et al., 2014b) has meant that we can now delve deeply into this non-traditional source of information for the field of archaeology. The definition of attributes for the detection of carnivore and anthropic cut marks, and the introduction of technological devices like microscopes have allowed us to identify materials bearing evidence of biological intervention. This information is useful to distinguish the various stages of the butchering process, discuss different exploitation scenarios, and make comparisons with evidence from controlled excavations at a coarse-grained scale. Radiocarbon data can provide information regarding when these interactions occurred. In short, fossil collections are a valid record with less specific information. The presence of various natural and anthropic filters does not mean that these collections should be ignored for use in current archaeological research.

This study presents the results of a revision of some Argentinean and European fossil collections. This is part of an ongoing project that is reviewing contextualised and decontextualised 19th-century collections to detect human and carnivore biological intervention in different skeletal elements of native fauna (Chichkoyan et al., 2015). Four cut-marked bones were recovered: a left humerus from a *Doedicurus* sp. from the “Museo Argentino de Ciencias Naturales Bernardino Rivadavia” (MACN), a right ulna from a *Megatherium americanum* from the “Muséum national d'histoire naturelle” (MNHN) and two caudal vertebrae from *Panochthus tuberculatus* from the Statens Naturhistoriske Museum (Zoologisk Museum) (ZMK). The low number of materials presented here is even more significant when the above-mentioned filters and the general American scarce recording of human traces are taken into account. The recovery of a few bones with cut marks is just an inkling of the irrecoverable information lost in these earlier campaigns. So, this type of material is highly relevant not only for its scientific value, but also because it represents the importance of the contribution of historic fossil collections.

2. Material

The collections come from diverse excavations that took place at different points in the area surrounding the Río de la Plata basin, which is currently part of Buenos Aires Province, Argentina. It corresponds to the Pampa Region, a fertile plain that is favourable to urban concentrations and agricultural activities (Fucks and Deschamps, 2008). It was subject to Quaternary loess deposition and environmental changes. This involved a complex geomorphologic formation with different regression and transgression events. The late Pleistocene-early Holocene period was characterised by the fluvial deposits formed during the transgression (subsequent to the Last Glacial Maximum) and the pedogenetic event at the beginning of the Holocene. Arid and dry paleoenvironment, redeposition of sediments and drastic climatic oscillations were typical during this period (Cione et al., 2009; Fucks and Deschamps, 2008).

We studied the following collections:

- the material housed at the MACN is labelled as MACN PV 6071. It comes from Arroyo Grande, Balcarce, located in southeast Buenos Aires Province at approximately 37°50' S 58°15' W. It comes from the late Pleistocene-early Holocene Luján Formation. The assemblage, assigned to *Doedicurus* sp., consists of a right mandible, a fragment of an ulna and some plates, in addition to the humerus presented here;
- the Vilardebó Collection housed at the MNHN. The *Megatherium americanum* ulna studied here is labelled as MNHN.F.PAM 751 and comes from the Pampean formation. In the 19th-century different naturalists, including D'Orbigny, Darwin, Doering and Ameghino, have defined this formation. In general terms, it referred to the sediments deposit during the Pleistocene until early Holocene periods (Tonni and Pasquali, 2006). de Blainville included this element in his fourth volume of 'Ostéographie' (1839–1864) (Planche III, Fig. 6 and 6');;
- the Lausen Collection housed at the ZMK. The material presented here proceeds from the town of Mercedes (34°39' S 59°25' W) and it is labelled ZMK 38/1889. It is an assemblage comprised of 11 more vertebrae, two patellae, a mandible, a chevron, a caudal tube and several fragments of *Panochthus tuberculatus* plates in addition to the vertebrae presented here.

The species named here belong to the diversified native South American group corresponding to the order of the Xenarthra, which is divided into Cingulata and Pilosa. The family Glyptodontidae belongs to the former, which includes the *Doedicurus* sp. and the *Panochthus tuberculatus*. This is a monophyletic group, characterised by a hard shell of fixed osteoderms (Zurita et al., 2010). *Doedicurus* sp. could have weighed up to 1400 kg, and the *Panochthus tuberculatus* could have weighed up to 1100 kg (Fariña et al., 1998). Pilosa includes the *Megatherium americanum* in the Megatheriidae family. It is the largest animal in this order, as it could weigh from four to over six tonnes (Fariña et al., 1998). According to the biochronological framework (Tonni, 2009), *Doedicurus* sp. appears in the *Mesotherium cristatum* biozone, and *Panochthus tuberculatus* and *Megatherium americanum* in the *Megatherium americanum* biozone that began at 400,000 BP. They all became extinct in the *Equus (Amerhippus) neogeus* biozone, which lasted until the early Holocene.

3. Methodology

Bones from the appendicular and axial skeleton of identified species and skeletal elements were reviewed. The different bone surface modifications were documented, such as post-depositional fractures, the presence of original sediments or concretions, fluvial erosion, trampling, weathering, roots, manganese spots and burning traces (Behrensmeyer, 1978; Binford, 1981; Fernández-Jalvo and Andrews, 2003, 2016; Lyman, 1994; Olsen and Shipman, 1988; Shipman, 1981; among others). Distinguishing these different alterations is necessary in order to evaluate the conditions to which the bones were subjected in the past and to identify possible human biological intervention.

Ancient cut marks macroscopically will have the same appearance of the rest of the bone and may have post-depositional agents on top of them (Dowd and Carden,

2016; Labarca, 2003; Perez et al., 2005; Prous, 1986; Redmond et al., 2012; Saunders, 2007; Toledo, 2009). These characteristics differentiate them from fresh marks or fractures made during excavation or handling at the museums. Such marks or fractures are different in colour from the surrounding cortical tissue (Fisher, 1995) because they were not exposed to the same post-depositional agents that affected the bones in the past. Nevertheless, sometimes the tool did not penetrate enough to expose subcortical bone (Fisher, 1995), and therefore morphological and configurational features (sensu Fisher, 1995) can be useful to identify past human intervention and consequently further inform our determinations. Among the morphological features, we looked at elongated transversal or longitudinal marks with a V cross-section and internal microstriations in their walls, or microscopic features such as smears (Bello et al., 2009; Binford, 1981; Fernández-Jalvo and Andrews, 2016; Lyman, 1994; Shipman, 1981). Configurational features, like the presence of several groups of marks with a parallel or semi-parallel orientation, were also taken into account (Binford, 1981; Fernández-Jalvo and Andrews, 2016; Lyman, 1994; Olsen and Shipman, 1988). These groups of marks had to be located in parts of the bone related to the different butchering stages as defined by Binford (1981). Cut marks made during the disarticulation of the limbs or filleting stages are diagnostic, as they will probably coincide with long bone ends (Galán and Domínguez-Rodrigo, 2013).

The material was reviewed with the naked eye and then with 3.5× and 12× magnifying glasses. A 4113 model Dinolite microscope and its software were also used. High-resolution digital images were taken using a Panasonic Lumix DMC-TZ35 camera. On MNHN and ZMK, bone casts were also taken to be reviewed with a Hirox KH-8700 digital microscope at IPHES. The material used for casting was Provil Novo Light for the negative and Polyvinyl Siloxane for the positive.

4. Results

A NISP of 943 bone remains have been analysed: 433 elements from the MACN, 51 elements from the MNHN and 459 from ZMK:

- in the left humerus from the *Doedicurus* sp. (MACN PV 6071) (Figs. 1 and 2), two groups of possible cut marks were detected. They are located on the anterior and posterior faces on the epicondylar medial side of the distal metadiaphysis region. One group is located on the anterior-medial face, obliquely oriented in relation to the long axis of the bone, over the epicondylar crest (Figs. 1A and 2A). This group is comprised of at least three long cut marks of approximately 2 cm in length, and two shorter marks measuring about 0.5 cm. The other group is located on the posterior face near the distal articular border. It is oriented perpendicularly in relation to the long axis of the bone (Figs. 1B and 2B). It is made up of five long marks measuring approximately 1.5 cm;
- the right ulna of the *Megatherium americanum* (MNHN.F.PAM 751) housed at MNHN has a set of cut marks on the proximal metadiaphysis of the bone in the posterior-medial position under the coronoid process. They are located perpendicularly to the long axis of the bone, and comprise a complex grouping of long and short marks that run parallel to one another. From the external border to the interior, the set was divided into four parts (Fig. 3). The first (Fig. 3A) is a group of seven short marks, measuring from 0.3 to 0.5 cm in length and situated 0.2 to 0.5 cm apart. On the distal part of this set there is a longer mark measuring 1.2 cm. Very near this mark, there is another grouping of four long marks (Fig. 3B) measuring approximately 2 cm in length and located 0.2 to 0.3 cm apart with a slightly concave orientation. This group also contains approximately located 3 cm cut mark with a more rectilinear orientation. Immediately next to this group, there are four marks measuring approximately 0.5 cm, with a V cross-section and superposed by a weathering crack (Fig. 3C). Finally, a group of two to four marks measuring approximately 1.5 cm in length is located on the posterior face of the bone (Fig. 3D). This last group is almost invisible and discontinuous, as if the pressure applied here was less intense than at the beginning of the mark. In the same position, but near the lateral side of the bone, at 6 cm from the end of this group of marks, there are three slight marks measuring approximately 0.5 cm in length and separated by 0.1 cm. They are as weak in appearance as the main mark described in the last set. The weathering cracks that crosscut these cut marks, the fossilised sediment inside of them, and their similar appearance to the rest of the bone indicates that the marks were not produced posterior to excavation. Three casts were made of the main cut mark. Acetone was used to clean inside and around the cut to remove the attached sediment. Of the three casts, the first two were taken for the same purpose. The third cast was analysed using the Hirox KH-8700 digital microscope. Although the pieces were thoroughly cleaned, the remnants of old sediments were firmly attached. A special effort was made during the cleaning procedures to remove the sediment without damaging the bone. Only at the beginning of the short cuts in the first set described (Fig. 3A) was it possible to appreciate one of the cut mark's walls with microstriations (Fig. 4). In the rest of the cast, the cut marks presented smooth walls. This was probably due to the attached sediment left in the groove;
- one of the *Panochthus tuberculatus* vertebra (ZMK 38/1889) from the ZMK presents a set of eight possible cut marks on the dorsal side of the right transversal process. They have the same oblique orientation in relation to the medial axis of the bone. They were divided into two groups. The first four cut marks form a group positioned on the anterior-medial side of the transversal process. They are short and superficial (from 1 to 2 cm in length) and do not touch the anterior edge of the transversal process (Fig. 5). The other four marks are posterior-laterally positioned, touching the posterior edge of the transversal process and are deeper. This group is comprised of one longer cut mark measuring 3 cm and the others measuring 1 and 2 cm. The marks have smears in both walls and asymmetric grooves (Fig. 5). Concretions of sediments were documented covering and surrounding some

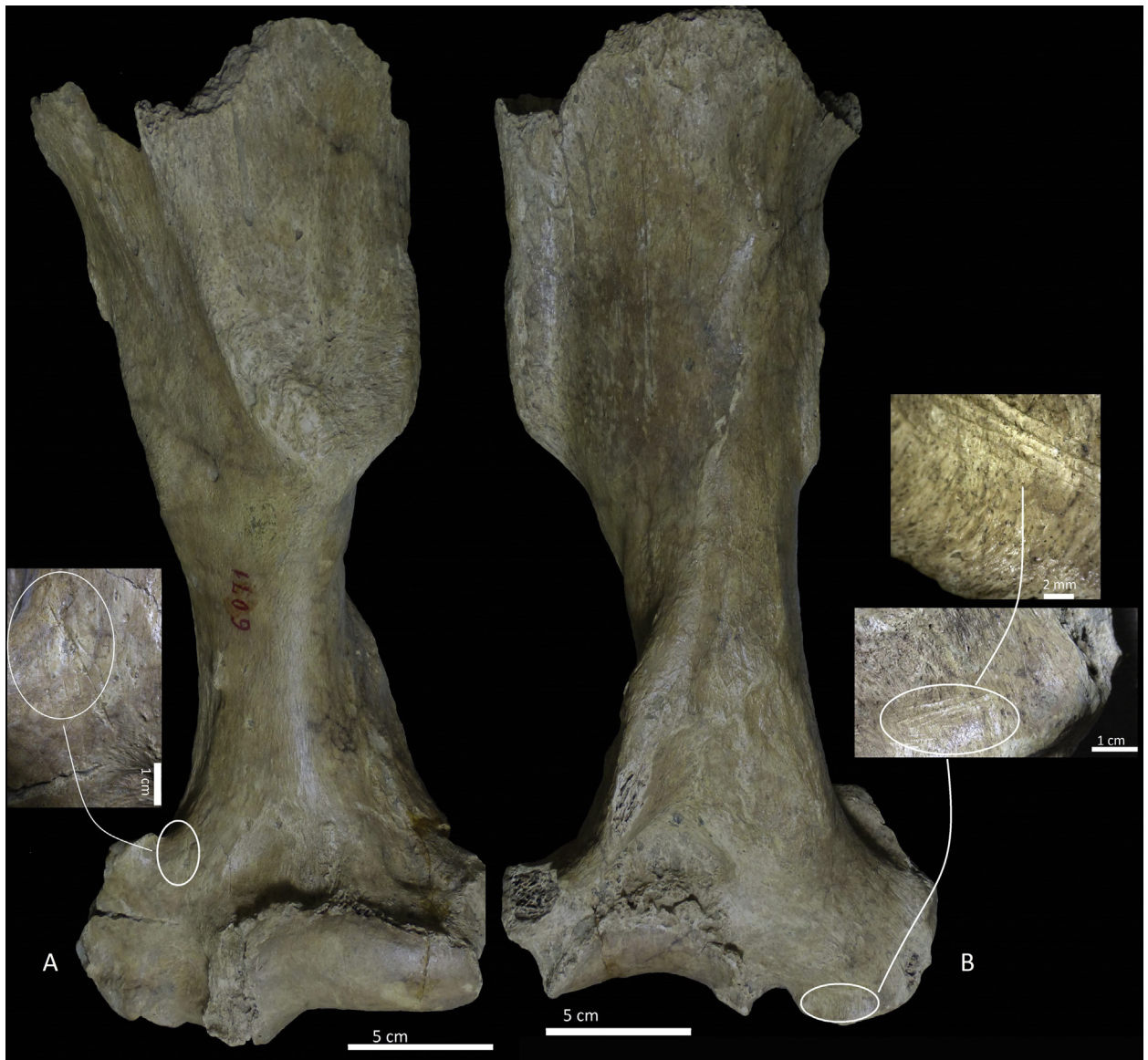


Fig. 1. Left humerus of *Doedicurus* sp. MACN PV 6071, A. Anterior face and B. Posterior face, in the circle, amplification of the cut marks.

Fig. 1. Humérus gauche de *Doedicurus* sp. MACN PV 6071, A. Face antérieure et B. Face postérieure ; les stries de boucherie sont visibles dans les cercles.

parts of the marks. This indicates that the marks occurred before the action of this agent. A sample of this vertebra was sent for dating to the 'Centre for Isotope Research' (Groningen), but regrettably was out of collagen. The other vertebra contains four grooves on the same side of the transversal process and in the same distribution. There are two superficial anterior-medially positioned marks measuring 1 and 3 cm. The other two are anterior-laterally positioned. As in the other case, this group is in contact with the border and the marks are deeper. One mark measures 4 cm in length and the other 1 cm. The grooves are wider and covered with sediment. The vertebrae underwent the same cleaning procedure and four casts were made. Microstriations and V shape were

observed in the larger mark of the external group of the first described vertebra (Fig. 6).

The basic morphological characteristics of cut marks as described in the bibliography were documented, some of the most important of which are elongation, the presence of microstriations, a V-shaped cross-section and smearing. Configurational features, such as the presence of groups of marks of similar characteristics on specific parts of the bone, strongly suggest an anthropogenic origin. The fact that evidence of anthropic intervention is found underneath other natural traces such as sediments, manganese and weathering cracks, and that they have the same condition that the rest of the cortical surface indicate that they

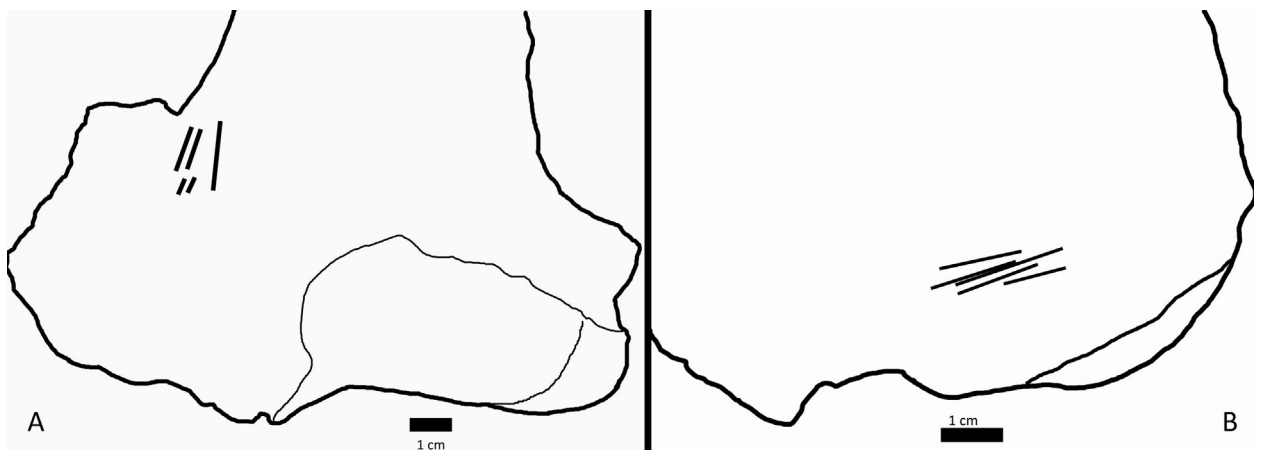


Fig. 2. Schematic drawing of *Doedicurus* sp. MACN PV 6071 with cut marks localization. A. Anterior face. B. Posterior face.
Fig. 2. Dessin schématique de *Doedicurus* sp. MACN PV 6071 avec les stries de boucherie. A. Face antérieure. B. Face postérieure.

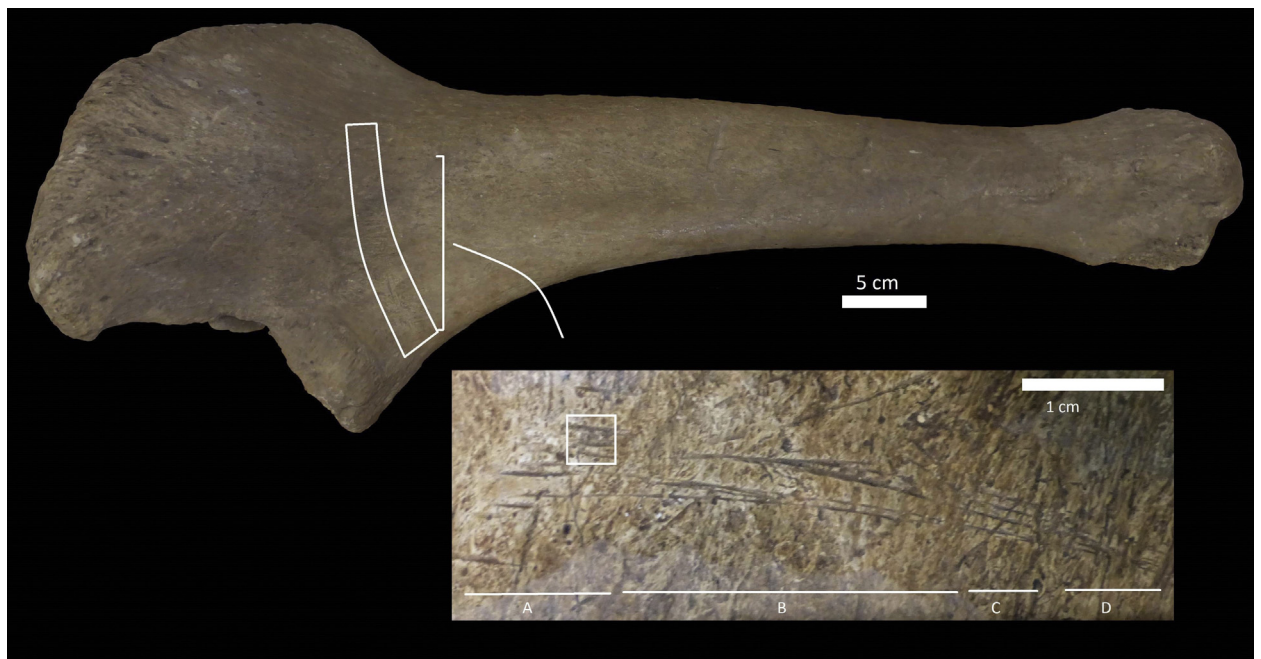


Fig. 3. Right ulna of *Megatherium americanum* MNHN.F.PAM 751, posterior-medial face with amplification of the groups of cut marks: A, B, C and D described in the text. In the rectangle: localization of Hirox image.

Fig. 3. Ulna droit de *Megatherium americanum* MNHN.F.PAM 751, face postéro-mésiale avec grossissement des groupes de stries de boucherie : A, B, C et D décrits dans le texte. Dans le rectangle : localisation de l'image de Hirox.

were probably made prior to burial and were not the result of excavation or museum handling processes.

5. Discussion

5.1. Butchering process

Because the identified cut marks are located on parts of the bone related to the epiphysis zones and or/muscle insertion points, they can be associated to the different butchering stages (Binford, 1981). These areas are the most susceptible to bearing anthropogenic traces left during the

disarticulation or filleting stages (Binford, 1981; Galán and Domínguez-Rodrigo, 2013).

Both groups of marks on the *Doedicurus* sp. humerus are located in the epicondylar medial region. Different species of Xenarthra possessed complex sets of muscles and tendons, such as the triceps muscle and the anconeus in the postmedial part of the humerus, which inserts into the olecranon of the ulna (Olson et al., 2016; Toledo et al., 2013). The first muscle extends over nearly the entire surface of the distal metadiaphysis of the humerus (see Toledo et al., 2013: Fig. 5). Butchering experiments on this part have shown that processing stages will leave cuts with

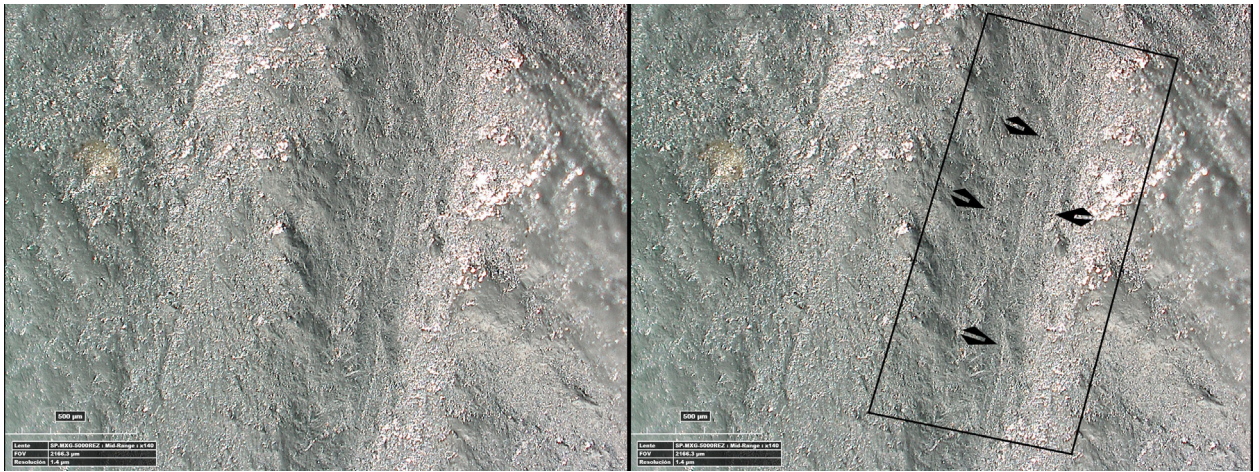


Fig. 4. Hirox image of the cast of the right ulna of *Megatherium americanum* MNHN.F.PAM 751 with indication of possible microstriations.

Fig. 4. Image Hirox des répliques des traces de l'ulna de *Megatherium americanum*, MNHN.F.PAM 751 avec les microstriations.

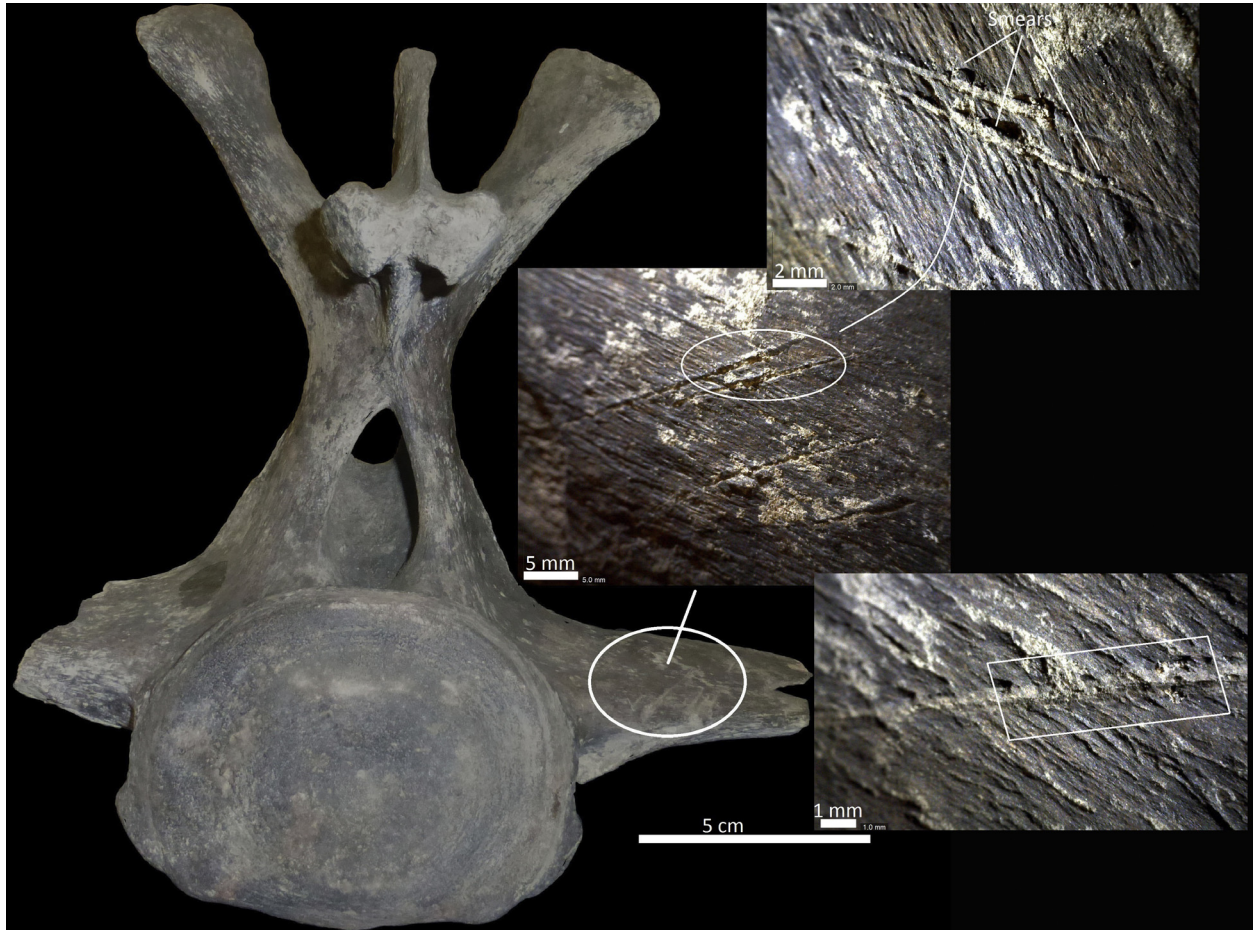


Fig. 5. Caudal vertebra of *Panochthus tuberculatus*, ZMK 38/1889. Posterior view with amplification of the group position on the transversal process. Indication of smeared bone. In the rectangle: asymmetrical groove, microstriations and localization of Hirox image.

Fig. 5. Vertèbre caudale de *Panochthus tuberculatus*, ZMK 38/1889. Vue postérieure avec grossissement du groupe de stries situées sur le processus transverse. Notez le bord avec épaulement. Dans le rectangle: le sillon asymétrique, les microstriations et localisation de l'image Hirox sont visibles.

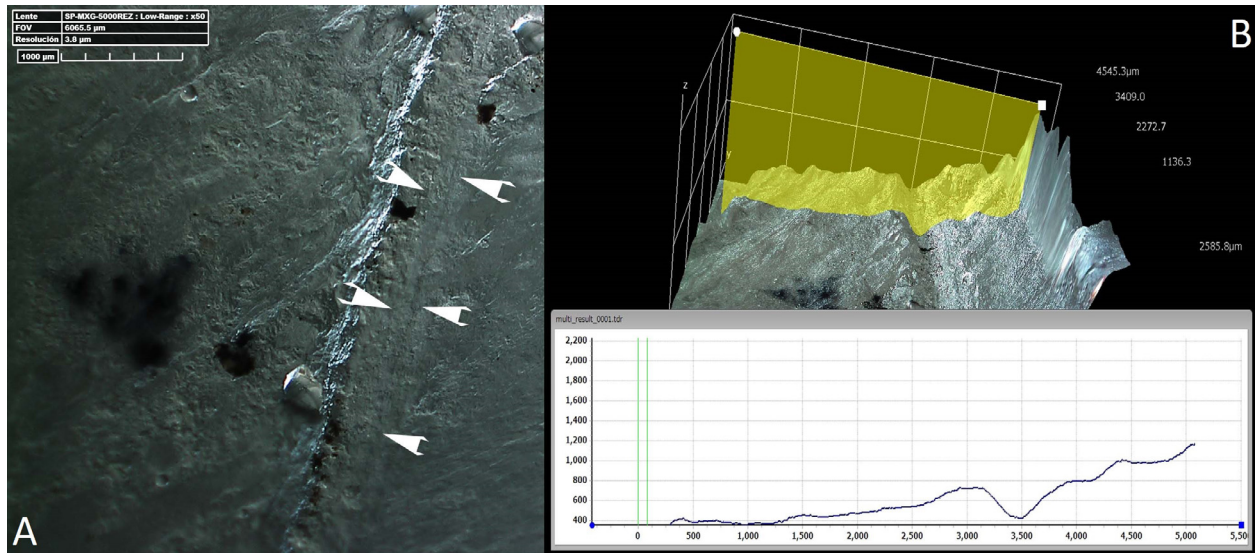


Fig. 6. A. Hirox image of the cast of the vertebra of *Panochthus tuberculatus*, ZMK 38/1889 with indication of microstriations. B. Hirox profile of the same section. Notice asymmetrical groove and V shape .

Fig. 6. A. Image Hirox des répliques de la vertèbre de *Panochthus tuberculatus*, ZMK 38/1889, présentant les microstries. B. Profil Hirox de la même section. Remarquez le sillon asymétrique et la forme en V.

an oblique and/or perpendicular orientation in the distal part (Binford, 1981; Galán and Domínguez-Rodrigo, 2013). Thus, the orientation of the cut marks and their position in similar areas of muscle or ligament insertion relates both groups of cut marks to the stages of disarticulation of the humerus from the ulna and/or the filleting of the muscle package. The marks on the *Megatherium americanum* ulna are located on the proximal metadiaphysis of the bone, under the coronoid process. This feature holds the insertion of the annular ligament, the insertion of the biceps brachii and the muscle brachialis (see Olson et al., 2016; Fig. 2; Toledo et al., 2013; Fig. 6). Furthermore, the supinator and the flexor digitorum profundus muscles are medially located (Olson et al., 2016; Toledo et al., 2013). Thus, the complex group of observed traces could be related to the intention of cutting the ligaments and separating the ulna from the humerus in a disarticulation stage or to fillet the different muscle groups. The different pressure executed at the beginning and the end of the cut mark are associated with the cutting edge of the instrument when this action was carried out or with the position of the animal during butchering. Also, the presence of the coronoid process might involve more pressure applied here than in the rest of the cutting motion. Finally, in the case of the *Panochthus tuberculatus* caudal vertebra, the cut marks are located on the transversal process. They can be related to the action of removing the muscle pocket contained in the tail (McNeill et al., 1999). This can be compared with the filleting process of tenderloin and sirloin extraction in the thoracic and lumbar vertebra. In these elements, the marks are elongated and transversally oriented to the dorsal spine (Binford, 1981) as they are here.

Thus, the presence of cut marks on the epiphyses would have served to cut ligaments, separate distal and proximal forelimb parts, or, as in the case of the vertebra, to extract

different muscles in the disarticulating or filleting butchering stages of meaty segments. The forelimb of a three tonne animal can yield 50 kg of meat (Arribas et al., 2001), while the muscle in the tail of a Glyptodonts can weigh 108 kg (McNeill et al., 1999). This evidence coincides with general American record. In fact, different sites along the continent have revealed evidence of butchering marks on the bones of the megafauna species cited here (humerus, ulna and vertebra) (see detail in Table 1). Anthropic manipulation is present in the form of cut marks, crescentic gouges, chopping, fracturing, impacts or were transported elements (see detail in Table 1). In those sites, these interventions were related to either disarticulation or filleting processing actions as it is proposed for the evidence presented here.

5.2. Access type

These traces could have been produced as the result of hunting or scavenging activities. At many sites throughout the Americas, most marks were created during scavenging activities. However, at other sites such as Murray Springs, Pleasant Lake, El Vano and Campo Laborde, hunting would have been the method of procurement (Casamiquela, 1979; Dillehay, 1997; Fisher, 1984; Hannus, 1989; Hemmings, 2007; Jackson et al., 2011; Jaimes Quero, 2005; Johnson, 1976; Martín, 2008; Prous, 1986; Saunders, 2007; Saunders and Daeschler, 1994). Both modalities of exploitation have been recorded at Pampas sites that contain the species of the same Order as discussed in this work (Fariña et al., 2014a; Politis and Gutiérrez, 1998; Politis and Messineo, 2008; Steele and Politis, 2009; Suárez and Santos, 2010). It should be noted also that in this region these species beside consumption have been exploited for bone technology and fuel (Politis and Messineo, 2008; Steele and Politis, 2009) (see detail in Table 1).

Table 1

Sites named in the text.

Tableau 1

Sites mentionnés dans le texte.

Region	Site name	Location	Species	Description	Humerus	Ulna	Vertebra	References
North American sites	Blackwater Draw	Clovis, Roosevelt, New Mexico/USA	<i>Mammuthus columbi</i>	Mammoth 1 with cut marks on the ulna and Mammoth 2 with cut marks on the humerus and ulna	x	x		Saunders and Daeschler, 1994
	Dent	South Plate River, Milliken, Colorado/USA	<i>Mammuthus columbi</i>	Cut marks on ulna		x		Saunders, 2007
	Lange-Ferguson	South Dakota/USA	<i>Mammuthus</i> sp.	Absence of vertebrae (including the caudal) suggests transportation/Separation of humerus from scapula	x		x	Hannus, 1989
	Murray Springs	San Pedro River, Arizona/USA	<i>Mammuthus columbi</i>	The right radius and ulna and lumbar and caudal vertebrae were missing, suggesting human intervention	x	x	x	Hemmings, 2007
	Lubbock Lake	Yellowhouse Draw, tributary of Brazos River/USA	<i>Mammuthus columbi</i>	Humerus butchering and secondary processing damage	x			Johnson, 1976
	Pleasant Lake	Washtenaw County, Michigan/USA	<i>Mammuthus americanum</i>	Impact depression on the head of the left humerus, fracture anterior border left humerus	x			Fisher, 1984
South American sites	Taima Taima	Paraguana Peninsula, State of Falcon/Venezuela	<i>Stegomastodon waringi</i>	Left humerus with 6 cut marks/Absence of right forelimb suggests human processing/Tail also removed and carried away	x		x	Casamiquela, 1979
	El Vano	Barbacoas Mountain Range, State of Lara/Venezuela	<i>Eremotherium rusconi</i>	Humerus and ulna with impact points and fractures	x	x		Jaimes Quero, 2005
	Gruta dos Brejoes	Bahia State/Brasil	<i>Glossotherium</i> sp.	Humerus with cut marks and fractures	x			Prous, 1986
	Monte Verde II	Chinchihuapi Creek/Chile	<i>Cuvieronius hyodon</i>	Three humeri with possible cut marks: 1 on the shaft, 2 on the proximal end	x			Dillehay, 1997
	Cueva Fell	Chico River, Pali Aike/Chile	Mylodontinae cf. <i>Myloodon</i>	Cut marks on an ulna		x		Martín, 2008
	Tagua Tagua 1	San Vicente de Tagua Tagua/Chile	<i>Cuvieronius hyodon</i>	Absence of forelimb suggests transportation for meat and bone exploitation	x	x	x	Jackson et al., 2011
Tagua Tagua 2	San Vicente de Tagua Tagua, Chile	<i>Cuvieronius hyodon</i>	Cut marks in humerus/Absence of caudal vertebra suggests transportation	x		x	Jackson et al., 2011	

Table 1 (Continued)

Region	Site name	Location	Species	Description	Humerus	Ulna	Vertebra	References
Pampean region sites	Arroyo Vizcaíno	Canelones/Uruguay	<i>Lestodon armatus</i>	Cut marks on an ulna		x		Fariña et al., 2014a
	Pay Paso 1	Quarai River/Uruguay	<i>Glyptodon</i> sp.	Glyptodon scutes in association with lithic artefacts				Suárez and Santos, 2010
	La Moderna	Azul, Buenos Aires/Argentina	<i>Doedicurus clavicaudatus</i>	Transport of meaty elements like forelimbs	x		x	Politis and Gutiérrez, 1998
	Arroyo Seco 2	Tres Arroyos, Buenos Aires/Argentina	<i>Megatherium americanum</i>	Tibia with helical fracture				Steele and Politis, 2009
	Campo Laborde	Olavarría, Buenos Aires/Argentina	<i>Megatherium americanum</i>	One rib with cut marks, one rib helically fractured, one rib transformed into informal tool				Politis and Messineo, 2008
	Paso Otero 5	Necochea, Buenos Aires/Argentina	<i>Megatherium americanum</i>	Burned bone used as fuel				Steele and Politis, 2009

If previous carnivore activity had occurred in the cut-marked bones described above, exploitable tissues would still have remained. Disarticulation or filleting marks indicating the presence of meat pockets at the time of human access. Though still scarce, the direct evidence of carnivore predation in the region (Scanferla et al., 2013), the variability of this native fauna implies that an important niche must have developed around this resource (Fariña, 1996). Carnivores may have accessed these animals by hunting or scavenging. However, these herbivores possessed defence systems that make the first option unlikely. Glyptodontidae coverage and accessory structures evolved as a defensive strategy to prevent carnivore predation (Zurita et al., 2010). *Megatherium americanum* could have been scavenged by canids like *Procyon* (Prevosti and Schubert, 2013) or could have been sporadically hunted by *Smilodon*, especially juveniles (Prevosti and Vizcaíno, 2006). However, the increasing body size of herbivores recorded during the Pleistocene was a defence system that evolved in response to carnivore diversification (Vizcaíno et al., 2012). Thus, as in the scavenging activities of megamammals that occurred in African or European environments, Pampas carrion would have sustained different carnivore groups, to which humans must be added, at the end of the Pleistocene (Borrero, 2009; Crader, 1983; Fariña, 1996; Haynes and Klimowicz, 2015; Yravedra et al., 2011). Humans also applied new ways of exploiting this resource, like direct hunting with novel technology (Cione et al., 2009).

6. Conclusions

Different types of evidence were considered to define the origins of the described anthropogenic alterations. Their general morphology was analysed with different magnifying glasses and microscopes, which allowed us to recognise several of the attributes defined for cut marks. Configurational features such as the presence of groups of similar marks with the same orientation led to the suspicion of anthropogenic origin. Additionally, all of the marks are, in general, related to the location of the epiphyses or to muscle/ligament attachments. This information

supports the relation of these marks to specific butchering stages, such as the separation of limbs or muscles, as observed in other American sites. This may have been the result of hunting and/or scavenging activities and would have implied that humans competed with Pampas carnivores for megamammal carcasses. At a coarse-grained level, this information adds to the body of knowledge on the relation between *Homo sapiens* and native species, and provides greater insight into paleoecological relationships (Chichkoyan et al., 2015).

The record of human biological marks on material collected during the 19th century means that these collections potentially contain archaeological information to be investigated. These collections are not only archives of the past, but also represent unrecoverable deposits that have to be explored in order to resolve modern enquiries. Consequently, these kinds of studies can not only increase the value of such fossil collections for the field of archaeology, but can also reveal information on the region and raise questions for future lines of research.

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