Ground sloths and humans in southern Fuego-Patagonia: taphonomy and archaeology

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Abstract

An evaluation of Late Pleistocene interactions between ground sloths and humans in the Fuego-Patagonia of Chile and Argentina is presented. Aspects of ground sloth taphonomy are explored, particularly the difficulties of using cut-mark and breakage evidence to recognize human exploitation. Selective transport of large animal bones is also reviewed in regards to its use as a marker of human exploitation of ground sloths. An evaluation of the relevant archaeological and paleontological records for the individual taxon *Mylodon* sp. is presented. It is concluded that there is little to no evidence for active human hunting of ground sloths and that scavenging is the only form of interaction that can be defended.

Keywords

Fuego-Patagonia; taphonomy; Late Pleistocene; *Mylodon darwini*.

Introduction

One of the main difficulties in debating the causes of the extinction of mega-mammals at the end of the Pleistocene is the quality of the evidence. Grayson (2007) highlighted the importance of discussing individual taxa instead of concentrating on assemblages of species. In this case a review of the available information for *Mylodon* sp. allows for the evaluation of a popular hypothesis that attributes their extinction to active human hunting. The first systematic archaeological excavations in Fuego-Patagonia showed that early human occupations were characterized by lithic artifacts and hearths associated with the bones of camelids (*Lama guanicoe*), horses (*Hippidion saldiasi*) and ground sloths (*Mylodon darwini*) (Bird 1938). These associations were interpreted as proof of human exploitation of those animals (Massone 1981; Menghin 1952). More recent work has

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demonstrated that camelids and horses were indeed exploited, and that corresponding bone cut-mark and fracture patterns indicate active hunting (Miotti 1998). However, the evidence was unclear for ground sloths. As such, in recent years associations between ground sloth bones and human artifacts have been interpreted as the result of human hunting (Borrero 1986), scavenging (Borrero 1999; Gutiérrez and Martinez 2008) and post-depositional processes (Borrero and Martin 2008).

In order to evaluate the interaction between sloths and humans, archaeological sites like Cueva Fell, Cueva del Medio, Cueva Lago Sofía 1 and Tres Arroyos 1 need to be considered. Paleontological sites like Cueva Lago Sofía 4, Cueva del Puma or Cueva Chica (Martin 2010; Martin et al. 2011) also provide important information. Other sites are more ambiguous, and have been interpreted by different authors as either archaeological or paleontological in nature (see Martin 2010). For example, the evidence of sloths living at Cueva del Milodón is abundant, and includes a thick and extensive dung carpet (Hauthal 1899; Nordenskjöld 1996 [1900]). The bones there include specimens from adults, juveniles and at least one newborn or unborn (Martin 2010; Nordenskjöld 1996 [1900]; Tonni et al. 2003). However, the evidence for a Late Pleistocene presence of humans at the site is minimal and there are no indications of sloth exploitation. The case of Cueva Las Buitreras – for years claimed to be a kill or processing site (Sanguinetti and Borrero 1983) – was recently re-evaluated, and it was concluded that there was no evidence of human exploitation of sloths (Borrero and Martin 2008). Sloth remains are also present at Pali Aike cave, but there is no evidence of interaction with humans (Bird 1988). A partially articulated sloth skeleton covered with rocks was recorded in Pali Aike cave's upper layers, and it was even suggested that sloth habitation of the cave may have been a deterrent to human occupation (Bird 1988; Martin 2010). Most of the sites with an early human presence also exhibit use by sloths before the arrival of humans, making any archaeological interpretations difficult. This interpretative difficulty makes it even more important to evaluate purported associations in greater detail.

Patagonian ground sloths

Ground sloths were large animals, weighing up to 1000 kilograms (Fariña et al. 1998; Prevosti and Vizcaíno 2006). It is known that *Mylodon darwini* had a diet based on grasses, hedges and herbs (Bargo and Vizcaíno 2008; Markgraf 1985; Moore 1978; Salmi 1955), which suggested that these animals often occupied open habitats (Moore 1978: 200). Independent paleoecological information confirms the existence of open habitats at the time that ground sloths were living in Fuego-Patagonia (Villa-Martinez and Moreno 2007).

It has been suggested that sloths were solitary animals, 'except in the breeding season' (P. Martin 2005: 33). They are characterized as slow animals on the basis of their large body mass (Borrero 1977), but also because their 'long, unretractable claws must have made it impossible for them to move quickly' (P. Martin 2005: 33). This might suggest difficulty in any escape from predators and P. Martin (2005) considered Mylodon easy prey. We believe that this may not necessarily be true. Sloths might have been easy to find, but not easy to hunt. They were probably dangerous animals to approach due to their strong claws, particularly in the upper members (Pascual et al. 1966): 'sitting on their haunches, propped by their tails and...using the curving claws' (P. Martin 2005: 33). For this reason, and because it was not abundant in the landscape, *Mylodon* was probably a costly prey to pursue. Work by Frison (1989, 2004: 57) demonstrated the difficulties of killing animals with thick hides like elephants (*Loxodonta africana*) using an atlatl and darts. Ground sloth hides were not only thick, but also included thousands of osteoderms that acted as dermal armor (Fig. 1). While the economic returns of sloths for hunter-gatherers were surely high, the costs were probably equally high.

It must be emphasized that the early weaponry systems recorded in Fuego-Patagonia included the atlatl and stone darts (Nami 1994), which were appropriate for long-distance hunting. The available evidence for horses (*Hippidion saldiasi*) and camelids (*Lama guanicoe, Lama sp.*) indicates systematic exploitation of these animals, probably using these weapons. However, their adequacy for hunting larger animals like sloths is still an open question.

Late Pleistocene Patagonian ground sloths also intensively used caves, which were characterized as 'living places' (Borrero 1983; Vizcaíno et al. 2001) or as maternal dens (Tonni et al. 2003; Martin 2010), perhaps indicating seasonal use. The paleontological evidence for the sloth cave use goes back at least to 28,000 years ago at cueva Cóndor (Barberena 2008; Borrero and Martin 2008).

The first human inhabitants of Fuego-Patagonia also selected caves as part of their settlement systems. Indeed most of our early archaeological evidence in Fuego-Patagonia is obtained from caves. As a result there might have been at least an indirect impact on the last ground sloth populations, since they probably lost many of their selected maternal dens. However, this is a separate matter from whether there is any evidence of sloths being actively hunted by humans.

The relationship of the last-appearance records of mega-mammals and the first-appearance records of humans is a crucial component of the assessment of interaction. In terms of understanding of extinction chronology, *Mylodon* in Fuego-Patagonia is a special case. 'No taxon other than *Mylodon* has >7 robust dates' (Barnosky and Lindsey 2010:

Figure 1 Fragment of *Mylodon* hide, with oseteoderms, Cueva del Milodón, Chile.

10), a number which has recently grown (Martin 2010). The chronological information for *Mylodon* – with forty-one radiocarbon dates (Borrero 1999; Martin 2010; and see Table 1) – constitutes a relatively robust last-appearance record for those animals in southern Fuego-Patagonia. Early human settlement is also well recorded and dated between 11,000 and 10,500 ^{14}C years BP at a number of sites in different Patagonian regions (Martin 2010; Massone and Prieto 2004; Nami and Nakamura 1995; Steele and Politis 2009). In other words, we can evaluate the overlap between humans and sloths on a firmer basis than we can for other taxa. Since it can be argued that the overlap of ground sloth with humans lasted approximately 1000 radiocarbon years (Barnosky and Lindsey 2010; Borrero 1999; Martin 2010), there is opportunity to evaluate the interaction between humans and sloths with some detail.

Table 1 Radiocarbon dates on ground sloth bone, dung and hide.

Site	*Taxón*	*Element*	*Age (^{14}C years BP)*	*Lab*	*Source*
Cueva Lago Sofía 1	Mylodon	Rib	9700 ± 100	31641	P. Moreno, pers. comm.
Cueva del Milodón	*Mylodon* sp.	Dung	10.200 ± 400	Sa-49	Emperaire and Laming 1954
Fell Cave	*Mylodon* sp.	Coxal	10.295 ± 65	Ua-34249	Martin 2010
Cueva del Puma	*Mylodontinae*	Osteoderm	10,340 ± 50	Beta-284446	Unpublished
Cueva del Milodón	*Mylodon* sp.	Undetermined bone	10.377 ± 481	LP-49	Tonni et al. 2003
Cueva del Milodón	*Mylodon* sp.	Hide	10.400 ± 330	A-1391	Long and Martin 1974
Cueva del Milodón	*Mylodon* sp.	Dung	10.575 ± 400	GX-6248	Markgraf 1985
Cueva del Milodón	*Mylodon* sp.	Dung	11.775 ± 480	GX-6246	Markgraf 1985
Cueva del Milodón	*Mylodon* sp.	Dung	10.812 ± 325	LP-34	Tonni et al. 2003
Cueva del Milodón	*Mylodon* sp.	Dung	10.832 ± 400	C-484	Arnold and Libby 1951; Bird 1988
Cueva del Milodón	*Mylodon* sp.	Dung	10.880 ± 300	GX-6243	Markgraf 1985
Cueva del Milodón	*Mylodon* sp.	Dung	11.330 ± 140	LP-255	Borrero et al. 1991
Dos Herraduras	Mylodontinae	Rib	11.380 ± 150	LP-421	Borrero et al. 1991
Lago Sofía 4	*Mylodon*	Vertebrae	11.590 ± 100	PITT-0940	Prieto 1991
Cueva del Milodón	*Mylodon* sp.	Dung	11.905 ± 335	GX-6247	Markgraf 1985
Cueva del Milodón	*Mylodon* sp.	Dung	12.020 ± 460	GX-6244	Markgraf 1985

(*continued*)

Table 1 (*Continued*).

Site	*Taxón*	*Element*	*Age* (^{14}*C years* BP)	*Lab*	*Source*
Cueva de los Chingues	Mylodontinae	Osteoderm	12.165 ± 80	Ua-32861	Martin 2010
Cueva del Milodón	*Mylodon* sp.	Dung	12.240 ± 150	A-2447	Markgraf 1985
Cueva del Milodón	*Mylodon* sp.	Dung	12.270 ± 350	A-2445	Markgraf 1985
Lago Sofía 1	*Mylodon* sp.	Undetermined bone	12.250 ± 110	OxA 9506	Steele and Politis 2009
Cueva del Milodón	*Mylodon* sp.	Dung	12.285 ± 480	GX-6245	Markgraf 1985
Cueva del Milodón	*Mylodon* sp.	Dung	12.308 ± 288	BM-1210B	Saxon 1979
Cueva del Milodón	*Mylodon* sp.	Dung	12.496 ± 148	BM-1209	Saxon 1979
Cueva del Milodón	*Mylodon* sp.	Dung	12.552 ± 128	BM-1375	Saxon 1979
Cueva del Milodón	*Mylodon* sp.	Dung	12.570 ± 160	LP-257	Borrero et al. 1991
Cueva del Medio	*Mylodon* sp.	Undetermined bone	12.720 ± 300	NUTA 2341 (AMS)	Nami and Nakamura 1995
Dos Herraduras	Mylodontinae	Rib	12.825 ± 110	AA-12574	Borrero and Massone 1994
Cueva del Milodón	*Mylodon* sp.	Dung	12.870 ± 100	A-2448	Markgraf 1985
Cueva del Milodón	*Mylodon* sp.	Undetermined bone	12.984 ± 76	BM-728	Burleigh et al. 1977
Lago Sofía 1	*Mylodon*	Undetermined bone	12.990 ± 490	PITT- 0939	Prieto 1991
Lago Sofía 4	*Mylodon*	Osteoderm	13.400 ± 90	AA-11498	Borrero et al. 1997
Cueva del Milodón	*Mylodon* sp.	Cuero (hide)	13.040 ± 300	W-2998	Martinic 1996
Cueva del Milodón	*Mylodon* sp.	Undetermined bone	13.183 ± 202	BM-1208	Saxon 1979
Cueva del Milodón	*Mylodon* sp.	Undetermined bone	13.260 ± 115	LU-794	Hakansson 1976
Cueva del Milodón	*Mylodon* sp.	Dung	13.470 ± 189	A-2446	Markgraf 1985
Cueva del Milodón	Mylodontinae	Undetermined bone	13.480 ± 40	Beta-164896	Martin 2010
Cueva del Milodón	*Mylodon* sp.	Cuero (hide)	13.500 ± 470	NZ-1680 (R-4299)	Long and Martin 1974; Saxon 1976
Cueva del Milodón	*Mylodon* sp.	Dung	13.560 ± 180	A-1390	Long and Martin 1974
Cueva del Milodón	Mylodontinae	Undetermined bone	13.630 ± 50	Beta-164895	Martin 2010

Taphonomy and expectations

If kill or processing sites of mega-mammals are found and excavated, perhaps as is the case for *Eremotherium rusconii* at El Vano, Venezuela (Jaimes 2003), in some situations we may expect no more than the recovery of a few bones. The wide dispersion of bones that results from processing large mammals and the small size of modern excavations may partially explain this (O'Connell et al. 1988a). Additionally, kill and processing sites are usually open-air, and thus very difficult to find.

However, once sites with sloth remains are found, there are a number of interpretative difficulties that must be considered, all related to the peculiarities of ground sloth taphonomy. As it is usually the case with mega-mammals, large amounts of meat can be obtained from *Mylodon* without disarticulating the carcass. But, in contrast to other mammals, the skeleton of *Mylodon* may have been more difficult to disarticulate. The short upper members are strongly articulated (Kraglievich 1940 [1934]: 282), while the spine has 'additional articulations' derived from its digging activities (Dawkins 2004: 295), with the segment of the lumbars to the last thoracic vertebrae and the sacrum forming a rigid whole of eleven to fifteen vertebrae (Owen 1842: 47; de Paula Couto 1979: 25; Kraglievich 1940 [1934]: 278–9). Therefore, the taphonomic principle, that the last bones of a mammal skeleton to disarticulate naturally are those of the spine (Borrero 1990; Hill and Behrensmeyer 1984), especially applies to Xenarthra. For that reason, the transport of these bulky ground sloth spines to central places seems unlikely (Savelle 1984, 1995; Smith and Kinahan 1984).

We know that bones of large mammals processed by the Hadza and left at the kill can be opened for marrow (O'Connell et al. 1988a), but this might not be expected for ground sloth bones since they have no easily utilizable marrow. Additionally, since bones were not regularly used for fuel in Fuego-Patagonia, as was sometimes the case in the Pampas (Joly et al. 2005), foragers may not have invested in their transport to central places. Finally, there are no known artifacts made of sloth bone. The exceptional perforated osteoderms found at Cueva de los Chingues probably constitute an example of cultural scavenging (Martin 2010). As such, no evidence for the use of sloth bones as implement raw material exists. In sum, transport decisions are the result of a balance between retrieval costs and benefits. It seems that in Fuego-Patagonia, the expected outcome for ground sloth bone may have been to leave the bones at the carcass site.

We might not expect many cut-marks resulting from the extraction of sloth meat, either. This is in part a function of 'the role soft tissues play in fortuitously protecting bone' (Gifford-Gonzalez 1989: 202). Unless there is intensive processing, the butchering of large mammals results in minimal contact between cutting tools and bones, since large amounts of meat can be stripped without touching the bones (Crader 1983; Gifford-Gonzalez 1989; Yravedra et al. 2010). While the case of Steller's seal exploitation in some coastal sites of North America shows that abundant marks can be produced through intensive exploitation (Lyman 1992), many other cases of large mammal exploitation show comparatively few cut-marks (Gaudzinski et al. 2005; Gifford-Gonzalez 1989; Haynes 1991; Yravedra et al. 2010). The kind of marks that can be best used to identify human activities on mega-mammal bones, and that are often present, are chop marks or other high-energy actions like those related to the disarticulation of elephants among the Bisa (Crader 1983: 134) or to the acquisition of large whale bone as raw material in the Late Holocene of Tierra del Fuego (Borella 2004; Borella et al. 2008).

Even when one suspects that cutting implements made contact with bones, that suspicion can be difficult to prove conclusively. Interpretative difficulties in the recognition of cut-marks include the fact that carnivore gnawing can mimic such marks. Furthermore, the pressure exerted by carnivores, instead of simply creating punctures, often ends in the fracture of the bones. This process produces notches, sometimes creating bone flake negatives (Martin 2010), which also be mistaken for human activity.

Stuart and Larkin (2010) noted the significance of trampling by large animals, such as mammoths, on the disarticulation of large carcasses (Haynes 1991; Sutcliffe 1985). However, under certain circumstances, especially in caves, a natural sloth death may be just as disorganized and may include some broken bones. This is why so much disarticulation and breakage, particularly of limb bones, should be expected at some natural sloth death sites in caves, in spite of their strong bone architecture. Therefore, to make the case for human exploitation of sloths no major breakages from trampling should be found at archaeological sites.

Trampling can also be problematic for interpreting human-sloth interactions because the scratches produced on bones during trampling can mimic cut-marks (Fiorillo 1989; Haynes 1991). We have many examples from Cueva del Milodon, a site where trampling by sloths seemed to have occurred frequently (Fig. 2) (also Borrero and Martin 2008).

Commenting on control cases for the exploitation of belugas (*Delphinapterus leucas*) and narwhals (*Monodon monoceros*), Savelle observed: ‘the whale bone elements remaining at the processing site are not a direct reflection of the anatomical parts that were utilized’ (Savelle 1995: 141). We wonder whether this might suggest that when ground sloths were processed there was little bone transport. When this is coupled with the interpretative difficulties to be had in bone markings it becomes clear that two of the most powerful indicators of human activity could be missing or misread even when sloth exploitation occurred.

Some of the early Patagonian archaeological sites seem to have been central living places where hunted fauna were transported. We will turn to presenting and evaluating the relevant information regarding the presence of sloth bone in those assemblages.

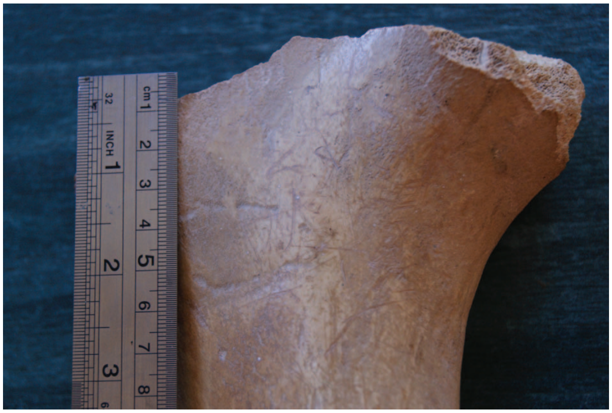

Figure 2 Trampling marks on Mylodon long bone, Cueva del Milodón, Chile.

Archaeological sites

The presence of humans is recorded for the period *c.* 10,900–10,200 ^{14}C years BP at Cueva Lago Sofia 1. The evidence consists of hearths, stone tools and broken and cut-marked bones of horse and guanaco (*Lama guanicoe*) (Prieto 1991; Martin 2010). Badly preserved *Mylodon darwini* bones dated to 12,990 ± 490 ^{14}C years BP (PITT-0939) and 12,250 ± 110 ^{14}C years BP (OxA 9506) (Massone and Prieto 2004; Prieto 1991: 81–3) were considered to be naturally deposited. Two teeth, one rib, two rib fragments and one undetermined bone fragment, together with thirty-seven osteoderms were recovered. Only a date of about 9700 ^{14}C years BP on a *Mylodon rib* (P. Moreno, pers. comm. 2008) suggests coexistence with humans, but no cut-marks were found on these bones.

Cueva del Medio has produced some of the best evidence in Fuego-Patagonia of Late Pleistocene human occupation in direct association with extinct faunas. According to Nami and Menegaz (1991) the upper component was characterized by triangular stemless projectile points in association with limited faunal remains, including three fragments attributed to *Mylodon* (?) *listai*. The lower component was characterized by the presence of fishtail projectile points and *Mylodon* (?) *listai* among other taxa. The faunal remains are dominated by camelids and *Hippidion saldiasi*. Independently of their provenience, all the dated faunal remains fall within the period between 11,000 and 10,000 ^{14}C years BP (Nami and Nakamura 1995). There is a total of only seven sloth remains, including: one tooth, one zygomatic arc, three vertebrae, one vertebrae apophysis, one phalange and an undetermined number of osteoderms. Nami and Menegaz (1991: 126) maintained that the presence of *Mylodon* at cueva del Medio could be either natural or cultural, but no cut-mark evidence was evident. Natural deposition can be argued for at least some sloth remains found below the archaeological layers, with a date on a *Mylodon* sp. bone of 12,720 ± 300 ^{14}C years BP (NUTA 2341).

Cueva Fell is located at the Pali Aike volcanic field and presents one case of humans probably transporting and consuming ground sloth tissues. The earliest archaeological assemblage recovered at Cueva Fell indicates an intensive period of human occupation of the cave between *c.* 10,000 and 11,000 ^{14}C years BP (Bird 1938; Emperaire et al. 1963). A few sloth bones – representing two juveniles and one adult – were found associated with hearths, fishtail projectile points, other lithic tools and horse and guanaco cut-marked bones (Bird 1988). No evidence for human use of sloth bones was recognized (Bird 1988; Poulain-Jossien 1963; Saxon 1976). However, recent taphonomic research of the sloth sample recognized cut-marks in bones of two juveniles, one of them probably a newborn (Martin 2010). With regard to the principles of large animal bone selective transport (O'Connell et al. 1992; Speth 2010), the idea might be entertained that sloth exploitation took place at Cueva Fell. Given the fact that some of the sloth bones display carnivore marks attributed to felids, scavenging is also a possibility.

The Tres Arroyos 1 rockshelter is located on the Isla Grande of Tierra del Fuego, and was occupied by humans before the opening of the Strait of Magellan (Massone 2004). Layer V, with several radiocarbon dates about 10,400 ^{14}C years BP, was characterized by the presence of five hearths, two projectile point fragments, other lithic tools and modern and extinct fauna, including horse and ground sloth. The latter is represented by fifty-four osteoderms, a molar fragment and a rib fragment found in Layer V and three osteoderms found in the lower, paleontological Layer VI (Mengoni Goñalons 1987; Borrero 2003). The bones found in association with hearths and lithic tools at Layer V present no evidence of human processing.

Hunting ground sloths?

Megafauna does not seem to have been important in the archaeofaunas of Fuego-Patagonia, and researchers emphasize that extant taxa were always dominant (Borrero 1984; Gutiérrez et al. 2010). Emperaire et al. (1963), Saxon (1976) and Borrero et al. (1991) have argued that no processing of sloths occurred at cueva del Milodon, cueva Fell and Pali-Aike. However, Bird (1988) interpreted the evidence from Fell cave as indicative of human sloth hunting. The same explanation was proposed for Las Buitreras cave on the basis of the number of recovered elements and marks recorded on the sloth bones (Borrero 1986; Sanguinetti and Borrero 1977). However, subsequent analyses disputed this evidence (Borrero and Martin 2008).

Hajduk et al. (2004) found marks on osteoderms recovered at the site of El Trébol in North Patagonia, but there is nothing to suggest hunting of sloths. Two carnivore dens, Cueva de los Chingues and Cueva del Puma, are examples of sites whose ground sloth assemblages are characterized almost exclusively by osteoderms (San Román et al. 2000; Martin et al. 2004; Martin 2010). A similar case was also recorded at Baño Nuevo (López Mendoza 2009). Osteoderm presence may signal either the transport of skins by carnivores or the deposition of carnivore droppings containing osteoderms. Indeed, well-preserved carnivore droppings with fragments of skins with osteoderms were found at Cueva del Milodón (Martin 2010).

The evidence at most of the sites discussed thus far consists of, at best, the stratigraphic association of small numbers of Mylodon bones with human stone tools and hearths (Bird 1988; Massone et al. 1993; Nami 1987). However, there is no clear evidence to support the notion that active hunting of ground sloths actually took place.

Scavenging ground sloths?

A model of carnivores creating a scavenging niche for humans in southern Patagonia suggests that the kills of *Panthera onca mesembrina* and *Smilodon* sp. may have provided large quantities of scavengeable flesh (Borrero et al. 2005). It is clear that large carnivores preyed on sloths, as demonstrated by the felid coprolites containing osteoderms found at cueva del Milodón. Three *Mylodon* skulls were also found there that display marks attributed to hunting by *Panthera onca mesembrina* (Martin 2008). The size of the skulls, the presence of other sloth bones found in large numbers, plus the accumulation of sloth dung, can all be used to argue that these animals were hunted by panthers at this large cave. Also, there is a *Mylodon* femur with large carnivore marks recovered at Dos Herraduras rockshelter, about 500m north of cueva del Milodón (Favier Dubois and Borrero 1997).

Scavenging is sometimes seen as a tactic that might be occasionally demonstrated by the earliest hominins, but evidence for scavenging among modern hunter-gatherers is abundant (Borella 2004; O'Connell et al. 1988b; Speth 2010: 70). While scavenging is one of many facultative responses for *Homo sapiens*, recognizing scavenging in the archaeological record can be difficult (Dominguez-Rodrigo 2002, 2003; Lupo 1994; Lupo and O'Connell 2002; O'Connell and Lupo 2003). The seizure of carcasses from their original predators is one possibility. Known as 'power scavenging', this activity will produce cut-mark and disarticulation patterns similar to those resulting from hunting, since carcasses will be reasonably complete and fresh (Bunn 2001; Shipman 1986). Passive scavenging, on the other hand, operates on partially consumed carcasses, and fewer cut-marks are expected (Bunn 2001: 203). Low processing costs of already opened and partially processed carcasses make scavenging a viable strategy (Martin 2010). This is particularly true during the initial times of exploration of a region, a time at which the human colonizers are learning about the resources and geography of new lands.

Conclusions

P. Martin (1973) presented an argument for the invisibility of mega-mammal kill-sites to explain the absence of overkill evidence. We consider this untestable (see also Grayson 1984). One thousand radiocarbon years is a long enough period to expect some sort of conclusive proof indicating a behavioral association between humans and sloths in Fuego-Patagonia. There is ample evidence for the exploitation and possible hunting of horses and camelids. As is well known, in North America the period of overlap between humans and megafauna was sufficient to produce good evidence of association of humans and mammoths (Haynes 2002; Grayson and Meltzer 2003; Waters and Stafford 2007).

Here, we evaluated the possibility that ground sloth extinction could be attributed to humans. In reference to a different geographic area and another sloth species, Paul Martin wrote that, '[i]f people and ground sloths had coexisted for a thousand years, my version of the overkill theory was in trouble' (2005: 84). We believe that he was right, and that the same conclusion applies to the case of the Patagonian ground sloths, which coexisted for over 1000 ^{14}C years with humans (Borrero 1999; Barnosky and Lindsey 2010; Martin 2010).

Meanwhile, at least 4000 ^{14}C years of interaction between sloths and extinct carnivores produced a solid record of *Mylodon* vulnerability to carnivore predation. Evidence recovered not only at den cave sites, like Cueva del Puma, Cueva de los Chingues or Cueva Lago Sofía 4, but also at exogene rockshelters like Dos Herraduras, confirms that sloths were prey of the large extinct carnivores. The shorter period of overlap between humans and Late Pleistocene fauna produced good evidence of horse and camelid hunting, but only fortuitous associations and minimal evidence of actual exploitation of sloths. In reviewing most of the faunal assemblages from southern Fuego-Patagonia, we found cut-marks on only two sloth bones (from cueva Fell). We interpret this to mean that there is little to no evidence of intensive skinning and stripping of sloth meat, in turn suggesting that sloths were not central to human subsistence.

We conclude by suggesting that if sloths were exploited at all, it was only partially through scavenging. However, for reasons highlighted in this paper we believe that the issue is not completely supported. While the absence of evidence of human ground sloth hunting cannot be used to say that it never happened, for the time being it clearly suggests that humans should not be suspected as the primary culprit for their demise.

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