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GEOARCHAEOLOGICAL PERSPECTIVES ON LATE PLEISTOCENE FAUNAS FROM ULTIMA ESPERANZA SOUND. MAGALLANES, CHILE

*ABSTRACT: A discussion of the formation processes associated with the extraordinary preservation of hide, hair and dung of extinct ground sloth (*Mylodon darwini*) at Cueva del Mylodon is presented. Information derived mainly from the study of the stratigraphy of that cave helps to explain this case of preservation. The discussion also makes use of data obtained at other archaeological and paleontological sites. These include Cueva del Medio, Cueva Lago Sofia 1, Cueva Lago Sofia 4 and Aleros Dos Herraduras. All these sites are dated between 13,500 and 10,000 BP by radiocarbon, and differ in the degree of preservation of the faunal remains and in the intensity of associated human occupation.*

KEY WORDS: Geoarchaeology – Patagonia – Megafauna – Preservation

INTRODUCTION

The geoarchaeology of the Ultima Esperanza region is important, since this is one of the few regions in the world in which preservation of muscle, hide, hair and dung of Pleistocene megafauna occurs. Together with several deep-freeze sub-Arctic localities (Sutcliffe 1985, Ukraintseva 1993) and very dry caves in SW North America (Agenbroad, Mead 1987), Ultima Esperanza is among the places with the best preservation of Late Pleistocene organic remains in the world. It is the purpose of this paper to discuss the conditions under which that kind of preservation was attained.

GEOLOGICAL BACKGROUND

The Ultima Esperanza Sound is a drowned glacial trough formerly occupied by a large outlet glacier from the Cordillera de los Andes. Arcs of terminal moraines, within which erratics are common, are located on the eastern side of lakes (Marden, Clapperton 1995). However, only a thin mantle of ground moraines remains witness of a landscape that was covered by ice, over which a thin vegetal layer was formed (Cortés 1985). Thus, the Holocene in this region is expressed in soil formation processes. Deposits with the potential to preserve archaeological or paleontological evidence are restricted to caves and rockshelters. These locations acted as traps for sediments and constitute environments where weathering debris from the walls and roof of the cave accumulate.

Three terraces, witness of a Late Pleistocene lake, were described in the region between Puerto Natales, Sierra Dorotea and Eberhardt Sound. The higher terrace has an altitude of about 150 m a.s.l. and its presence is recorded widely. Lakes Sofia, Toro, and Sarmiento are relicts of this lake (Cortés 1985, Prieto 1991). The ice in the western part of Golfo Almirante Montt dammed up the lake during the colder periods (Stern 1993a, 1993b). During those periods the lake attained higher levels (Clapperton 1993),

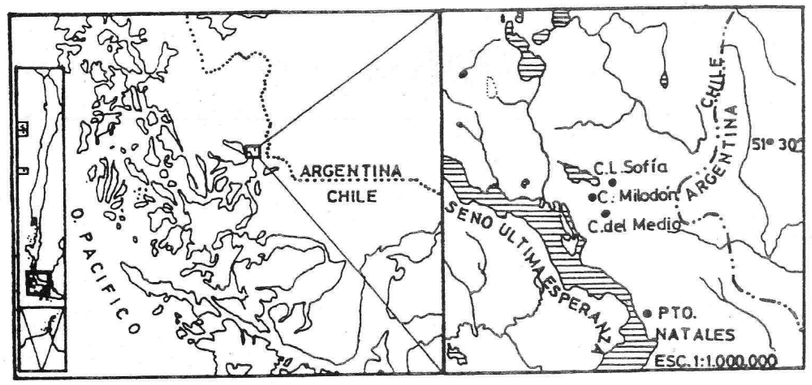

FIGURE 1. Location of sites discussed in text. Aleros Dos Herraduras are located by C. Milodón (taken from Borrero *et al.* 1991).

in close proximity to places which later were used by carnivores and humans (i.e. Aleros Dos Herraduras and Cueva del Mylodon).

Cerro Benítez, within which most of the sites are located, basically is formed on the Cerro Toro Formation (Cretaceous). This formation is more than 2,000 meters long, and is composed of dark lutites alternating with fine grained sandstones and lenticular conglomerates (Cortés 1985).

Wellman (1972) suggested that the formation of caves in the Cerro Toro Formation is a result of preferential salt weathering (haloclasty). The process requires active evaporation and is usually restricted to very arid regions or to coastal bands exposed to marine spray. Salt action, according with Wellman, operates specially on the lutites. Indeed, these rocks are sensible to the attack of salts. As for the conglomerate, it is possible that more frequent processes of chemical weathering mediated by water (dissolution, oxidation, hydrolysis, hydration) sufficiently explain its digregation. This process certainly collaborates in creating the weathering pattern. The intensity of this process may have been accelerated with the more humid climate of the Holocene, and it was certainly active during the 20th century in Cueva del Mylodon (Hauthal 1899, Emperaire, Laming 1954, Bird 1988, Borrero *et al.* 1991). A sector of the cave that was covered by rock meal in 1976 was clearly disturbed in 1939, when a photograph was taken by Junius Bird (Bird Archives, American Museum of Natural History, New York). Then, less than 40 years constituted time enough to cover the surface of the cave with a continuous blanket of rock meal. Saxon (1976, 1979) mistakenly took that as a proof of lack of perturbation in that sector of the cave.

In general, the Late Pleistocene in caves and rockshelters of this area should be marked by a low production of endogenous material resulting from chemical weathering due to the low water availability and extreme cold, and a high production of exogenous material resulting from the dryness of climate. The production of debris by physical weathering (haloclasty in shelters and crioclasty in the region) should have been the main process. The reverse should be true during the Holocene, with a higher proportion of endogenous debris due to increasing chemical weathering, and a lower production of exogenous material associated with the stability of the local landscape (pedogenesis).

THE SITES

The most important site is Cueva del Mylodon *(Figure 1)*, where the best preserved remains were found. This cave is 180 m long, 150 m wide and 30 m high *(Figure 2)*. A carpet of ground sloth dung (*Mylodon darwini*) being more than 1 m thick and larger than 40 m^2, was found *(Figure 3)*, which contained ground sloth, horse (*Hippidion saldiasi*) and guanaco (*Lama guanicoe*) bones. Even fragments of ground sloth hide, hairs, and the remains of insects were found in the cave (Nordenskiold 1900, Hauthal 1899). Twenty seven radiocarbon dates firmly put these materials between ca 13,500 and 10,000 BP (Borrero *et al.* 1991).

Additional findings of well preserved hide were recorded outside the present carpet of ground sloth dung in Cueva del Mylodon (Saxon 1979), but analysis of the deposits suggest that they consist mostly of decayed dung. The quality of preservation is variable within the cave, with the best preserved remains concentrated in the locations where the dung deposits were not altered by the filtration of water.

Other sites of the Ultima Esperanza region, even when delivering well preserved osteological samples, never produced the quality of preservation observed at Cueva del Mylodon. These sites, all located within five kilometers from Cueva del Mylodon, include Cueva del Medio, Cueva Lago Sofía 1, Cueva Lago Sofía 4 and Alero Dos Herraduras 3. All of them produced Late Pleistocene faunal assemblages.

Cueva del Medio is a large cave which was used by panthers (*Panthera onca mesembrina*) and ground sloths before the arrival of humans (Nami 1987). Chronological

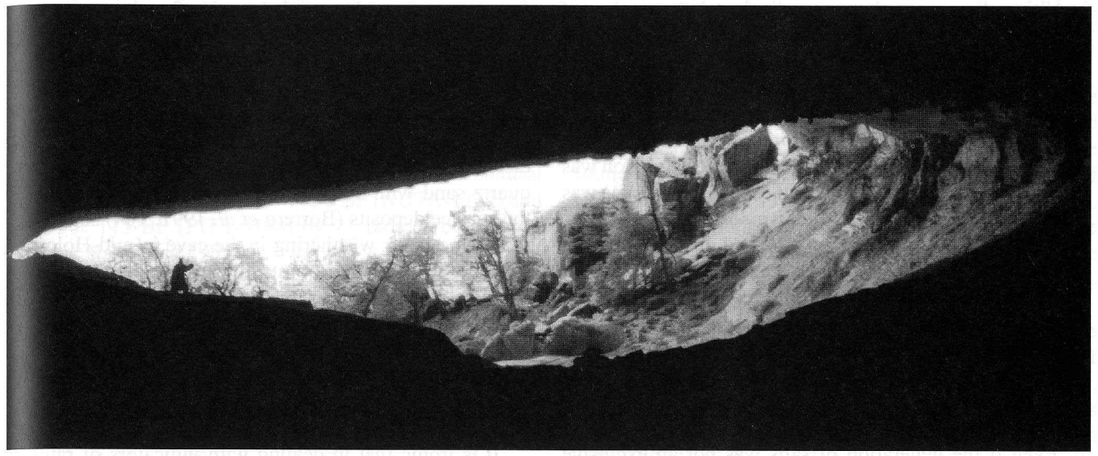

FIGURE 2. Cueva del Mylodon. Picture taken from the back of the cave. The figure on the left is a natural size reproduction of a ground sloth (*Mylodon darwini*).

evidence indicated that ground sloths were there ca 12,700 BP. As for panthers, it is known that their remains were recovered below cultural layers dated between ca 9,600 and 11,100 BP (Nami, Nakamura 1995: 128).

At Cueva Lago Sofía 1, a smaller and darker cave, remains of ground sloth were found under the human occupation, and dated in 12,990 ± 490 (PITT-0939). The posterior human use of this cave is indicated by a hearth, dated in 11,570 ± 60 BP (PITT-0684), broken and burnt bones and retouched tools. The species exploited by humans were ground sloth, horse, and guanaco (Prieto 1991).

Cueva Lago Sofía 4 is a dark cave that records the second best preserved Late Pleistocene bone assemblage in the region. The faunal remains were recovered basically within a matrix of calcium carbonate, except for a few bones found on the surface. The deposit was interpreted as a den probably formed by panthers (Borrero *et al.* 1997). Three radiocarbon dates between 11,050 ± 60 BP (NSRL-3341) and 13,400 ± 90 BP (AA11498) are available.

The location of Alero Dos Herraduras 3, a rockshelter in a more open situation, marks a difference with the rest of the Late Pleistocene deposits of the region. The remains of what appears to be a single ground sloth embedded within a tephra layer were recovered. The ossicles attest to the former presence of a hide which was subsequently decomposed (Massone *et al.* 1993). The tephra was fingerprinted to an explosive eruption of the Reclus volcano, located some 100 km north of Dos Herraduras, that occurred ca 12,000 BP (Stern 1992). Analysis of the better preserved ground sloth bones has uncovered carnivore damage, suggesting that it was prey of an extinct panther, the only carnivore with an adequate size to take young ground sloths and to produce punctures as those identified in a femur found at Dos Herraduras.

DISCUSSION

What is the cause of the excellent preservation observed at Cueva del Mylodon? The case can be classified as an example of natural mummification (Micozzi 1991), but the process that produced it is not yet well understood.

Extreme cold is one reason that usually explains the preservation of organic remains (Lyman 1994:138). Under deep freezing conditions soft tissues can be preserved, as exemplified by mammoth carcasses in Siberia (Haynes 1991), or the bison carcass found near Fairbanks, Alaska (Guthrie 1990). Extremely cold temperatures inhibit bacterial activity which is an important cause of decomposition.

Paleoecological data suggest the importance of cold conditions at the end of the Pleistocene in Ultima Esperanza, with a late glacial treeless vegetation that "consists of tundra or dwarf shrub heath and grassland or steppe" (Heusser *et al.* 1994: 100, Heusser in Prieto 1991, McCulloch *et al.* 1997).

An analysis of a piece of ground sloth hide from Cueva del Mylodon was made by Reginald Harris:

"... finding even the nuclei of the cells preserved, [Harris] concluded that the skin had been naturally freeze-dried at a time of very cold climate" (Sutcliffe 1985: 183).

Moreover, DNA was recently extracted from two bone specimens dated between 13,500 and 10,000 BP (Hoss *et al.* 1996).

"... low temperatures may be one condition that is critical for the survival of DNA over long time periods. Presumably, the reason is the decreased rate of chemical processes that degrade nucleic acids" (Hoss *et al.* 1996: 184).

Thus, cold climate appears to be related with preservation at Cueva del Mylodon. The problem is that similar cold conditions applied at the rest of the sites studied

in Ultima Esperanza, but none displayed the quality of preservation observed at Cueva del Mylodon. All these sites are dated within the relevant period comprised between 13,500 and 10,000 BP. Then, even when a cold environment appears to be a necessary condition, it is not a sufficient one.

Dryness may be also a factor. Nordenskiold (1900) mentions that the dung layer from Cueva del Mylodon was completely dry and hard-packed in 1899, and the same was observed by Gusinde in 1920 (Gusinde 1921).

But dryness was probably preserved during Holocene times due to the action of an auxiliary factor, salts. Nordenskiold specifies the presence of a layer of magnesium sulfate of 3–5 cm in thickness above the dung layer, and observed that it may have helped preservation. Perhaps the physical isolation produced by the rock meal layer was not as important as the chemical effect of the salts in preserving the dung layer from humidity.

Even if the generation of salts was not an exclusive property of Cueva del Mylodon, and it is presumed that salts could also be deposited at sites like Cueva del Medio, the shear size of the former have produced an inner environment minimally influenced by external conditions.

Then, it can be assumed that a combination of a cold and dry climate, and deposition of salts within a huge cave, were important in granting organic preservation. Anyway, other factors still need to be considered.

Another condition under which organic remains preserve well is when the rate of sediment deposition is quick enough for the carcasses to be covered by them before bacterial activity took place. Perhaps the accumulation of sediments in Cueva del Mylodon was faster than in the other caves.

SEDIMENTATION RATES AND PRESERVATION

Our chronological control over the different involved deposits, measured by radiocarbon dating, and the proportion of endogenous : exogenous materials helps to calculate sedimentation rates. We will examine the situation at each of the studied sites.

Cueva del Mylodon. Most of the recovered remains come from an extensive and thick deposit of dung. Perhaps the very process of dung accumulation produced conditions suitable for preservation under the prevalent cold-dry climate? A buried carcass is more difficult to reach by carrion insects and fungi (Lyman 1994: 140). Anyway, the preservation of dung is part of what needs to be explained.

Radiocarbon dates from the dung pile *(Figure 3)* suggest that between 12,570 ± 160 BP (LP-257) and 11,330 ± 140 BP (LP-255) 75 cm of dung were accumulated, and 20 dates bracket the whole dung deposit of almost two meters between 10,200 ± 400 BP (SA-49) and 13,560 ± 180 BP (A-1390).

The accumulation of rock meal, which is part of the process of cave formation (Wellman 1972) may help to explain the preservation. Indeed, it is known that the formation of a substantial deposit of rock meal on the surface of the cave took place in a period measurable in decades during the last 100 years (Borrero *et al.* 1991). But it is improbable that this process was very important in Late Pleistocene times.

Additionally, the deposits dated ca 5,000 BP that constitute Level 7 (*sensu* Saxon 1976) which are made of quartz sand with abundant calcium carbonate similar to the surface deposits (Borrero *et al.* 1991: 104) suggest an increase of rock weathering in the cave in mid-Holocene times. This evidence points toward the importance of chemical weathering for the production of rock meal, as opposed to the mechanism of physical weathering as suggested by Wellman, which is restricted to arid environments.

Human occupation in this cave started toward ca 8,000 BP (Saxon 1976).

It is ironic that in dealing with indicators of rates of sedimentation, a high proportion of endogenous: exogenous materials is taken to mean a slow rate (Favier Dubois 1997). The basic point is that the endogenous component generally accumulates as a result of weathering, which is usually slow in comparison with the accumulation of the exogenous component by sedimentation. Cueva del Mylodon appears

FIGURE 3. Cueva del Mylodon. Ground sloth dung pile and fragments of rocks fallen from the roof.

to be an exception to this idea. The presence of more than one process of weathering, together with the organic accumulation produced by the ground sloths, makes possible continuous and higher rates of deposition in the site.

Cueva del Medio. It is a large and relatively open cave (87 m long, 41 m wide and 6 m high), with two cultural layers dated between 11,120 ± 130 BP (NUTA-1737) and 9,595 ± 115 BP (PITT-0344) by 17 radiocarbon assays (Nami, Nakamura 1995).

A deposit of sand, over 2 m long, is located below the layers with organic remains suggesting the importance of a supply of exogenous sand material during the Pleistocene. This process was specially active in the frontal part of the cave, where sedimentation rates were higher. Accordingly, remains of ground sloth, horse, guanaco and *Cervidae*, deposited together with lithic tools and hearths, were well preserved (Nami 1987).

A change is noted for the Holocene layers, since practically no exogenous contribution is recorded in the front. Only 10 cm of mostly endogenous material accumulated in about 9,000 years in that part of the cave, and weathering was important as attested by the finding of only small bone fragments.

Test pits in the rear of the cave presented evidence suggestive of a more important accumulation of sediments during the Holocene (see Nami, Nakamura 1995). This is probably related with a more efficient chemical weathering process in the rear, which is more humid. Endogenous deposits were produced in that way, which under analysis proved to be very similar to the rock meal accumulation from Cueva del Mylodon (Borrero *et al.* 1991).

A pebble layer, dated ca 9,000 BP, acted as a seal for the lower deposits, and it is approximately contemporaneous with the Pleistocene/Holocene limit.

Cueva Lago Sofia 1. This cave is smaller than Cueva del Medio (30 m long, 8 m wide and 5 m high), and well protected from the elements. The inner part has been excavated. Endogenous materials are predominant all along the sequence (lutite and conglomerate debris). Exogenous materials are limited to volcanic ashes and pumices (Prieto 1991), then, relatively independent of the regional geomorphic dynamics.

It is not expected that erosion may have been present in the inner part of this cave. A protected microenvironment was created in this sector. Ancient bones, even on the surface, and including some with cutmarks, were preserved, in spite of low sedimentation rates.

On the basis of a radiocarbon date of ca 10,900 BP, only 30 to 40 cm of sediments were deposited during the Holocene. This deposit includes a human burial dated ca 3,900 BP.

As for the Late Pleistocene, three radiocarbon dates between 12,990 ± 490 BP (PITT-0939) and 10,910 ± 260 BP (AA11498) mark that some 22 cm were deposited in about 2,000 years. The remains of ground sloth, horse and guanaco, and the oldest human occupation of the cave dated in ca 11,600 BP, were found within that interval.

Cueva Lago Sofía 4. The paleontological remains were found within an inner chamber, almost completely isolated from the exterior. Unweathered ground sloth bones were found on the surface, revealing the complete lack of Holocene deposits. More faunal ramains (ground sloth, horse, guanaco, *Felidae*) were found in stratigraphy. These remains were within some 40 cm of late Pleistocene deposits, which took more than 2,000 years to accumulate.

Aleros Dos Herraduras. They are open rockshelters where exogenous materials are prevalent. There is evidence of different pulses of sedimentation of varying duration, including lake deposits and a tephra layer which is practically "instantaneous" in origin. The latter is related with the finding of a ground sloth skeleton that was partially in anatomical position. However, erosion was important in this location, since a gap of more than 8,000 years long is inferred from the radiocarbon dates.

The lower layers are dated between 11,380 ± 150 BP (LP421) and 12,825 ± 110 BP (AA-12574), while the upper aeolian layers are dated 2,530 ± 70 BP (LP386) and 2,575 ± 70 BP (A-7236). Pedogenesis predominated over morphogenesis during the Late Holocene, as attested by the scarce aeolian deposits within this interval which is contemporaneous with the cultural activity.

It can be sustained that an accumulation of endogenous material (debris and fallen rocks from the roof) alone is not adequate to preserve organic remains in a location like this. The reason is that – in contrast with the protected environments of Cueva Lago Sofía 1,4 or Cueva del Mylodon – it is too exposed to weathering.

In sum, high rates of sedimentation were probably instrumental in creating adequate conditions for preservation. Anyway, in some cases it appears to have been a secondary factor in comparison with the exceptional microenvironmental conditions obtained at some of the sites studied at Ultima Esperanza.

THE DUNG CARPET

It may well be asked if at some point in the past there were not dung deposits comparable with those from Cueva del Mylodon in the rest of the sites, that were subsequently desintegrated. The importance of panthers at Cueva del Medio argues against the existence of important contemporary ground sloth dung deposits. In both Cueva del Medio and Cueva Lago Sofía 1 the human use during the Late Pleistocene may have contributed to disturb any previous dung carpet, if ever available. As already said, this may have been true only for the latter, where use by ground sloths is indicated. The interpretation of Cueva Lago Sofía 4 as a carnivore den argues against the former presence of ground sloth dung.

Finally, an event of ground sloth carcass deposition is present at Alero Dos Herraduras 3. For lack of protection the place is not adequate as an habitation site. Moreover, the open location is not adequate for the preservation of dung. A tephra deposit covered the remains. Anyway, it is difficult to assert which comes first, the carcass or the tephra. The chronology of the explosion of the Reclus volcano firmly points to ca 12,000 BP as the date of the tephra (Stern 1992, McCulloch *et al*. 1997), and two radiocarbon dates on ground sloth bones are 12,825 ± 110 BP (AA12574) between –30 and –50 cm, and 11,380 ± 150 BP (LP421) at –40 cm. Skeletonization of the ground sloth occurred *in situ* as indicated by thousands of hide ossicles, but the fact that the skeleton remained at least partially in anatomical position at the time of recovery suggest that it was quickly removed from scavengers. The tephra deposit may have played a role in this, but it was not an environment with the capacity to preserve muscle or hide.

In sum, at none of the rest of the sites there exists any evidence of the former presence of ground sloth dung.

CONCLUSIONS

A combination of dryness and extreme cold, plus the sealing effect of salts, explain the preservation of organic remains at Cueva del Mylodon during Late Pleistocene times. The high rates of sediment accumulation proposed for the Holocene and the presence of salts allowed the remains to survive during a period characterized by a climate that was warmer and more humid. The importance of the salts is that being hygroscopic they inhibit the penetration of humidity to the levels containing fragments of hide, hairs and dung.

As for the rest of the sites, the situation was variable.

In well protected dark caves like Cueva Lago Sofía 1 and Cueva Lago Sofía 4, sedimentation was basically endogenous, with very low rates of sedimentation. Despite these conditions a favorable microenvironment was created, in which organic remains were well preserved. On the other side, open places like the Aleros Dos Herraduras are capable of accumulate abundant exogenous material, a condition that produced reasonable protection of organic remains. However, erosion can be active in an open place like this, as expressed by the long temporal hiatus.

Cueva del Medio is interesting in that there were differences in the sedimentation rates recorded in pits located in the front and rear of the cave. Accordingly, different expectations for preservation exist at that cave.

A geoarchaeological perspective was helpful in clarifying some of the issues, but still more research is needed in order to attain a better understanding of the processes involved in the formation of these rich and rare deposits.

REFERENCES

AGENBROAD L. D., MEAD J. I., 1987: Late Pleistocene alluvium and Megafauna dung deposits of the Central Colorado Plateau. *Geologic diversity of Arizona and its margins: excursions to choice areas*. Arizona Bureau of Geology and Mineral Technology Special Paper Phoenix V:68–84.

BIRD J., 1988: *Archaeology and Travels in South Chile*. University of Iowa Press, Iowa City. 246 pp.

BORRERO L. A., LANATA J. L., CARDENAS P., 1991: Reestudiando cuevas: nuevas excavaciones en Ultima Esperanza. *Anales del Instituto de la Patagonia* (Serie Ciencias Sociales) XX: 101–110.

BORRERO L. A., MARTIN F. M., PRIETO A., 1997 (in print): Cueva Lago Sofía 4: una posible madriguera del Pleistoceno tardío. *Anales del Instituto de la Patagonia* (Serie Ciencias Sociales) XXV.

EMPERAIRE J., LAMING A., 1954: La grotte du Mylodon (Patagonie occidentale). *Journal de la Société des Américanistes* XLIII: 173–206.

CLAPPERTON C. M., 1993: *Quaternary Geology and Geomorphology of South America*. Elsevier, Amsterdam. 779 pp.

CORTES R., 1985: Geología y Geomorfología de Ultima Esperanza entre los paralelos 51° y 52° de Lat. Sur. In: O. Boelcke, D.M. Moore and F.A. Roig (Eds.): *Transecta Botánica de la Patagonia Austral*. Pp.49–57. Conicet-Royal Society-Instituto de la Patagonia, Buenos Aires.

FAVIER DUBOIS C. M., 1997 (in print): Indicadores de tasas de depositación relativas en el registro arqueológico. Su aplicación en sitios de Fuego Patagonia. *Arqueología*, Facultad de Filosofía y Letras, Universidad de Buenos Aires VII.

GUSINDE M., 1921: Estado actual de la Cueva del Mylodon (Ultima Esperanza, Patagonia Austral). *Revista Chilena de Historia Natural* XXVII: 406–419.

GUTHRIE D., 1990: *Frozen fauna of the Mammoth Steppe: the story of Blue Babe*. University of Chicago Press, Chicago. 323 pp.

HAUTHAL R., 1899: Reseña de los hallazgos en las cavernas de Ultima Esperanza. *Revista del Museo de La Plata* IX: 409–420.

HAYNES G., 1991: *Mammoths, mastodons, and elephants: biology, behavior, and the fossil record*. Cambridge University Press, Cambridge. 413 pp.

HEUSSER C. J., BORRERO L. A., LANATA J. L., 1994: Late Glacial Vegetation at Cueva del Mylodon. *Anales del Instituto de la Patagonia* (Serie Ciencias Naturales) XXI: 97–102.

HOSS M., DRILLING A., CURRANT A., PAABO S., 1996: Molecular phylogeny of the extinct ground sloth Mylodon darwini. *Proceedings of the National Academy of Science* XCIII: 181–185.

LYMAN R.L., 1994: *Vertebrate Taphonomy*. Cambridge University Press, Cambridge. 524 pp.

MARDEN C. J., CLAPPERTON C. M., 1995: Fluctuations of the South Patagonian Ice-field during the last glaciation and the Holocene. *J. of Quaternary Science* X:197–210.

MASSONE M., BORRERO L. A., MARTIN F. M., CARDENAS P., 1993: *Investigaciones arqueológicas en Dos Herraduras, Ultima Esperanza*. Report National Geographic Society.

McCULLOCH R., CLAPPERTON C. M., RABASSA J., CURRANT A., 1997 (in print): The Natural Setting: The Glacial and Post-Glacial Environmental History. In: C. McEwan, L.A. Borrero, and A. Prieto (Eds.): *Patagonia: Natural History, Prehistory and Ethnography at the Uttermost End of the Earth*. British Museum Press, London.

MICOZZI M. S., 1991: *Postmortem change in human and animal remains: a systematic approach*. Charles C. Thomas, Springfield. 124 pp.

NAMI H.G., 1987: Cueva del Medio: Perspectivas Arqueológicas para la Patagonia Austral. *Anales del Instituto de la Patagonia* (Serie Ciencias Sociales) XVII: 73–106.

NAMI H. G., NAKAMURA T., 1995: Cronología radiocarbónica con AMS sobre muestras de hueso procedentes del sitio Cueva del Medio (Ultima Esperanza, Chile). *Anales del Instituto de la Patagonia* (Serie Ciencias Humanas) XXIII:125–133.

NORDENSKIOLD E., 1900: Jakttagelser och fynd y grottor vid Ultima Esperanza y Sydvestra Patagonien. *Kongl. Svenska Vetenskaps Akademiens Handlingar* (Stockholm) XXXIII/, 3:1–24.

PRIETO A., 1991: Cazadores tempranos y tardíos en la Cueva 1 del Lago Sofía. *Anales del Instituto de la Patagonia* (Serie Ciencias Sociales) XX: 75–99.

SAXON E.C., 1976: La prehistoria de Fuego-Patagonia: colonización de un habitat marginal. *Anales del Instituto de la Patagonia* VII: 63–73.

SAXON E. C., 1979: Natural prehistory: the archaeology of Fuego-Patagonian ecology. *Quaternaria* XII: 329–356.

STERN C., 1992: Tefrocronología de Magallanes: nuevos datos e implicaciones. *Anales del InsInstituto de la Patagonia* (Serie Ciencias Humanas) XXI:129–141.

STERN C., 1993a: Holocene tephrochronology of Tierra del Fuego. Abstracts. *International Workshop "The Quaternary of Chile"*, 5th Meeting of the Project IGCP-281 "Quaternary Climates of South America", Santiago de Chile.

STERN C., 1993b: Implications from tephrochronology for the history of a large pro-glacial lake in Ultima Esperanza, Magallanes, Chile. MS

SUTCLIFFE A., 1985: *On the Track of Ice Age Mammals*. Harvard University Press, Cambridge. 224 pp.

UKRAINTSEVA V. V., 1993: Vegetation Cover and Environment of the "Mammoth Epoch" in Siberia. In: L. D. Agenbroad, J. I. Mead and R. H. Hevly (Eds.): *The Mammoth Site of Hot Springs, South Dakota*, Inc., Hot Springs. 309 pp.

WELLMAN R. W., 1972: Origen de la Cueva del Mylodon en Ultima Esperanza. *Anales del Instituto de la Patagonia* III: 97–102.

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