



THE HUMAN OCCUPATIONS OF EL MIRÓN CAVE (RAMALES DE LA VICTORIA, CANTABRIA, SPAIN) DURING THE LAST GLACIAL MAXIMUM/SOLUTREAN PERIOD

Las ocupaciones humanas de la cueva del Mirón (Ramales de la Victoria, Cantabria, España) durante el Último Máximo Glacial y el periodo Solutrense

Lawrence Guy Straus^{1, 2}, Manuel González Morales², Ana Belén Marín Arroyo²
y María José Iriarte Chiapusso^{3, 4}

Recibido el 14 de febrero de 2013. Aceptado el 30 de junio de 2013

Abstract. *El Mirón Cave (Ramales de la Victoria, Cantabria, Spain) has evidence of brief visits (by hunting parties) to the montane zone of the upper Asón valley in easternmost Cantabria during the Last Glacial Maximum with 14C dates ranging between 19.2-18.4 kya uncal BP. Landscapes were largely treeless (scattered pines), with varying degrees of humidity and some amelioration at the end of the sequence of seven levels. Armed with a variety of Solutrean foliate, concave base and shouldered stone points and antler sagaies, decorated with beads of shell, tooth, bone and stone, the visitors camped repeatedly at the rear of the cave vestibule, made informal hearths, hunted red deer and ibex and caught fish, and did some stone knapping of both local and high-quality non-local raw materials. This is one of relatively few montane Solutrean sites known in the Cantabrian region, where, in fact, all major Solutrean base camps are in the coastal zone.*

Keywords: *Cantabrian Coast, Solutrean, subsistence, technology, palaeoenvironment, ornaments.*

Resumen. *La cueva del Mirón (Ramales de la Victoria, Cantabria, España) conserva el testimonio de breves visitas de grupos de cazadores al alto valle del Asón, en la zona más oriental de Cantabria, durante el Último Máximo Glacial, con fechas de radiocarbono que oscilan entre los 19200 y 18400 uncal BP. Durante este tiempo, el paisaje carecía casi por completo de árboles (acaso pinos dispersos), con diversos grados de humedad y una leve mejora climática al final de la secuencia de los siete niveles solutrenses. Armados con una variedad de puntas foliáceas, puntas de base cóncava y de muesca, azagayas de asta, y adornados con cuentas de concha, diente, hueso e incluso piedra, los visitantes acamparon repetidas veces al fondo del vestíbulo de la cueva, hicieron varias hogueras ocasionales, cazaron ciervos y cabras, pescaron salmones y realizaron actividades de talla con materias primas locales y con otras no locales de alta calidad. Este yacimiento es uno de los pocos yacimientos solutrenses de la región cántabra situado en una zona montañosa, donde de hecho, todos los principales campamentos base solutrenses se encuentran en zonas costeras.*

Palabras clave: *costa cántabra, Solutrense, subsistencia, tecnología, paleoambiente, adornos.*

(¹) Anthropology Department, MSC01 1040. University of New Mexico. Albuquerque. NM 87131. USA.

(²) Instituto Internacional de Investigaciones Prehistóricas de Cantabria. Universidad de Cantabria. E-39005 Santander (España).

(³) Área de Prehistoria. Departamento de Geografía, Prehistoria y Arqueología. Facultad de Letras. UPV-EHU. Francisco Tomás y Valiente s/n. E-01006 Vitoria (España).

(⁴) IKERBASQUE. Basque Foundation for Science. E-48011 Bilbao (España).



1. INTRODUCTION

The human responses to the climatic crisis of the Last Glacial Maximum (LGM) were technological, geographic, subsistence-strategic, social and probably ideological in nature. The area inhabited and used by people in Western Europe was reduced with the abandonment of England, the Low Countries, Germany, Poland, Austria, Switzerland and northern France, although there may well have been minor, temporary re-advances into some of these regions, possibly in response to the several moderating fluctuations within the LGM that are attested in both the classic palynological and the new ice core records. Defined by the presence of large (i.e., non-microlith) projectile points with a variety of standardized shapes (laurel and willow leaf, rhomboidal, asymmetrical, concave base, shouldered and stemmed points) made by either invasive or (for some shouldered types) backing retouch, the Solutrean is unique within the overall scheme of Paleolithic prehistory of the world *neither* in terms of having leaf points in general *nor* in its possession of specific artifacts (including osseous ones such as *sagaies* or eyed needles) or manufacturing techniques (e.g., some use of pressure flaking, heat treatment, overshot flaking).

Furthermore, the derivation of the Solutrean from the Gravettian in Western Europe, with which it was chronologically continuous, is clear, despite repeated efforts to attribute the phenomenon to various invasions (from either Eastern Europe or Northwest Africa). In southern France, Spain and Portugal, the distribution of Solutrean sites is essentially identical to that of the Gravettian and many of the same caves and rock shelters that were used during the Gravettian were also inhabited during the Solutrean. Trends toward increased site density in southern Iberia (where the Aurignacian is scarcely, if at all, represented) that had begun in the Gravettian, continued apiece in the Solutrean. Although such numbers can never be exact –only suggestive– reflections of population realities, Solutrean sites continue to outnumber Gravettian ones in several peripheral regions of Iberia. This is despite the recent discovery of several new Gravettian sites in Vasco-Cantabria. The case of Andalucía is notable in terms of a "boom" in Solutrean loci, suggestive of relatively favorable conditions for human survival in the southernmost part of the SW European LGM refugium. In general, the lower middle and middle latitudes of Atlantic Europe were regions abundant in pasturage (due to relatively long growing seasons, despite the cold temperatures) and thus rich in game. This was because, naturally, insolation remained high, thus helping to mitigate the cooling effect of the southward displacement by arctic waters of the Gulf Stream from the Bay of Biscay to a landfall at southern Portugal. In addition, and also in contrast to many parts of northern Europe, the many karstic limestone regions of the Southwest were well-endowed with caves and rock over-

hangs for human shelter, and supplied with sparse, localized stands of pines, junipers, birches (and, in the far South, even temperate arboreal species) for fuel and construction. Particularly in the many areas of complex relief (hills, valleys, canyons, with many places protected from the prevailing winds, including S- and SW-facing slopes favorable for vegetation, animals and humans alike), Solutrean groups could survive and indeed did thrive in what –if not a hunter's paradise– was at least viable, especially in comparison to the polar deserts and ice sheets of the North during the LGM. The choice of the most favorable places for habitation within band territories relatively rich in game, as well as available water and fuel, against the backdrop of severe temperature depression and storminess, is undoubtedly what lies behind the uneven distribution of Solutrean sites in the archeological record. In short, there were "good" areas in which to live, marginal zones, and areas to be avoided, especially during the worst episodes of cold and aridity within the LGM.

Thus the Solutrean is characterized by "hot spots" (areas of dense settlement including major sites), zones of light density settlement without major sites, and apparently empty or nearly empty "marchlands" (inter-territorial areas that may have been crossed to visit other Solutrean groups, but which were avoided as much as possible and where settlement was limited or nil, except perhaps during brief, slightly temperate episodes). In the "favored" areas, especially those with an abundance of caves or rock shelters from which to choose, Solutrean bands may have shifted their principal residential loci from spot to spot within narrow radii (perhaps for reasons of local fuel availability and/or site hygiene), which would explain why in areas of dense Solutrean archeological presence there may be several nearby major sites; these places may have been occupied sequentially (albeit repeatedly), not simultaneously. Examples of Solutrean core territories with major sites would include Laugerie-Haute and the Vézère valley/Les Eyzies cluster (Dordogne), plus the Tardoire (Le Placard *et al.*), Dronne (Fourneau du Diable *et al.*), Corrèze (Badegoule *et al.*) and Couze (Jean-Blancs *et al.*) valleys of SW France, the Isturitz-Brassempouy-Montaut area of the French Basque Country and adjacent southern Landes, the lower Rhone valley of SE France (Salpêtrière *et al.*), the central coastal plain of Cantabria between Santander and Santillana (Altamira, El Pendo, *et al.*), Posada de Llanes (Cueto de la Mina, La Riera, *et al.*), Ribadesella (El Cierro, Cova Rosa, *et al.*), and the middle Nalón valley (Las Caldas, La Lluera, La Viña, *et al.*) (all three areas in Asturias), Reclau Viver and the other Serinyadell sites (Girona), southern Valencia (Parpalló, Les Mallaetes *et al.*), Nerja and the other sites of the Bay of Málaga area (Andalucía), the Lisbon Peninsula (Salemas, Casa da Moura *et al.*) and upland sites (Caldeirão *et al.*) of Portuguese Estremadura, and the sites of the Côa valley in northern Portugal. In the peripheral or "marchland" zones between major site

clusters, the ephemeral nature of Solutrean encampments (some perhaps even in the open-air, especially if vernal in seasonality of occupation) probably often led to their elimination from or invisibility in the archeological record, thus accentuating the impression of "empty quarters" in the map of human settlement during the LGM. The occasional discovery of isolated (generally minor) Solutrean sites in the midst of vast "empty" regions (e.g., Grottes de Mayenne and St. Sulpice-de-Favières on the edges of the Paris Basin in northern France, Peña Capón in Guadalajara or El Sotillo and Las Delicias in Madrid) attests to the existence of what may have been shorter-term uses of certain "marginal" territories as climatic conditions within the LGM permitted. Significant territories that were used for occupation and/or were routes of communication among Solutrean centers are hinted at by such seemingly isolated sites as Solutré itself in the Saône basin of eastern France, Chaves in the Ebro basin of Aragon, Legintxiki in Navarra, Val Boi in Algarve and Valverde in Galicia. Even within regions that are generally rich in Solutrean evidence, there are zones of lesser site density. One such zone is in eastern Cantabria and western Vizcaya; it is the subject of this paper.

2. THE SOLUTREAN OCCUPATION OF THE RÍO ASÓN VALLEY

Without repeating too much of what has been published elsewhere (e.g., Straus and González Morales 2009; Straus *et al.* 2011), the principal drainage basin of eastern Cantabria, that of the Asón, roughly equidistant between the cities of Santander and Bilbao, has to date yielded only relatively scarce evidence of Solutrean occupation (and even less of the Early Upper Paleolithic), despite a wealth of important Magdalenian and Azilian sites (Fig. 1). And unlike those latter two periods, the Solutrean is only represented by sites in the montane zone, with none near the present day shore. As is true of all Vasco-Cantabrian valleys, the Asón is relatively short, descending from the Cordillera (maximum elevation in the sector, ca. 1400 m). During the LGM glaciers covered the highest summits and filled the upper valleys of the Cordillera in this sector (as in others to the east and west), though they may have reached their greatest extent in the millennia immediately before 20 kya. uncal BP. The LGM shore (-120 m below present sea level) would have been at most 8–9 km north of the modern littoral. Thus the walking distance (along the Asón valley floor) from El Mirón Cave and the other sites in Ramales to the LGM shore would have been ca. 28–29 km. The town of Ramales de la Victoria (elevation, only 70–100 m) is at the confluence of the Asón with two short, deeply entrenched tributaries (the Calera and Gándara) at the western end of a broad stretch of the main valley (Valle de Ruesga) that runs between the first and second foothill chains of the



▲ FIGURE 1. Map of the Asón River Valley with the location of El Mirón and other Solutrean sites (L. G. Straus and R. Stauber).

Cordillera, the latter with peaks at and slightly above 1000 m a.s.l. Isolated finds of Solutrean points have been reported in the adjacent decorated caves of La Haza and La Luz, as well as on the slope at the NE edge of Ramales not far below La Haza. The only other hint of Solutrean occupation of the Asón valley is a pair of recently obtained radiocarbon dates of 18.5 and 18.3 kya uncal BP associated with two possible Solutrean point base fragments from a 1x1 m test pit dug in Cobrante, a large cave at the inner edge of the coastal plain (Rasines 2010). It is possible that it *could* harbor evidence for a major Solutrean residential base camp on the coastal plain sector of the Asón valley that is so far missing from the archeological record. Only larger excavations in Cobrante could test this idea. It is also possible that the "missing" sites are on the now-flooded coastal plain off Laredo, awaiting discovery by divers, as in the case of Cosquer Cave off Toulon—with its Solutrean-age rupestral art.

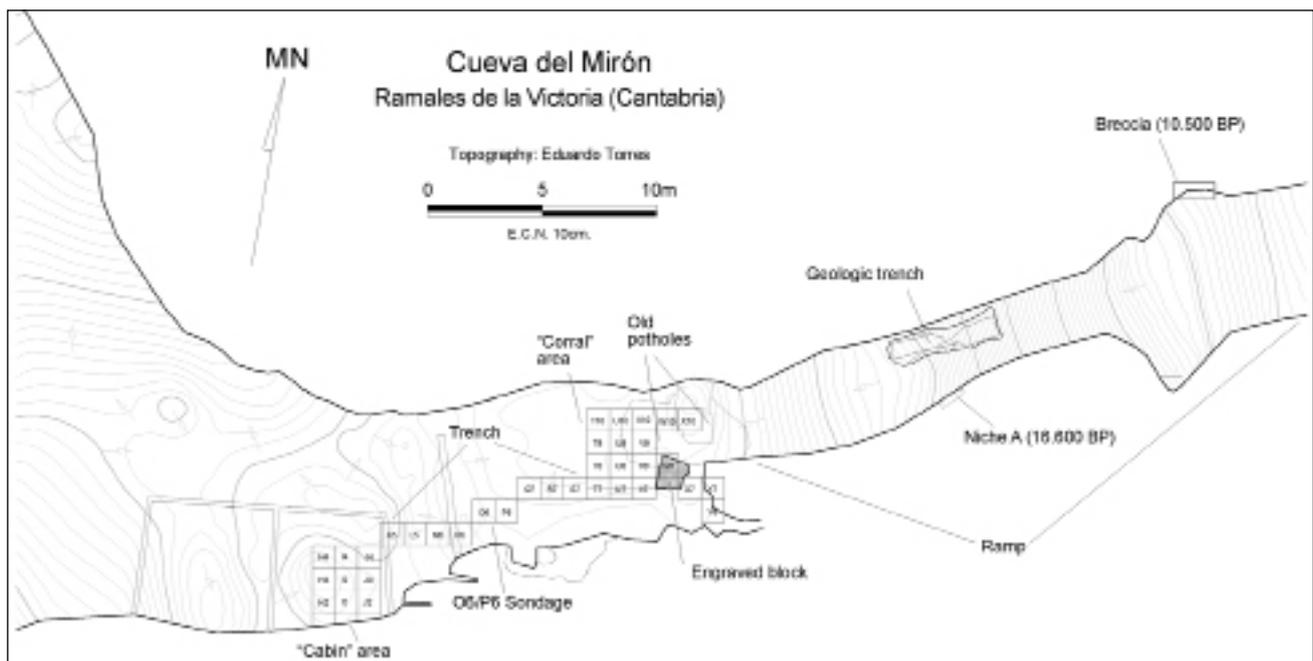
3. SOLUTREAN EVIDENCE IN EL MIRÓN CAVE: EXCAVATION AND STRATIGRAPHY

El Mirón Cave dominates Ramales and the whole valley from a cliff at its westernmost end. It has a very large (ca. 16 m wide x 19 m high) mouth that faces due west and its vestibule floor is at 260 m a.s.l. That vestibule is capacious (30 m deep and ca. 8 m wide, with a 13 m-high ceiling), dry, sunlit and sheltered from the winds (Fig. 2). Straus and González Morales (e.g., 2012) have been conducting excavations therein (plus tests in the dark, 100-long inner cave and the narrow ramp passage connecting it to the vestibule) since 1996. In the vestibule there are three excavation areas: toward the front within the foundation walls of an old dismantled cabin (9.5 m²), at the rear in an area that was being used as a corral as recently as the 1990s (13 m²), and a mid-vestibule trench that connects the two areas (7.5 m²). A separate numbering scheme was used for the strata in each of the three areas, although approximate correlations can be made based on sedimentary and cultural characteristics, as well as radiocarbon dates now totaling 78.

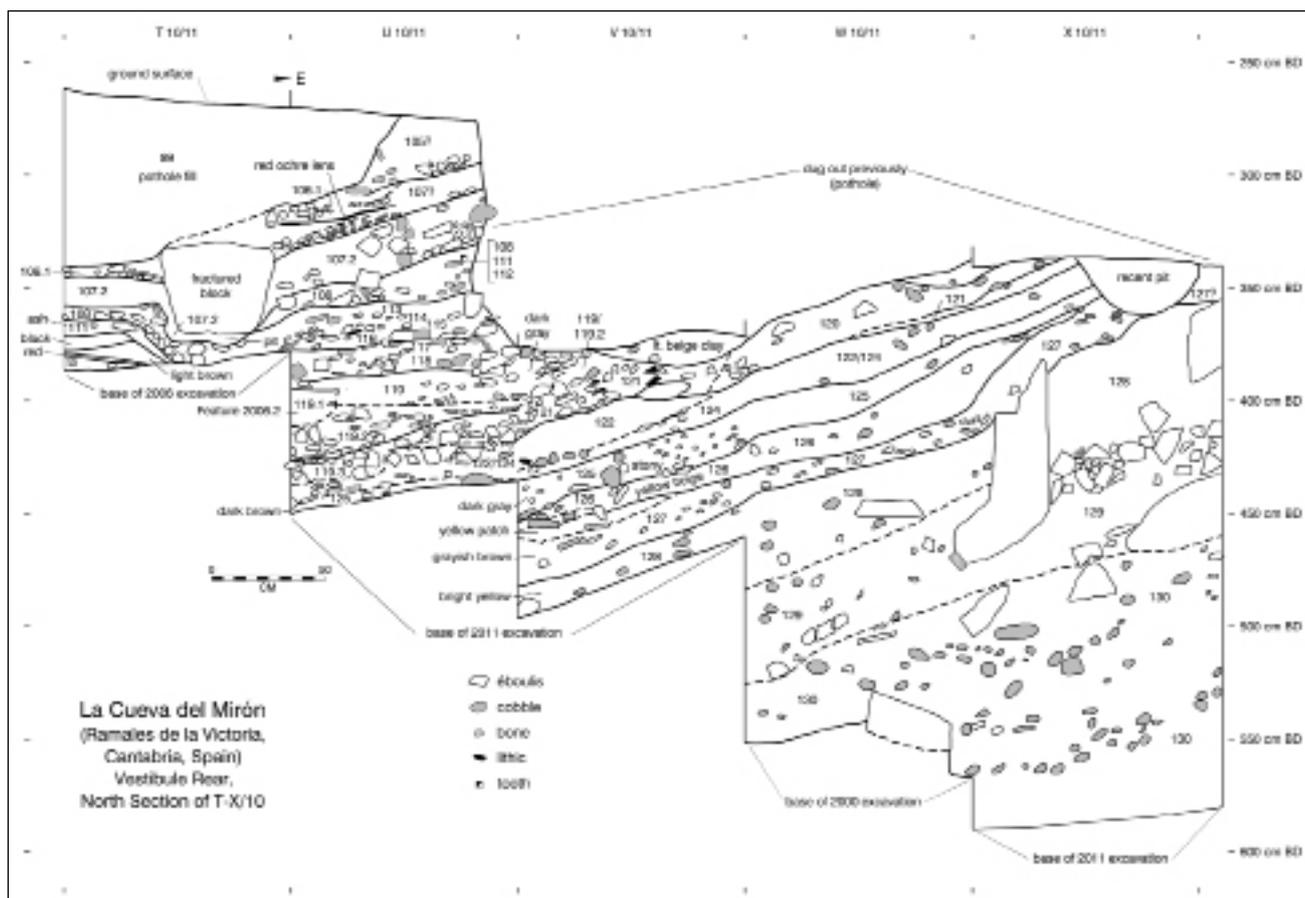
The Cabin area has revealed a cultural sequence from the Initial Magdalenian through the Bronze Age; the Mid-Vestibule Trench from the Initial Magdalenian (or Solutrean without Solutrean points) through the Neolithic; and the Corral from the late Mousterian through the Azilian. The Initial Magdalenian of the Cabin was found in a ¼ m sondage dug below the base of a rich Lower Cantabrian Magdalenian horizon (Level 17) and there is no trace of Solutrean occupation, though a deep core boring showed that very low-density cultural and faunal materials do continue below the

Initial Magdalenian in the vestibule front. The corresponding Lower Magdalenian horizon (Level 312) was encountered in two sondages dug at the base of the Mid-Vestibule trench and it was excavated in one of them (meter square P6). Below it was found a culturally poorer level (313) with no Solutrean points, but with a bone collagen radiocarbon date of 17,400 ± 270 uncal BP. This layer is in turn underlain by a gravelly silt level (314) with angular *éboulis* that was not excavated, but that, like 313, *could* pertain to the Solutrean. However it is only in the Corral area that proven Solutrean levels have been uncovered, and only in 4–5 sq.m (X-U10, plus V9 for the uppermost level). Discovery of a Solutrean presence in El Mirón Cave was made possible by a large "treasure-hunter" crater at the foot of the ramp passage in the extreme NE corner of the vestibule rear.

During the course of our excavation of intact sediments in the vestibule rear we also dug out (and dry-screened) the backfill of this hole, reaching at its base an intact layer of what looked to be "sterile", compact, clayey silt of a yellowish, light brown color that contrasted radically with the dark grey-brown, organically and culturally rich Initial and Lower Magdalenian layers overlying it in the stratigraphic profile of the looters' pit. We surmise that the looters stopped digging upon reaching this lighter stratum because they thought they had run out of "treasures". Their digging made it possible for us to go deeper (below the base of the crater) in a 1 sq.m sondage (in 1998), later (2000) expanded to 2 sq.m (W-X10), revealing a series of Solutrean point-bearing levels (121–127), plus a layer (128) with a sparse, banal lithic artifact assemblage but with a 27580 ± 210 uncal BP charcoal date, in turn underlain by a sterile stratum, and another one



▲ FIGURE 2. Plan of the El Mirón Cave vestibule with the excavation areas (E. Torres).



▲ FIGURE 3. Northern stratigraphic section of the U-X/10 trench. Solutrean levels are 121–127 (L. G. Straus and R. Stauber).

(level 130) with a few flakes, denticulate/notches, faunal remains and a charcoal date of 41280 ± 1120 uncal BP. Based on the Solutrean discoveries, two other contiguous meter squares were then dug (in 2010) at the western edge of the crater base: V10 and (for Level 121 only) V9. Finally, to physically link these levels with the full overlying sequence of Magdalenian levels, we dug below the base of the Initial Magdalenian (Level 119–119.3) in contiguous square U10 in 2011 (Level 119 dates on charcoal to 16960 ± 80 uncal BP). The result is a 3x1 m trench (plus a 1 m² appendage in V9) in which the Solutrean levels were completely or partially excavated, with fine-mesh water screening and (except in the original sondage) piece-plotting of *in situ* finds.

The sediments of Levels 127–121 (Fig. 3) were analyzed by the late W.R.Farrand (2012: 55–56) and can be summarized as follows:

- 127 (10 cm): "yellowish-,brown to brownish-yellow, sandy and gravelly loam including a fine-grain lense in middle; limestone fragments more abundant than exotic [waterworn, allochthonous] pebbles [from the alluvial infilling of the inner cave, upslope of the vestibule rear]; modest amount of CaCO₃... relatively rich in organic matter and cul-

tural debris; lower contact wavy and clear, probably erosional. Stratigraphic unconformity?"

- 126 (20–25 cm): "Medium yellowish-brown, sandy loam with abundant limestone fragments, exotic pebbles, flint, and bones...low CaCO₃, and organic matter; clear color contact with 125 above but gradational with 127 below."
- 125 (10–12 cm): "Distinct olive-brown, sandy loam with about equal numbers of limestone fragments and exotic pebbles [...] especially rich in bones and charcoal; low CaCO₃, but relatively rich in organic matter."
- 124–122: "Medium yellowish-brown, sandy loam with pebbles and limestone fragments, similar to 120, but a bit more yellow." Level 124 is 5 cm thick; 123 (where present, namely in the southwest part of the W-U trench) is 3–7 cm thick; and 122 is 10–20 cm thick and where 123 is lacking it merges with Level 124 to be at its thickest.
- 121 (3–7 cm): "Thin, dark brown layer at base of 120 with fewer rocks; limestone fragments are chalky; low CaCO₃ and organic matter."
- 120: "Dark yellowish-brown, loamy matrix with abundant exotic pebbles and chalky limestone

fragments and some bone; low CaCO₃ and organic matter." ("Level" 120 in squares V9-10, W-X10 is now understood likely to be a layer of compacted, mixed back dirt at the base of the looters' crater, since it does not exist between intact levels 119.3 and 121 in the contiguous stratigraphic sequence of square U10. It did yield a Solutrean shouldered point and other Upper Paleolithic artifacts, but no modern artifacts.)

All these sediments are interpreted by Farrand as having been derived from the reworking of colluvial deposits from the ramp, themselves ultimately having eroded from the alluvial fill of the inner cave. To this day, after intensive rains, especially in winter, rivulets of water (presumably infiltrating through the ceiling of the inner cave) run down the steep colluvial-alluvial ramp to the eastern end of the Corral area. Altogether the Solutrean strata represent some 70 cm of deposit, apparently laid down in about a millennium, with most of the sediments being of natural (non-anthropogenic, mineral), autochthonous origin, namely the ramp face of the alluvial in-filling of the inner cave. The contrast between them and the overlying initial Magdalenian levels could not be sharper in terms of organic content and hence color, as well as in terms of the density of humanly transported materials (artifacts and faunal remains).

The radiocarbon chronology of the Solutrean-point bearing levels is as follows (Tab. 1).

Bracketed by dates of 27.5 and 17 kya uncal BP (terminal Marine Isotope Stage 3 and initial Oldest Dryas/Greenland Stadial 2b respectively), the Solutrean levels probably correspond to Heinrich Event 2, Greenland Interstadial 2 and/or Greenland Stadial 2c, namely the Last Glacial Maximum *sensu lato*.

The analysis of micro-mammalian (mainly rodent) remains from the Solutrean levels by Gloria Cuenca (Cuenca-Bescós *et al.* 2008, 2009) reveals assemblages devoid of woodland species, but including the Nordic vole (*Microtus oeconomus*) which suggests the presence of local humidity despite severe cold. Open grassland and rocky habitat species (*Arvicola terrestris*, *Talpa*, *Terricola*, *Microtus agrestis*, *M. arvalis*, *Chionomys nivalis*) are dominant and the extinct *Pliomys lenki* may also have been a rocky montane species, whose living relatives are found in the former Yugoslavia. Wood- or shrubland species (e.g., *Apodemus sylvaticus-fla-*

vicollis, *Sorex coronatus-araneus*) only gradually recovered during the succeeding early Magdalenian (i.e., Oldest Dryas) levels in El Mirón, finally taking off in the final Magdalenian, Azilian and Mesolithic levels. This might be suggestive of subtle, yet perhaps critical differences between the Solutrean and early Magdalenian levels in terms of the relative long-term habitability of El Mirón as a montane zone site.

4. PALYNOLOGICAL ANALYSIS

The long stratigraphic sequence and the large size of El Mirón Cave permitted sampling different areas of the vestibule for pollen. With regard to levels of Solutrean age, samples were taken in the Mid-Vestibule Trench (P-O/6 section, Levels 313 and 314) and in the Vestibule Rear (W-X/10 section, Levels 127-121). Unfortunately the samples from the former area were totally sterile, while those from Levels 121, 126 and 127 (plus Level 128 of Gravettian age) from the latter area did yield pollen (Fig. 4). The other samples (Level 122), as well as ones from Initial Magdalenian Level 119 in the Vestibule Rear area of the Corral, were also sterile.

Level 128, with a radiocarbon date of 27580 ± 210 uncal BP on charcoal, yielded evidence of rigorous climatic conditions, especially at the top of the layer. The landscape was characterized by minimal arboreal coverage, dominated by pine. Birch (far scarcer than pine) was present at the base of the level, but absent at the top. The herbaceous-shrub spectrum is clearly dominated by the Compositae, which increased through time while the grasses and heathers decreased, reflecting a progressive decline in humidity.

The samples from the first Solutrean level (127) and the basal one from Level 126 are characterized by even colder and drier climatic conditions than those of Level 128. The arboreal fraction is even smaller (AP: ca. 5%) and is only composed of pine. The Compositae maintained the same percentages as before and, although the grasses increased their representation in the open landscape, the development of the heathers and the ferns, along with the sporadic presence of *Artemisia* and *Centaurea*, indicate a further decrease in the degree of humidity.

Beginning in the upper part of Level 126 there is a clear change in the pale climatic dynamic. Humidity increased (as attested by a continuous, significant increase in heathers,

Level	Material	Date(uncal BP)	±1σ	Cal BC ±1σ	Lab Number
127	Charcoal	19230	50	21170-20680	UG-7216
126	Bone collagen	18950	350	21070-20010	GX-24471
125	Bone collagen	18980	360	21110-20040	GX-24470
121	Bone collagen	18390	300	19420-20380	GX-32655

▲ TABLE 1. Radiocarbon chronology of the Solutrean-point bearing levels.



▲ FIGURE 4. Pollen spectra of Levels 128-121 (M. J. Iriarte).

grasses, ferns and other hygrophile taxa versus a decrease in Compositae and the disappearance of the few previously present steppe taxa), while the arboreal stratum increased (maximum AP in Level 122=20%) and birch reappeared.

The only sample from the uppermost Solutrean level (121) seems to attest the same dynamic, but the poor preservation of the pollen does not lend itself to giving greater details.

During the whole Solutrean period in El Mirón Cave, the surrounding environment was dominated by open landscape. Although in the whole sequence the principal components of the herbaceous-shrub stratum were the same, it was the degree of humidity that conditioned their expansion. Similarly, when conditions were colder, but especially drier, taxa such as grasses, heathers and ferns decreased their coverage. In the case of arboreal taxa, pine is the only tree represented by pollen in the whole sequence, joined by birch only during episodes of slight climatic amelioration (first part of the Gravettian level and at the top of Level 126). Scattered pine trees dotted the valley floor.

Comparing this palynological record with others from the Cantabrian region (both archeological and non-archeological), one can observe coincident general tendencies, although with local differences. Problems of pollen preservation are also seen in Solutrean deposits at other sites, such as Antoliñako Koba in central Vizcaya (García-Ibaibarriaga *et al.* en este volumen). Nonetheless there was clear predominance of open landscapes during Solutrean times, with arboreal pollen percentages rarely over 20% (the average being around 10%). The main arboreal taxon was pine, although in some records such as La Riera in coastal eastern Asturias (Leroi-Gourhan 1986), Amalda in Guipúzcoa (Dupre 1990) and Morín in coastal central Cantabria (Leroi-Gourhan 1971) hazel and/or alder appear continuously. In La Riera and Amalda, although more sporadically, birch, oak, elm and alder also appear. In the case of the paleontological site of Kiputz IX Cave in Guipúzcoa (García-Ibaibarriaga *et al.* en este volumen), pine is almost the only arboreal component in a layer dated to 19870 ± 150 uncal BP (Castaños *et al.* 2006; García-Ibaibarriaga *et al.* en este volumen). The palynological sequence which has this site,

whose Solutrean level is very late (17420 ± 200 uncal BP, presumably after the worst of the LGM), the arboreal pollen index more than once reaches 40% and pine is almost continuously accompanied by alder, hazel, birch and linden. Nonetheless, it is important to keep in mind that several of the Chufín samples do not reach (or just barely reach) a count of 100 pollen grains.

Within the open landscapes, grasses and heathers were significant components, even during the coldest climatic episodes (La Riera, Amalda and Morín). During these periods, which also attest decreases in humidity, there were increases in Compositae, which at times outnumbered the grasses. The dynamic of the ferns is a faithful reflection of humidity. A common characteristic of all these deposits is the scarce presence of steppe taxa, even during moments of greatest climatic rigor.

The comparison of the palynological results from El Mirón with the study of the micro-mammalian remains by Cuenca-Bescós *et al.* (2008, 2009) tends to confirm the relative aridity and cold temperatures that existed during at least part of the Solutrean levels with a regression in wood- and wetlands.

5. CULTURAL CONTENTS

The dramatic contrast between the Solutrean levels and the immediately overlying early Magdalenian ones in terms of the density and diversity of human occupation residues cannot be overly stressed. The Magdalenian levels, from 119.3 to 108 are very dark ("chocolate" brown to black in color), in part as a result of the abundance of charcoal from numerous evident and latent hearths, also attested by large quantities of fire-cracked rocks. In addition, those levels contain masses of faunal remains, generally blackened by fungal activity (Marín-Arroyo *et al.* 2008), manganese oxide staining and burning and lithic and osseous artifacts (debris and finished implements), as well as patches of ochres and other pigments that may have been prepared (ground) on-site. In addition to dug-out hearths, there are also pits and (in the Magdalenian levels of the Corral area) a possible stone wall. All the evidence, at least for the Initial and Lower Magdalenian period, points to long, repeated, multipurpose occupations of the cave, probably by fairly large numbers of people (including men and women, based on the diversity of artifact types). The Solutrean levels (at least in the small area in which they have been excavated) have very little of this; artifact, manuport, and bone densities are low and there are only hints of a simple hearth with some fire-cracked rocks in Level 121 (and possibly 123, which may by itself be a localized hearth), though scattered charcoal flecks are not unusual. Unlike the Lower Magdalenian horizon, which is found throughout the vestibule, from the ramp

to the front, the Solutrean levels seem to be more restricted in extent, although this cannot be absolutely affirmed, particularly for the Mid-Vestibule trench.

5.1 Lithic Artifacts

As detailed in earlier publications, Levels 127-121 yielded modest lithic artifact assemblages. These are summarized in Tables 2 (lithic debris: debitage + cores) and 3 (retouched tools). The debris items are classified according to a system devised to provide simple, standardized technological information on lithic reduction by G. A. Clark and refined over the years by Straus. The tools are classified according to the original typology of D. de Sonneville-Bordes and J. Perrot (with the substitution in type 90 of continuously nibbled bladelets for Dufour bladelets *sensu stricto*).

The lithic debris amounts are uneven, but this in part reflects the extent of the respective levels, since 121 and 123 were limited in area and 127 was excavated in a somewhat smaller area than 122 (the richest level), 124-126. All the assemblages are massively dominated by trimming flakes and shatter (chips resulting from primary flaking and retouching that are all >1 cm in maximum dimension). The significant presence of these small, light items may indicate that the sediments of these levels have not been subjected to major water erosion despite the steep slope (*ca.* 15 degrees). At the other end of the size spectrum, cores are present in all but one level (generally poor Level 123), though their numbers are small in four levels and very small (1 and 3 items) in two levels (121 and 127). They are mainly flake and mixed (flake+blade[let]) cores, though the presence of bladelet cores in three levels (6 of them in Level 122, which is especially rich in unretouched bladelets [97+7 backed bladelets]) is noteworthy in a Solutrean context.

Chunks are quite abundant in all levels (except localized Level 123); these may include core remnants and exhausted cores, strikingly included many that bear some cortex, notably in Level 124 where cortical chunks (65) actually (and exceptionally) outnumber non-cortical ones (38). Plain (non-cortical) flakes and secondary decortication flakes (flakes with cortex covering less than the entire dorsal surface, both >1cm in length) are usually the dominant debitage categories, while blades (>2cm in length) are not very abundant despite constant presence. Platform renewal flakes, crested blades and splintered pieces (exhausted bipolar cores) are present in trace quantities only. The most abundant lithic raw materials are excellent-quality flints, probably from outcrops of Upper Cretaceous age along the present day shore of western Vizcaya and possibly central Cantabria, some 40-70 km from El Mirón, although there could have been closer outcrops on the Late Glacial

coastal plain that are now flooded (as hinted at by the Lower Cretaceous flint found on Sonabia Point that juts out into the ocean 10 km west of the present mouth of the Asón) (Risetto 2009). There are also local lithics (mainly mudstone and quartzite, with some quartz and limestone) represented among the Solutrean debris, but they are much less abundant than among the initial Magdalenian assemblages. It seems that most of the lithics were transported to El Mirón, even if it is obvious that knapping did take place here during Solutrean visits to the cave. The cores are small and portable, so it would seem that people going up to El Mirón from the coastal zone came prepared for camping in an area lacking in good-quality lithic materials. They worked the cores they brought "to exhaustion", hence the many "chunks".

This suggestion is supported by the small numbers of lithic retouched tools and weapon elements, which are mostly made on good-quality, "coastal" flysch flints—mainly our most common fine-grain flint groups (A and B, both including a variety of color-based categories), but also a variety of other types. This is especially true of the 28 Solutrean points (almost all fragmentary) from Levels 122–127 as well

as several other artifacts with invasive retouch: flint groups A and B dominate and there are several other raw material types are represented, including some very colorful ones. Not only are there many types of excellent, homogeneous (some translucent, chalcedony-like) flints among the points, but there is even one concave base point fragment (from mixed surface deposits) on fine grain quartzite, reminiscent of such points in central Asturias, where quartzite is the dominant material for making this type of artifact. The diversity of materials is suggestive of human groups visiting El Mirón after having been in (or traded with natives of) a variety of other areas within the Cantabrian region. The Solutrean points pertain to a number of types: unifacial, laurel and willow leaf, concave base and shouldered points. And the latter type includes different tang morphologies. All of the points (admittedly all but one fragmentary) are small. Snaps and pseudo-burinations on many of the fragments indicate that they were used, broken and abandoned. Tip fragments may have returned to the site embedded in animal carcasses and bases may have come back still hafted to their spear or dart shafts. Solutrean points were consumed at El Mirón, presumably during the hunt.

Types/Levels	121	122	123	124	125	126	127
0. Micro-burin						1	
1. Plain trimming flake	531	2506	311	987	2070	1447	1038
2. Cortical trimming flake	5	23	9	2	129	61	9
3. Plain shatter	26	390	20	218	282	202	72
4. Cortical shatter	9	56	2	108	28	31	24
5. Plain flake	123	407	41	181	293	226	165
6. Primary decort. flake	6	13	1	7	4	13	5
7. Secondary decort. flake	44	77	14	27	52	57	31
8. Whole/proximal plain blade	6	18	2	13	37	29	10
9. Distal/mesial plain blade		16	5	6	24	32	20
10. Primary decortication blade	1	1	1		2		
11. Secondary decortication blade	4	2		6	9	5	6
12. Distal/mesial cortical blade						6	1
13. Whole/proximal plain bladelet	28	43	8	21	29	23	3
14. Distal/mesial plain bladelet	16	51	26	32	60	90	19
15. Whole/proximal cortical bladelet	3	1	1	2		2	
16. Distal/mesial cortical bladelet		2		3	1	2	
17. Burin spall	6	6	1	6	6	5	9
19. Bidirect crest blade	1						
20. Flake core	1	3		2	1	1	1
21. Prismatic blade core				1	2	2	
23. Prismatic bladelet core		6		1	1		
25. Mixed core		5		2	2	4	2
26. Plain chunk	29	78	8	38	42	84	14
27. Cortic. chunk	10	34	1	65	27	28	14
28. Platform renewal flake				2	3	4	
29. Splintered piece		1			2		
Totals	849	3739	451	1730	3106	2355	1443
General total:	13673						

▲ TABLE 2. Solutrean Lithic Debris (Debitage + Cores)

Types/Levels	121	122	123	124	125	126	127
1. Simple endscraper						1	
2. Atypical endscraper					1		
5. Endscraper on retouched blade or flake	1	1			1	2*	
8. Endscraper on a flake	2		1	3			
15. Nucleiform scraper				1			1
17. Endscraper /burin			2		1	1	1
23. Perforator		1			1		
24. Atypical perforator/bec		1					1
25. Multiple perforator				1			
26. Microperforator		1					
30. Angle burin on a break	1	2	2		2	1	3
31. Multiple dihedral burin		1					1
38. Transverse burin on lateral truncation				1			
39. Transverse burin on a notch		1					
43. Nucleiform burin			1				
44. Flat burin			1				
52. Font Yves point						1	
58. Totally backed blade		2				1	
59. Partially backed blade				1			
61. Oblique truncation piece					1		
64. Bitruncated piece				1			
65. Continuously retouched piece, 1 edge	2	11	2	5	2	12	4
66. Continuously retouched piece, 2 edges		2	1	2	1	1	
69. Unifacial point		1		1	4**	1	1
70. Laurel leaf point		1			1	3	
71. Willow leaf point			1		1	1	2
72. Shouldered point			2***	2	1	4	1
74. Notch		5	1	3	1	6	2
75. Denticulate	4	12		7	6	4	6
74+75. Notch+denticulate			1				
76. Splintered piece		5	1	1	3		
77. Sidescraper				1	1	2	3
78. Raclette				1			
83. Circle segment				1			
85. Backed bladelet		6	5		3	1	
86. Truncated backed bladelet		1					
88. Denticulated bladelet						1	
89. Notched bladelet			1	1			
90. Nibbled bladelet			2			1	
92. Other		1					
Totals	10	55	24	33	31	44	26
General total:	223						

*: One is bifacial (unfinished or failed laurel leaf point?); **: One is partially bifacial; ***: May be from Lev. 125. There is also a shouldered point from mixed Level 120.

▲ TABLE 3. Solutrean Retouched Artifacts (de Sonneville-Bordes and Perrot typology).

Other retouched tools are very scarce, with the exception of continuously retouched pieces, denticulates, notches, sidescrapers, splintered pieces (which may actually be bipolar cores) and backed bladelets. Endscrapers and burins are remarkably rare, and the latter are very simple (burins on breaks). Curiously, the only types normatively associated with the so-called Badegoulian cultural phase in France (raclette and transverse burin on lateral truncation) are here represented by only one

item each, both in Level 124 –squarely in the middle of the Solutrean sequence, not at the end. Backed bladelets (and other types of retouched bladelets), though not absolutely abundant, are present in all the Solutrean levels except the top- and bottom-most ones (121 and 127). The presence of bladelet tool elements is a constant in all Cantabrian Solutrean collections from modern-quality (i.e., water-screened) excavations, suggesting the co-existence of two very different projectile types: large,

monolithic Solutrean points vs. composite microlith/*sagaie* points.

The relative abundance of continuously retouched pieces (de Sonneville-Bordes/ Perrot types 65 and 66), sidescrapers, denticulate and notches might suggest *in situ* butchery. In contrast, the scarcity of endscrapers, burins or perforators hints at the rarity of maintenance or domestic activities.

5.2 Osseous Artifacts

Although not abundant, there are osseous artifacts in each of the Solutrean-point bearing levels (albeit one only in Levels 127 and 123). There are three antler blanks and one antler wand. Each level (except 127) has one or two antler points (*sagaies*) (mostly fragmentary). There are "fine points" (which functionally could be diminutive *sagaies*, large needles or awls) in Levels 126 (n=2) and 124 (n=1). There are 1, 2 and 3 bone needles respectively in Levels 126, 121 and 122. One of the needle fragments is eyed. (One could ask whether hunters carried needles to repair torn clothing, footwear or equipment such as quivers or bags. Well-maintained clothing would be essential in the full glacial climate of Solutrean times.)

The *sagaies* include a possible proximal (basal) bevel fragment of half-round section with parallel, oblique engraved lines on the flat bevel surface and a nearly whole fusiform item (gracile *sagaie* or fine point?) with a long basal bevel that is engraved with fine, parallel, oblique lines (Level 122); an oval section, distal tip or proximal bevel base fragment with a dozen (sometimes partly double) fine, oblique engravings across one surface (Level 123); an undecorated, flattened oval section distal tip and a nearly complete item with central flattening and parallel oblique engraved lines on both the flattened face and the opposite one (Level 125). The centrally flattened *sagaie* is typical of the Cantabrian Solutrean and early Magdalenian. Even with such a small sample of *sagaies*, it is interesting to note their morphological variety –reminiscent of the variety among the Solutrean points. Whether these variations in projectile tips are stylistic or functional in character is an intriguing but as yet unanswered question. The *sagaies*, like the Solutrean points and backed bladelets, are all testimony to the importance of hunting during the occupations that formed Levels 127-121.

In addition to these obvious osseous artifacts, there are several bones with "cut marks" or "engravings" that could most parsimoniously be attributed to butchery. One piece of antler tine has some marks that could possibly be engravings.

5.3 Personal Ornaments

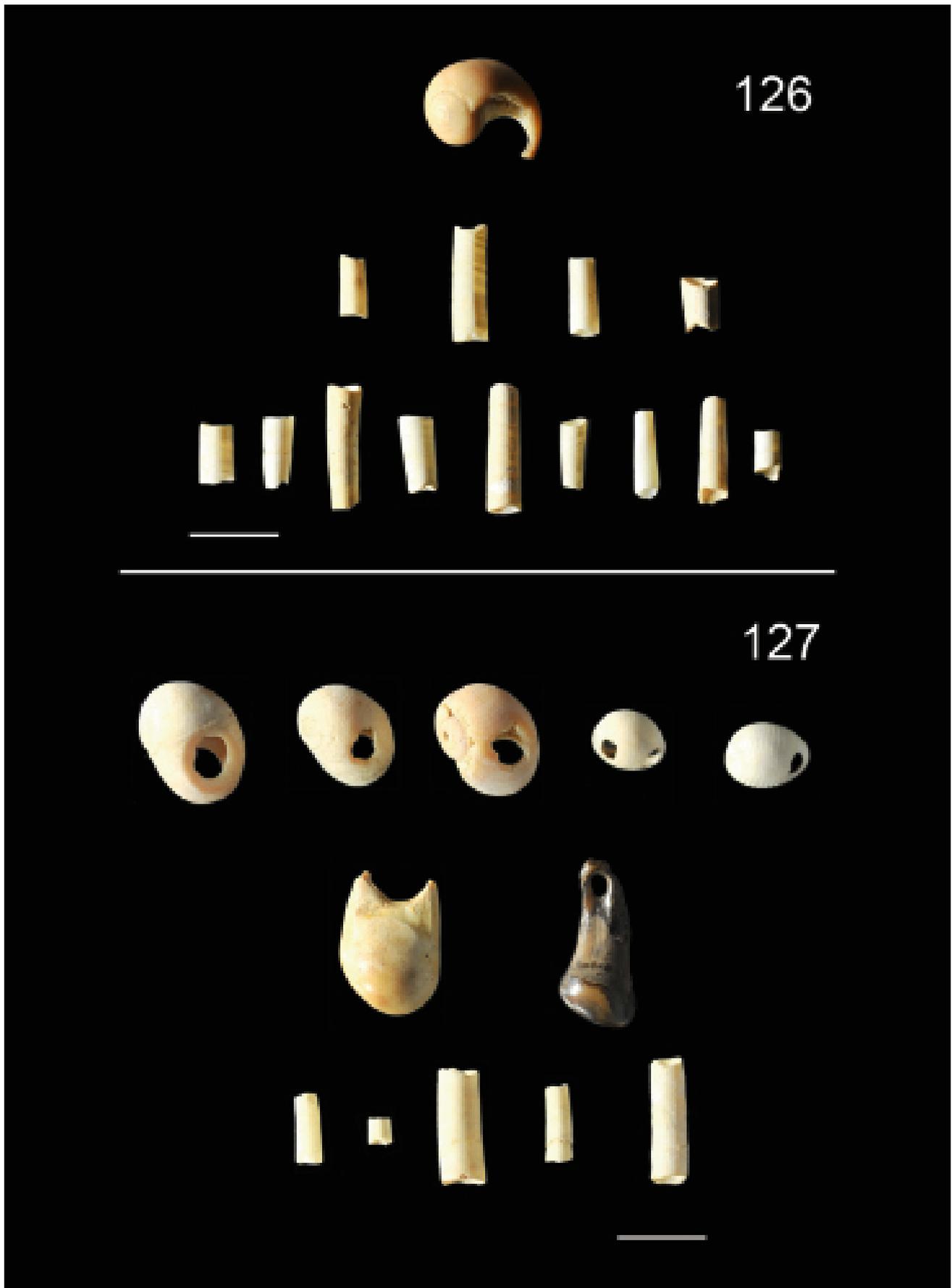
One of the most extraordinary characteristics of the Solutrean levels in El Mirón is the presence of relatively large

numbers of beads made of shell, tooth, bone and stone (Fig. 5). The perforated shells (along with several non-perforated ones, mainly *Patella* and *Littorina*) were identified by Igor Gutiérrez Zugasti. The most abundant mollusc taxon is *Antalis* (formerly *Dentalium*) and, all modified to remove their ends, these shells undoubtedly served as beads (total MNI=29, mostly in Levels 126 and 127). Not including the *Dentalia*, Level 127 yielded 1 perforated shell, 1 perforated red deer canine and 2 perforated polished bones cut to resemble such canines. Level 126 produced 5 perforated shells and a perforated stone that resembles a red deer canine. Level 124 had 1 perforated shell and Level 122 one perforated shell. Thus, altogether, there are 41 perforated objects from this small area of the site, with Levels 126 and 127 at the base of the Solutrean sequence being by far the richest. Nearly half the Solutrean points also come from this pair of levels. In terms of the apparent loss of personal ornaments at what may have been a limited-function hunting camp in Solutrean times, one is reminded of the discovery of a cluster of 9 perforated and engraved red deer canines in Upper Magdalenian Level 2 of El Rascáño, a specialized ibex-hunting site in the upper Miera valley, just to the west of the Asón (González Echegaray and Barandiarán 1981:115-116).

6. PRELIMINARY ARCHEOZOOLOGICAL ANALYSIS

What follows is a preliminary study of a sample (ca. 25%) of the faunal remains from Levels 121-125, specifically from square V10 in the Corral area of El Mirón Cave. The methodology used is the same that was employed in the study of late Magdalenian and Azilian levels from the site (Marín-Arroyo 2010). Identification of remains was done by comparing with the reference collection in the Archeozoology Lab at the Universidad de Cantabria. Basically the species identified are *Capra pyrenaica*, *Cervus elaphus* and *Rupicapra rupicapra*. The remains that could not be taxonomically assigned were grouped into the categories of medium- and small-size mammals. The latter category includes animals of the size of chamois and roe deer, and the former includes red deer and ibex in the case of this site. No large mammals of horse or bovine size were found in these samples.

Quantification of the assemblages was done by calculating the following indices: Number of Identified Remains (NISP), Minimum Number of Individuals (MNI) and Minimum Number of Elements (MNE), although the latter did not permit determination of the kinds of transportation of the represented species, given the scarcity and fragmentation of the samples. In determining seasonality of death, we took the following to be the times of birth for the three main



▲ FIGURE 5. Solutrean beads (M. R. González Morales).

species: red deer between May and June (Carranza 2004), chamois between April and May (Pérez Barbería and García-González 2010), and ibex between April and June (Alados and Escós 2012).

Taphonomic analysis was concentrated on identifying human activities conducted in the cave by means of butchering marks on the bones, the patterns of bone breakage and traces of heating or burning. Among other modifications we note the presence of some bones that had been digested and others that had been weathered, particularly by dirt concretions on bone surfaces, especially in Level 125, which prevented observation of possible cut marks on some bones.

The total number of identified remains is 362, Level 125 being the richest in finds. The best represented species are red deer and ibex, while chamois occurs sporadically during the Solutrean occupations (Tab. 4). From the taxonomic standpoint, the proportion of identified remains is high, with 58% being attributable to red deer, ibex and chamois, while the rest could only be assigned to the categories of medium-size (34.5%) and small (7.2%) mammals. Anatomically identifiable bones reach 77% of the total assemblage and the remainder are unidentifiable long bone epiphysis and flat bone fragments, as well as long bone shafts between 2-9 cm in length, which, by their cortical thickness and morphology could only be classified as remains of medium or small mammals.

Among the faunal remains from the samples of the five Solutrean levels analyzed, 52% are long bones (humerus, radius/ulna, metacarpal, femur, tibia and metatarsal). Of these, 76% show evidence of having been broken while fresh in order to extract the marrow and 13% display the impact points from direct percussion by humans. We found butchery marks on 16% of the bones, of which 53% were from disarticulation, 32% from meat stripping and 13% indeter-

minate. None of the bones shows evidence of hide removal, perhaps because such activities were conducted outside this rear area of the cave vestibule, although we must analyze the remains from the Solutrean levels of the other squares (U, X, W/10, V9) before affirming this hypothesis. Traces of burning are very scarce: just 3 bones were either burned or at least had been close to a fire. Finally, we found 6 bones with traces of digestion and 3 others bear tooth marks from small carnivores.

In general the bones' state of preservation is good, although in Level 125, 64% of the bones are covered with a fine dirt concretion, which, although permitting us to see whether the bones had been broken when fresh, does obscure any possible cut marks on their surfaces. This type of diagenetic alteration can be produced during times of seasonal warmth when bones that are partially covered by sediments that had been in ponded water high in calcium carbonate during cold times, something which is frequent in karstic contexts. When there are brief rises in temperature the water can evaporate causing lime to precipitate on rough surfaces such as the dirt sticking to the bones.

Seasonality of human occupations of the site can be determined by a few deciduous teeth and mandibles from levels 121 and 122 (Tab. 5). In these levels, it seems that human visits occurred between April and July –the warm season, as in the cases of the Upper and Middle Magdalenian and Azilian occupations.

The archeozoological analysis reveals the existence of a subsistence strategy typical of the mid-Upper Paleolithic based on both red deer and ibex (Marín-Arroyo 2009; Straus 1992). As in the later occupations, and despite the presumably colder climatic conditions of the LGM, the topographic setting of the site (the steep rocky cliffs above and around

	Level 121			Level 122			Level 123			Level 124			Level 125		
	NISP	MNE	MNI												
<i>Cervus elaphus</i>	20	13	2	17	11	2	4	4	1	22	16	2	39	22	2
<i>Capra pyrenaica</i>	28	17	2	19	15	1	4	5	1	12	10	2	35	22	3
<i>Rupicapra rupicapra</i>				6	6	2	2	2	1				2	2	2
Mammal, medium	19			21			11			30			44		
Mammal, small	6			6			1			8			6		
TOTAL	73	30	4	69	32	5	22	11	3	72	26	4	126	46	7

▲ TABLE 4. NISP, MNI & MNE totals by levels & species.

Nv.	E	F	M	A	M	J	J	A	S	O	N	D	n
121													1 Red deer ±1 year
121													1 Ibex ±1-3 months
122													1 Red deer ±1 year

▲ TABLE 5. Seasonality data from Solutrean levels based on ungulate remains.

the cave and the relatively broad Valle de Ruesga below it), lent itself to consistently hunting both species, also as in the Magdalenian and Azilian.

7. CONCLUSIONS

Under rigorous Last Glacial Maximum conditions, small parties of Solutrean hunters repeatedly ascended the Rio Asón from the coastal zone of eastern Cantabria during the warm season and each time they camped briefly in El Mirón Cave, as well as in nearby La Luz or La Haza. Bearing a variety of lithic and osseous projectile points and decorated with perforated shells, teeth, stone and bone beads (either sewn onto clothing or as necklaces), they took approximately equal numbers of red deer and ibex, as well as a few fish. They made a few informal fires, but otherwise did not much modify the site. Their arguably logistical visits were in sharp contrast to the massive residential camps that were to follow during the Initial and Lower Magdalenian that

took place in Oldest Dryas. El Mirón gives us a glimpse of the exploitation of the northern edge of the Cantabrian Cordillera before the more significant human use thereof during the Magdalenian.

ACKNOWLEDGMENTS

The excavations in El Mirón Cave, directed by LGS and MGM since 1996, have been authorized and partially funded by the Gobierno de Cantabria. Other funds have been provided by the US National Science Foundation, Fundación Marcelino Botín, L. S. B. Leakey Foundation, Ministerio de Educación y Ciencia (Proyectos PB96-0442 y HUM2006-13729), National Geographic Society, University of New Mexico and the UNM Stone Age Research Fund (J. and R. Auel, principal donors). Material support has been provided by the Universidad de Cantabria and the Town of Ramales de la Victoria. ABM-A has a Ramón y Cajal Research Program contract (RYC-2011-00695) at the Universidad de Cantabria. •

REFERENCES

- ALADOS, C.L. and ESCÓS, J. 2012: "Cabra montés - Capra pirenaica". In L. M. Carrascal and A. Salvador (eds.): *Enciclopedia Virtual de los Vertebrados Españoles*. Museo Nacional de Ciencias Naturales, Madrid. <http://www.vertebradosibericos.org>
- BOYER-KLEIN, A. 1984: "Analyses polliniques cantabriques au Tardiglaciaire". *Revue de Paléobiologie* vol. spec.: 33-39.
- CARRANZA, L. 2004: "Ciervo - *Cervus elaphus*". In L. M. Carrascal and A. Salvador (eds.): *Enciclopedia Virtual de los Vertebrados Españoles*. Museo Nacional de Ciencias Naturales, Madrid. <http://www.vertebradosibericos.org>
- CASTAÑOS, J., CASTAÑOS, P. and MURELAGA, X. 2006: "Estudio osteométrico preliminar de los restos de ciervo (*Cervus elaphus*) del yacimiento paleontológico del Pleistoceno superior de Kiputz (Mutriko, Gipúzcoa)". *Geogaceta* 40: 163-166.
- CUENCA BESCÓS, G., STRAUS, L. G., GONZÁLEZ MORALES, M. and GARCÍA PIMENTA, J. C. 2008: "Paleoclima y paisaje del final del cuaternario en Cantabria: los pequeños mamíferos del Mirón". *Revista Española de Paleontología* 23: 91-126.
- 2009: "The reconstruction of past environments through small mammals: from the Mousterian to the Bronze Age in El Mirón Cave". *Journal of Archaeological Science* 36: 947-955.
- DUPRÉ, M. 1990: "Análisis polínico de la cueva de Amalda." In J. Altuna, A. Baldeón and K. Mariezkurrena (eds.): *La Cueva de Amalda (Zestoa, País Vasco)*. Colección Barandiarán, 4. Eusko Ikaskuntza, Donostia: 49-51.
- GONZÁLEZ ECHEGARAY, J. and BARANDIARÁN, I. 1981: El Paleolítico Superior de la Cueva del Rascaño. Centro de Investigación y Museo de Altamira, Monografías 3. Madrid.
- LEROI-GOURHAN, ARL. 1971: "Análisis polínico de Cueva Morin". In J. González Echeagaray and L. G. Freeman (eds.): *Cueva Morin. Excavaciones 1966-1968*. Patronato de las Cuevas Prehistóricas, Santander: 359-365
- 1986: "The palynology of La Riera Cave". In L. G. Straus and G. A. Clark (eds.): *La Riera Cave*. Anthropological Research Papers 36. Tempe: 59-64.
- MARÍN-ARROYO, A. B. 2010: *Arqueozoología en el Cantábrico Oriental durante la Transición Pleistoceno/Holoceno: La Cueva del Mirón*. Publican. Servicio de Publicaciones de la Universidad de Cantabria, Santander.
- 2009: "The human use of the montane zone of Cantabrian Spain during the Late Glacial: faunal evidence from El Mirón Cave". *Journal of Anthropological Research* 65: 69-102.
- MARÍN-ARROYO, A. B., LANDETE, D., VIDAL, G., SEVA, R., GONZÁLEZ MORALES, M. and STRAUS, L. G. 2008: "Archaeological implications of human-derived manganese coatings: a study of blackened bones in El Mirón Cave, Cantabrian Spain." *Journal of Archaeological Science* 35: 801-813.
- PEREZ-BARBERÍA, F. J. and SALVADOR, A. (eds.) 2010: "Rebeco - *Rupicapra rupicapra*". In L. M. Carrascal and A. Salvador (eds.): *Enciclopedia Virtual de los Vertebrados Españoles*. Museo Nacional de Ciencias Naturales, Madrid. <http://www.vertebradosibericos.org>
- RASINES, P. (ED.) 2010: "Arqueología en la Cueva de Cibrante (Cantabria, España)". *Sautuola* 15: 35-243.
- RISSETTO, J. 2009: *Late Pleistocene hunter-gatherer mobility patterns and lithic exploitation in Eastern Cantabria (Spain)*. Ph.D. dissertation. University of New Mexico.
- STRAUS, L. G. 1992: *Iberia before the Iberians*. University of New Mexico Press, Albuquerque.
- STRAUS, L. G. and GONZÁLEZ MORALES, M. R. 2009: "A preliminary description of Solutrean occupations in El Mirón Cave (Ramales de la Victoria, Cantabria)". *Munibe* 60: 117-137.
- 2012: *El Mirón Cave, Cantabrian Spain*. University of New Mexico Press, Albuquerque.
- STRAUS, L. G., GONZÁLEZ MORALES, M. R., GUTIÉRREZ ZUGASTI, I. and IRIARTE, M. J. 2011: "Further Solutrean evidence in El Mirón Cave (Ramales de la Victoria, Cantabria)". *Munibe* 62: 117-133.