

The Magdalenian Human Remains from the Galeria da Cisterna (Almonda karstic system, Torres Novas, Portugal) and their Archeological Context

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ABSTRACT

The Galeria da Cisterna yielded an ensemble of human remains in Pleistocene remnant deposits radiocarbon-dated to the later part of the Magdalenian, in good agreement with their scarce stone tool and faunal content. The archeological context also includes a set of perforated shell beads, suggesting that the human remains entered the site as a result of burial practices. The dental remains of Cisterna 1 to 3 represent minimally a young child, a late juvenile, and an adolescent/young adult, and the three isolated manual and pedal remains (Cisterna 4 to 6) could belong to the same individuals. The remains are notable for their absence of developmental or degenerative lesions and the dimensions of the teeth, generally larger than those of most Late Upper Paleolithic Europeans and similar to those of earlier Upper Paleolithic Europeans.

Keywords: Upper Paleolithic – modern humans – teeth – stratigraphy – fauna

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RESUMO

Os depósitos plistocénicos residuais da Galeria da Cisterna forneceram um conjunto de restos humanos contidos em níveis que o radiocarbono data da parte final do Magdalenense, datação que se ajusta ao seu escasso conteúdo em fauna e indústria lítica. O respectivo contexto arqueológico inclui também conchas perfuradas, sugerindo que a presença de restos humanos estará relacionada com práticas funerárias. Os restos dentários dos indivíduos Cisterna 1 a Cisterna 3 representam, no mínimo, uma criança de pouca idade, um imaturo avançado e um adolescente ou adulto jovem, e é possível que os três restos isolados de mãos e pés (Cisterna 4 a 6) pertençam aos mesmos indivíduos. O conjunto destaca-se pela ausência de lesões degenerativas ou de desenvolvimento e pelas dimensões dos dentes, em geral superiores às da maioria dos europeus do Paleolítico Superior final e semelhantes às dos europeus de momentos mais antigos do Paleolítico Superior.

Palavras-chave: Paleolítico Superior – homem moderno – dentes – estratigrafia – fauna

INTRODUCTION

Upper Paleolithic human remains are relatively rare from Iberia south of the Pyrenees (Ferembach & Roche, 1971; Aguirre *et al.*, 1991; Zilhão, 1997; Trinkaus *et al.*, 2001; Arsuaga *et al.*, 2001; Zilhão & Trinkaus, 2002), and it is therefore of

interest to describe in detail those remains which are known and have reliable stratigraphic contexts. With this in mind, we describe here a series of fragmentary human remains from the Galeria da Cisterna (also known as «Gruta da Nascente do Almonda»), Torres Novas, Portugal ($39^{\circ}30'18''$ N; $08^{\circ}36'55''$ W) (Figure 1). These dental and postcranial remains derive from a Magdalenian context (level 3) and provide additional data on these poorly known Upper Paleolithic populations of southwestern Iberia.

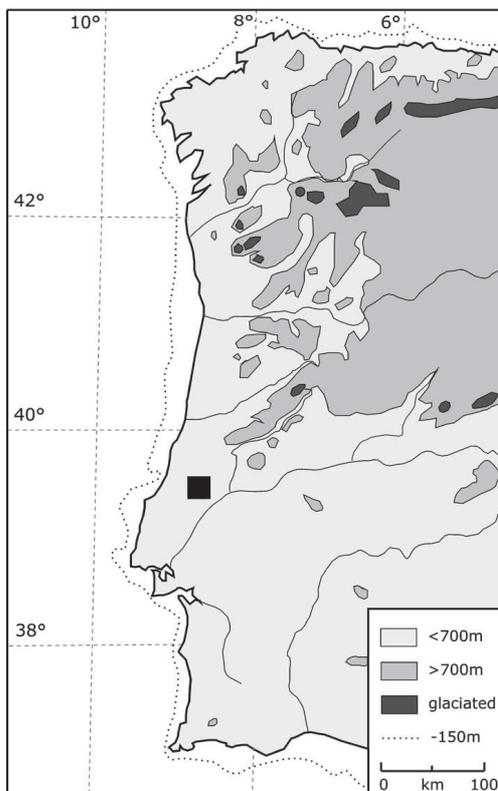


Fig. 1 – Paleogeography of western Iberia in Late Glacial times. The black square denotes the location of the Almonda karstic spring.

ARCHEOLOGICAL CONTEXT AND AGE

The Galeria da Cisterna is a fossil spring. The river now flows out of the karst ~ 5 m below, at the base of a ~ 75 m high rock face, part of the NE–SW fault escarpment that separates Portuguese Estremadura's Central Limestone Massif from the Tertiary Basin of the Tagus, of which the Almonda is a tributary. Until 1989, and since its exposure by a landslide in the 1920s, the Galeria da Cisterna provided the only access to the interior of the karstic system, which

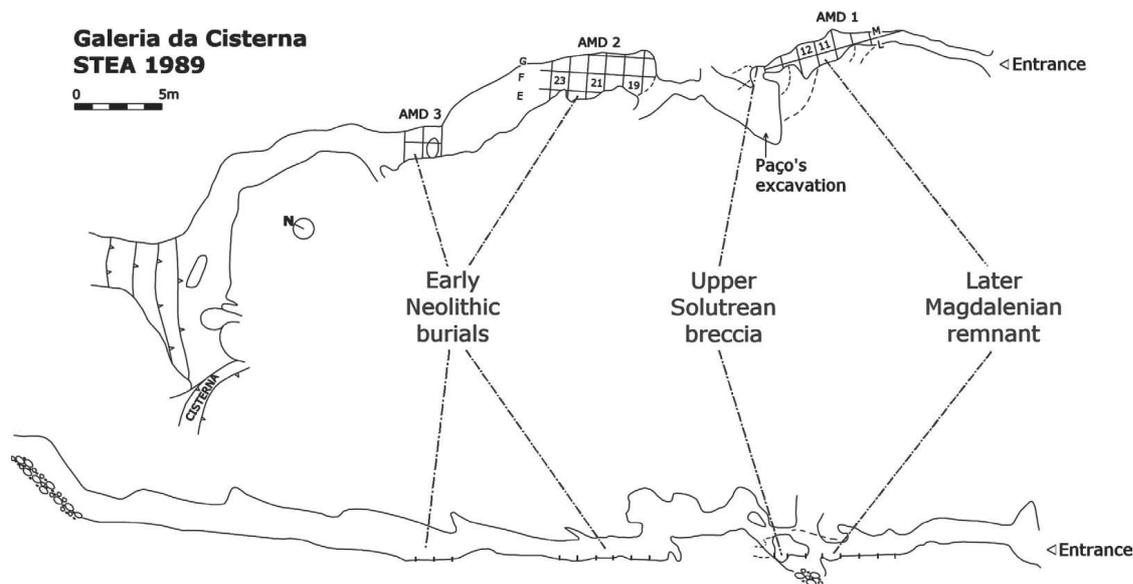


Fig. 2 – Topographical plan and profile of the Galeria da Cisterna. The areas preserving archeological deposits of different periods are indicated.

currently features some 12 km of mapped underground galleries. Over the last 20 years, several other collapsed entrances were found at different elevations, and some were reopened for archeological excavation of the sealed Lower, Middle or Upper Paleolithic sequences they contain (Zilhão *et al.*, 1991, 1993; Zilhão & Mckinney, 1995; Zilhão, 1997; Marks *et al.*, 1999, 2001, 2002; Chabai *et al.*, 2000/2001; Trinkaus *et al.*, 2003, 2007).

The length of the narrow, meandering Galeria da Cisterna is approximately 100 m, and its cross-section is in general less than 2×2 m (Figure 2). Archeological investigation of this gallery was carried out for the first time between 1937 and 1942 (Nogueira *et al.*, 1941; Paço *et al.*, 1947; Guilaine & Ferreira, 1970). As described by Paço *et al.*, the work consisted of the collection of surface material and the excavation of a small chamber located ~15 m from the entrance, and generated an assemblage of Iron Age, Bronze Age and Early Neolithic pottery currently kept at the Geological Museum, Lisbon.

In 1987, a small sediment pocket adjacent to Paço *et al.*'s excavations yielded three typical Solutrean points (Maurício, 1988). Following-up on these finds, two subsequent excavation seasons (1988 and 1989) revealed and explored other pockets of sediments accumulated in discontinuous depressions of the limestone bedrock of the Galeria da Cisterna that had not been touched by previous work: zones AMD1, AMD2 and AMD3 (Figures 2 & 3). The latter two featured Holocene deposits directly atop bedrock or lying on archeologically sterile river-accumulated Pleistocene sands. Zone AMD1, however, preserved remnant Upper Paleolithic deposits in two areas physically separated by an outcrop of the cave floor, described in detail elsewhere (Zilhão, 1997).

In grid unit M15, the AMD1 deposits consisted of a thin film of heavily indurated reddish sands (level β) coating the walls of a narrow fissure filled with loose, redeposited orange-brown sands (level α). The latter yielded a mix of Holocene and Solutrean material (including the three 1987 finds), while the level β breccia yielded fourteen lithic artifacts, including twelve Upper Solutrean projectile points of diverse typology. In grid units L-M/11-12, an area of <math><2\text{ m}^2</math> located some 10 m from the entrance, the AMD1 Pleistocene deposits were preserved at the bottom of a ~ 90 cm deep depression, under a Holocene «dark-earth» deposit, level 1, which yielded Copper and Bronze Age finds (Figures 3 & 4). Against the West wall of the gallery, the immediately underlying Pleistocene sequence (levels 2-3) had been eroded away down to the indurated top of level 4, leaving only a remnant preserved against the East wall. In squares L-M/11, levels 3 and 4 were separated by a thin black lens, very rich in organic material (sublevel 3a), and in squares L-M/12 most of level 3 was tainted black. This lens was interpreted as the result of a post-depositional process of lateral impregnation, occurring in the early Holocene and caused by the formation of stagnant pools in the depression left by the excavation of the erosional channel mentioned above. Geochemical analysis of the sediments provided results consistent with this interpretation (Cruz, 1993).

Basal level 5 was a sterile fluviatile deposit, but the other levels yielded stone tools and faunal remains (Tables 1-3). The lithic material was generally undiagnostic, and the sequence was initially assigned, tentatively, to the Last Glacial Maximum (level 4 to the Late Gravettian and level 3 to the Proto-Solutrean), on

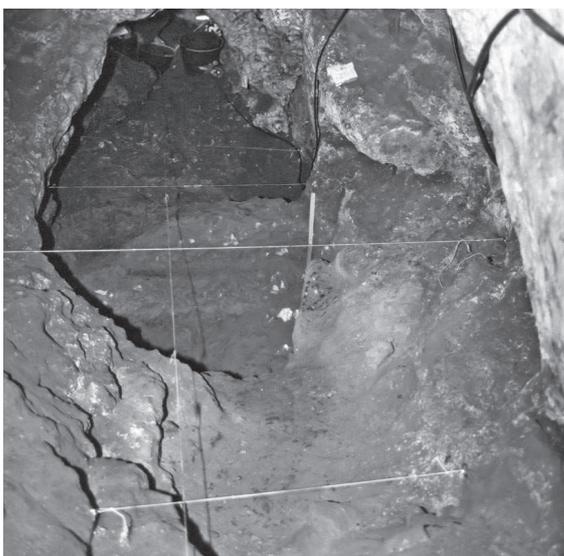


Fig. 3 – View over zone AMD1 towards the interior of the gallery, half way through the excavation process (before removal of the Pleistocene sediments in row 12 of the excavation grid), with the transversal stratigraphic profile exposed.

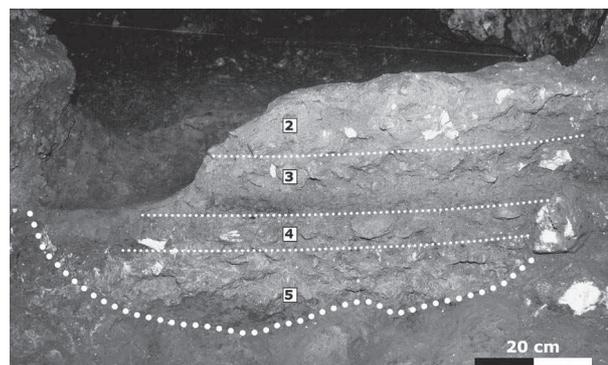


Fig. 4 – Pleistocene stratigraphy of zone AMD1: level 2, dense eboulis of mid-sized (5-10 cm long) angular clasts packed in brecciated red sands, ~ 12 cm thick; level 3, non-brecciated red sands containing scattered angular clasts, ~ 12 cm thick; level 4, dense eboulis of mid-sized (5-10 cm long) rounded clasts with a few larger blocks (20-30 cm long), packed in variably indurated yellow-brown sands, ~ 10 cm thick; level 5, fluviatile yellow sands, grading into reddish-brown silt at contact with bedrock, containing scattered blocks and speleothem fragments, ~ 16 cm thick, the upper part forming a horizontal, highly-indurated, 5-10 cm thick continuous plaque.

the basis of arguments relating to technology, raw-material procurement patterns, and the preservation of Solutrean material in the adjacent M15 breccia (Zilhão, 1997). Subsequent radiocarbon dating (Figure 5), however, proved that level 3 is later Magdalenian in age, which in turn suggests that level 4 is probably of Upper Magdalenian age, in good agreement with both the multiple dihedral burin found therein and the backed bladelet recovered at the interface between levels 3 and 4.

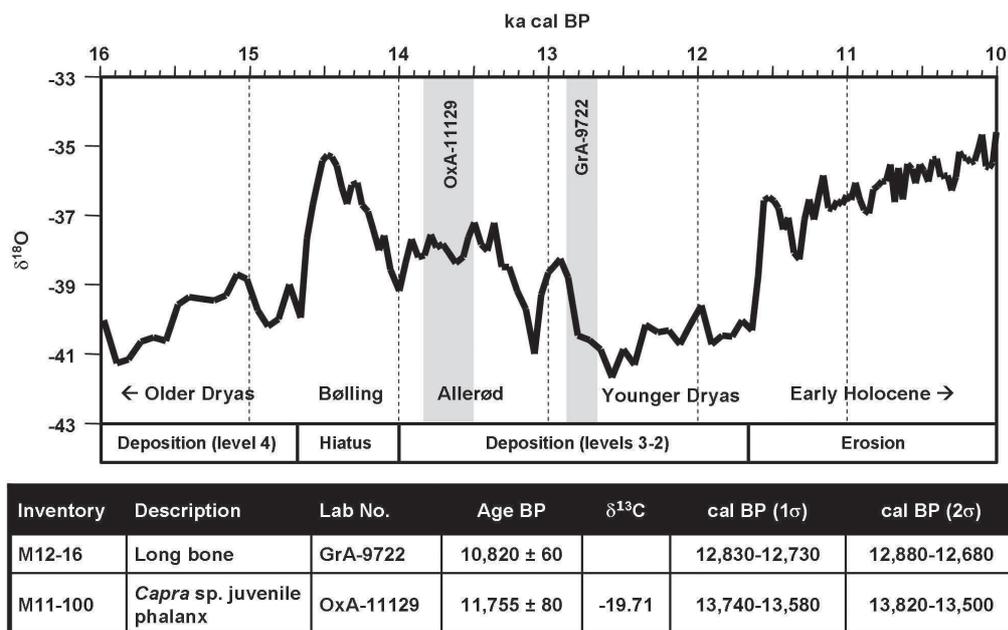


Fig. 5 – Climatic oscillations of the Tardiglacial as recorded in Greenland ice cores and AMS radiocarbon dates for level 3 of zone AMD1, Galeria da Cisterna. The shaded areas in the graph represent the 2 σ calibrated age ranges. Calibration data and paleoclimate curves generated by CalPal, 2007 Hulu version (Weninger and Jöris, 2004).

Artifact Class	Level 2	Levels 3–3a	Level 4
Cores	6	3	–
Core rejuvenation debris	–	2	–
Chips	–	6	30
Chunks	–	5	–
Flakes	–	33	12
Blades	–	1	–
Retouched tools	2	2 (a)	2 (b)
Total	8	52 (c)	44 (d)

(a) one pointed blade and one backed bladelet

(b) one denticulated blade and one multiple dihedral burin

(c) 31% flint, 31% quartz, 36% quartzite, 2% basalt

(d) 20% flint, 9% quartz, 71% quartzite

Table 1 – Lithic artifacts from the Pleistocene levels of zone AMD1, Galeria da Cisterna.

Latin name	English name	Stratigraphic unit			
		4	4-3	3	2
<i>Cervus</i>	Red deer	–	–	3	1
<i>Capra</i>	Ibex	4	1	3	–
<i>Sus</i>	Wild boar	–	–	1	–
<i>Lepus</i>	Hare	–	2	–	–
<i>Oryctolagus</i>	Rabbit	–	3	10	1
<i>Lynx</i>	Lynx	+?	–	–	–
<i>Felis</i>	Wildcat	1	+	1	–
<i>Vulpes</i>	Fox	3	4	–	–
<i>Chiroptera</i>	Bats	–	–	Several	14
<i>Aves indet</i>	Birds	–	–	2	–
<i>Galliform</i>		–		–	1
<i>Turdus</i>	?Thrush	–	2	4	–
<i>Corvus</i>	?Crow	1	2	1	–
<i>Amphibia</i>		–	–	1	–

Table 2 – Numbers of bones recorded at Galeria da Cisterna. Recording procedure follows Davis (1992, 2002). «+» refers to cases where bones other than «Parts of the Skeleton Always Counted» (POSACS) were found and could be identified to genus.

Number	Layer	Bone	Taxon	Fus	GL	Bd	Dd	DLS	SLC	M1 length
L12-2	3a	Phalanx III	<i>Cervus</i>	–	–	–	–	472	–	–
M12-4	2	Astragalus	<i>Cervus</i>	–	499	298	278	–	–	–
M11-177	4	Scapula	<i>Felis silvestris</i>	F	–	–	–	–	133	–
L11-1	3a	Mandibula	<i>Lynx?</i>	–	–	–	–	–	–	~100-110
M11-70	3a	Tibia	<i>Oryctolagus</i>	F	–	108	–	–	–	–
M12-97	3a	Calcaneum	<i>Oryctolagus</i>	F	210	–	–	–	–	–
M11-116	4	Tibia	<i>Oryctolagus</i>	F	–	105	–	–	–	–
M11-22	4	Calcaneum	<i>Vulpes</i>	F	336	–	–	–	–	–
M11-19	4	Calcaneum	<i>Vulpes</i>	F	323	–	–	–	–	–

Table 3 – Measurements (following Driesch, 1976), in tenths of a millimeter, of the Galeria da Cisterna mammal bones and teeth. «Fus» refers to the state of epiphysial fusion, where «F» is fused (i.e., adult).

This small Pleistocene remnant thus corresponds to a succession of Tardiglacial deposits, with their erosion signaling a return to a pattern of regular (seasonal?) water flow in the gallery during the following, wetter-than-present Preboreal period. Subsequent to the excavation of the Galeria da Cisterna, cave-sheltering around the Almonda spring in such terminal Paleolithic times has been rather more extensively documented at the Lapa dos Coelhos, some 10 m higher

up (Gameiro & Almeida, 2004). The radiocarbon dates for Galeria da Cisterna place the formation of its level 3 in the later part of the Allerød and the earlier part of the Dryas III, ~13,000 cal BP. Level 2, therefore, must date to later Dryas III times, while the discontinuity *cum* cementation at the top of level 4 probably reflects the warm peak at the beginning of the Bølling/Allerød interstadial (Figure 5), implying an age >14,500 cal BP for the underlying deposits.

This chronostratigraphic reading of the evidence is consistent with the faunal evidence (Table 2). Three large herbivore taxa – red deer, a caprine (presumably the Iberian ibex), and wild boar were identified, as well as hare and rabbit. Remains of wildcat, fox, possibly lynx, bats, several birds (a galliform; *Turdus pilaris*, fieldfare; *T. cf. merula*, blackbird; *Corvus cf. frugilegus*, rook; and *C. monedula*, jackdaw) and an amphibian were also found. It is not possible to determine who was responsible for accumulating these taxa, although it seems probable that at least the bats and songbirds accumulated naturally or were predated by small carnivores, while the larger mammals were brought into the cave by people. None of the bones shows any signs of partial digestion. Among the carnivores, the damaged felid carnassial is tentatively identified as a very small lynx, although wildcat cannot be ruled out. With a crown length of 10 to 11 mm (Table 3), it is outside the range of measurements of a large collection of modern *Felis silvestris* from Europe, the Maghreb and the Near East. It is also outside the range for wildcats from the Upper Pleistocene levels of Caldeirão cave, but smaller than a small sample of present-day lynx carnassial teeth as well as the specimens from Caldeirão (Davis, 2002, Fig. 33, 35).

Cervus, *Capra* and *Sus* were among the more common taxa recovered in the Mousterian, EUP, Solutrean and Magdalenian levels of Caldeirão, situated at a similar elevation and ~25 km to the NE as the crow flies. By comparison with this material, the Cisterna red deer astragalus is very small, although the cervid terminal phalanx with a DLS of 47.2 mm plots among the larger specimens of *Cervus elaphus* from Caldeirão (Davis, 2002). The absence of *Equus* in the Galeria da Cisterna sample may be due to the smallness of the sample, although at Caldeirão equids became scarcer with time and by the Magdalenian they comprised a mere 6% of the large herbivores. The fact that ibex is a major component of the fauna in both levels 3 and 4 implies for a lowland site such as Galeria da Cisterna a rather open immediate landscape, in agreement with regional environmental reconstructions for the colder phases of last glacial's Dansgaard–Oeschger cycles (Zilhão, 1997).

STRATIGRAPHIC PROVENIENCE AND TAPHONOMY

The human remains recovered in the Pleistocene deposits of the Galeria da Cisterna (Table 4) all come from level 3 (including sublevel 3a) of zone AMD1, the excavation of which was initiated and completed during the July 1988 field

season. The Cisterna 1 and Cisterna 3 groups described below include material collected in both level 3 and the 3a black lens. The fact that each of these groups is likely to represent a single individual provides additional support for the interpretation of that lens as a lateral variation without stratigraphic significance. The fact that Cisterna 6, found at the interface between levels 3 and 4, could belong to the same individual as Cisterna 2, whose left P_3 is a piece-plotted item recovered at the base of the black lens, supports the inclusion of Cisterna 6 in the human bone assemblage from level 3.

Individual	Anatomical Portions	Number
Cisterna 1	right C^1	M12-20
	right P^3	M12-125
	right P^4	M12-126
	right M^2	M12-127
	fragmentary right maxilla with dm^1 to M^1	M12-132
Cisterna 2	left C_1	M12-116
	Left P_3	M12-11
Cisterna 3	left di^1	L12-217
	right di^2	L12-218
	right dm_2	L12-219
	right dm_1	L12-220
	left dm_2	M12-128
Cisterna 4	Metacarpal diaphysis	M12-118
Cisterna 5	Manual Proximal Phalanx 5	M12-119
Cisterna 6	Pedal Proximal Phalanx	M12-157

Table 4 – Human remains from levels 3–3a of the Galeria da Cisterna.

Assessing the taphonomy of the human bone requires consideration of the fact that the preserved remnant is but a small percentage of the Magdalenian deposits that once, prior to early Holocene erosion, must have filled the irregular rock bottom of the initial section of the Galeria da Cisterna. The deposits containing the human bone assemblage also yielded four shell beads – three pierced *Theodoxus fluviatilis* and one pierced *Hynia reticulata* – making it reasonable to speculate that ritual mortuary activity (burial?) occurred at the site during the later part of the Magdalenian.

MATERIALS AND METHODS

The Cisterna human remains are described using standard paleontological approaches and measurements (e.g., Bräuer, 1988). The dental crown morphology is scored in part using the Arizona State University Dental Anthropology System (ASUDAS) (Turner *et al.*, 1991).

In order to assess the size and proportions of the remains, the dental and postcranial remains are compared, where possible, to European Upper Paleolithic and recent human remains. The fossil sample is divided into «Early Upper Paleolithic» (EUP) and «Late Upper Paleolithic» (LUP) samples, with the division between them being the last glacial maximum. The former Paleolithic sample is mostly Gravettian, whereas the latter is principally Magdalenian in association. Sample sizes vary depending upon both preservation and the current detail of publication of these comparative samples. The comparative data derive from primary paleontological descriptions or personal study of the original material. Since the remains from the Galeria da Cisterna are Magdalenian in age, they fall within the LUP time span. Recent European (or Euroamerican) data are included for the dental and phalangeal metrics; the permanent tooth metrics are from Twisselmann & Brabant (1967), the deciduous dental metrics are for the Euroamerican males from Black (1978), the hand metrics derive from Musgrave (1970), and the pedal metrics are from Trinkaus & Hilton (1996). In the calculation of sample summary statistics, right and left sides (when available) were averaged to provide a value per individual prior to the computations.

THE HUMAN REMAINS

The Galeria da Cisterna human remains are listed in Table 4. They consist principally of isolated teeth which, based on morphology and developmental age, derive from three individuals (Cisterna 1 to 3). In addition, there are three isolated postcranial elements, one of them immature, which are described here as separate specimens but might have derived from two or more of the dentally identified individuals.

Cisterna 1

This specimen consists of a fragment of the right maxillary alveoli in matrix with the dm^1 , dm^2 and M^1 preserved, plus the isolated right C^1 , P^3 , P^4 and M^2 (Table 4; Figure 6).

The dm^1 crown is substantially worn and has suffered postmortem damage resulting in the loss of the mesiobuccal corner (about one-quarter of the tooth is missing). The exposed lingual root exhibits slight root resorption, whereas the buccal root is enclosed in bone and is not observable. The distal portion of the



Fig. 6 – Occlusal views of the Cisterna right maxillary teeth. Left: C¹, P³, P⁴ and M². Right: dm¹ to M¹. Scale in millimeters.

dm² is partially covered by matrix. Enamel has chipped off distally, exposing the dentin horn of the hypocone.

The fully formed crown and partial (~4 mm) root of a right C¹ are preserved. The crown is complete and in good condition with only a small fracture that runs sagittally along the crown.

The fully formed crown and partial root (~5 mm) of a right P³ are preserved. The tooth is in good condition, with only minor fractures running mesio–distally along the occlusal surface of the buccal cusp. A fully formed crown and partial root (~3 mm) of a right P⁴ are preserved. The crown is in good condition with a small fracture that runs mesiodistally along the buccal cusp.

The M¹ crown is complete and well preserved. Only a small sagittal fracture runs along the hypocone. The lingual root is exposed distally but obscured by matrix otherwise. The incomplete crown and partial root (~2.7 mm) of a right M² are preserved. Approximately one–quarter of the distal crown is missing. Postmortem damaged has resulted in the loss of tooth enamel from the buccal tooth surface. The crown is fractured along the mesiobuccal fissure and along the mesial buccal cusp; its root was lost postmortem.

The occlusal morphology of the dm¹ has been obliterated by extreme wear, but some occlusal details remain on the dm². It is a four–cusped tooth, and the lingual surface is featureless (i.e., it lacks a Carabelli's trait); no other morphology is observable due to damage and wear.

On the C¹, the lingual surface exhibits weak shoveling (ASUDAS grade 2) and a well–developed distal accessory ridge (ASUDAS grade 4). There is slight swelling of the gingival area but no lingual tubercle is present. Lingually, the tooth exhibits barely perceptible mesial and distal marginal ridges. In addition, short (1–2 mm) and shallow grooves radiate up from the cervix but are not pathological (i.e., enamel hypoplasia).

The buccal and lingual tooth surfaces of the P³ are featureless. Occlusally, the crown exhibits small accessory mesial and distal cuspules but lacks accessory ridges on either the buccal or lingual cusp. In contrast, both the buccal and lingual cusps of the P⁴ exhibit mildly expressed accessory ridges mesially and distally (MxPAR: Burnett, 1998); they are more strongly expressed on the buccal cusp

than on the lingual cusp. The buccal tooth surface of the P⁴ exhibits barely perceptible mesial and distal ridges, while the lingual surface is featureless.

The M¹ is a four-cusped tooth. The protocone is the largest cusp (43.7 mm²) followed by the paracone (28.7 mm²), with the remaining two cusps (metacone and hypocone) equal in size (28.2 and 28.3 mm² respectively) (*cf.*, Bailey, 2004). The occlusal polygon area is large (38.8 mm²) suggesting that the cusp tips are widely spaced. Finally, the cusp angles (Bailey, 2004) are very close to the mean for a pooled Upper Paleolithic European sample, reflecting the squared outline of the tooth. Lingually, the protocone presents a medium sized Carabelli's cusp (ASUDAS grade 3), while the buccal surface is featureless.

Occlusally, the tooth is morphologically simple. It lacks accessory cusps and presents only a weakly developed mesial marginal ridge. The M² is a four-cusped tooth that exhibits a much reduced hypocone (ASUDAS grade 2). The relative cusp areas are protocone > paracone > metacone > hypocone. Occlusally, the tooth is more complex than the M¹, exhibiting two accessory ridges that emanate from a mesial marginal ridge and run toward the central fossa. Both buccal and lingual tooth surfaces are featureless.

The deciduous molars are quite worn. The dm¹ exhibits heavy, basin-like wear that has exposed the tooth's small pulp chamber, and the dm² is more moderately worn, with more dentin exposed lingually than buccally. The M¹ exhibits only occlusal wear facets but no dentin exposure. The unerupted P³, P⁴ and M² are

	Tooth	Mesio-distal Diameter	Bucco-lingual Diameter	EUP B-L Diameter	LUP B-L Diameter	Recent European B-L Diameter
Cisterna 1	C ¹	8.7	9.6	9.2 ± 0.9 (19)	8.9 ± 1.0 (14)	8.3 ± 0.6 (108)
	P ³	7.6	11.0	9.8 ± 0.6 (22)	9.3 ± 1.1 (18)	8.6 ± 0.6 (108)
	P ⁴	6.9	10.1	10.0 ± 0.8 (21)	9.9 ± 1.0 (13)	8.8 ± 0.6 (106)
	M ¹	12.0	12.5	12.2 ± 0.8 (32)	11.6 ± 0.9 (20)	11.2 ± 0.5 (104)
	M ²	10.7	13.5	12.5 ± 0.9 (28)	11.8 ± 0.9 (21)	10.7 ± 0.7 (102)
	dm ²	—	11.1	10.4 ± 0.7 (11)	10.3 ± 0.5 (7)	9.5 ± 0.5 (69)
Cisterna 2	C ₁	7.8	8.2	8.7 ± 0.7 (20)	7.9 ± 0.8 (19)	7.8 ± 0.5 (109)
	P ₃	7.2	8.6	8.6 ± 0.5 (17)	7.7 ± 0.8 (18)	7.3 ± 0.5 (108)
Cisterna 3	di ¹	7.7	5.7	5.3, 5.4, 5.7	5.3 ± 0.4 (7)	5.1 ± 0.4 (69)
	di ²	5.7	5.1	4.8, 5.5	5.2 ± 0.5 (12)	4.7 ± 0.4 (69)
	dm ₁	9.0	7.7	7.8	7.2 ± 0.6 (13)	7.4 ± 0.5 (69)
	dm ₂	11.1	9.7	9.2 ± 0.7 (12)	9.0 ± 0.5 (19)	8.9 ± 0.4 (69)

Table 5 – Dental metrics for Cisterna 1 to 3 dental crowns and comparative bucco-lingual diameters. Mean ± standard deviation. Measurements are in millimeters and sample sizes are in parentheses.

unworn. There is no distal interproximal wear facet on the M^1 , confirming that the M^2 was unerupted.

The presence of both deciduous molars with the first molar indicates a juvenile age for Cisterna 1. The degree of development of the premolar roots (about one-half formed) narrows its age-at-death to between eight and ten years post-natal, although the degree of canine root development may suggest an age closer to eight years (Smith, 1991). This is supported by the presence of resorption on the dm^1 lingual root, indicating that the dm^1 is not far from exfoliation, and hence the P^3 would have been erupting within a year or two if the individual had survived.

None of the tooth crowns exhibits macroscopic enamel hypoplasias or caries.

The bucco-lingual diameters of the teeth (Table 5) are all relatively large, falling at least 0.5 mm above the mean values for the LUP sample for all except the P^4 . They are above all of the recent human means and most similar to the mean values for the EUP sample. They nonetheless remain within two standard deviations of the LUP means, although they are all more than two standard deviations above the recent European values.



Fig. 7 – Views of the Cisterna 2 and 3 teeth. Above: Cisterna 2 left C_1 and P_3 in lingual view. Below from left to right: Cisterna 3 left dm_2 in occlusal view, left di^1 and right di^2 in lingual view, and right dm_1 with mandibular fragments in occlusal view. Scale in millimeters.

Cisterna 2

The two teeth assigned to Cisterna 2 (Table 4; Figure 7) consist of mandibular left C_1 and P_3 , both of which retain the complete crown and the fully formed root. Both teeth are in good condition. The C_1 crown has small fractures on the buccal and lingual surfaces that run sagittally from the crown tip to the root.

The lingual surface of the C_1 exhibits barely perceptible mesial and distal marginal ridges (ASUDAS grade 1 shoveling) and is otherwise featureless. The single root exhibits shallow mesial and distal developmental grooves. The P_3 presents a mesially oriented transverse ridge that connects the buccal and lingual cusps. This ridge, combined with the mesial and distal marginal ridges of the tooth, creates a small anterior fovea and a larger (but shallower) posterior fovea.

The C₁ cusp tip is slightly worn, but the wear does not expose the dentin below. The position of the mesial wear facet may indicate dental crowding and/or that the canine was rotated lingually. The distal interproximal wear facet on this tooth and the mesial interproximal wear facet on the P₃ match in size and shape. In addition the P₃ exhibits small occlusal wear facets with no dentin exposure.

Metrically, these teeth are moderately large (Table 5). The C₁ breadth falls between the EUP and the LUP means, and the P₃ breadth is on the EUP mean and above the LUP and recent human means.

There are no signs of pathological alterations of the teeth, despite the presence on the C₁ of short (1–2 mm) and shallow grooves that radiate up from the cervix. The complete formation of the tooth roots with minimal occlusal wear suggests an age-at-death during adolescence or early maturity.

Cisterna 3

This individual consists of five teeth of a child (Table 4; Figure 7). Two of the teeth, the right dm₁ and the left dm₂, are preserved in fragments of mandibular alveoli.

The left di¹ preserves a completely formed crown and root. The root apex appears to have broken off postmortem. The crown is in good condition with a minor sagittal fracture along the distal lobe. The right di² retains the complete crown and nearly complete root (the apex is missing). The tooth is in good condition with minor fractures along the lingual and buccal surfaces.

A complete right dm₁ is preserved in a very fragmented alveolus that is covered by matrix. The tooth is in good condition. It is missing a small amount of enamel from the mesio-lingual surface, and presents minor fractures along the buccal surface. The mesial root is not fully formed (the apex is missing), but the tooth was fully erupted. It is not possible to observe the distal root, because it is enclosed in bone. The lingual root sockets of the dm₂ are preserved in the associated alveolar bone.

A partial crown (distal portion of the metaconid and mesial portion of the hypoconid) and root (~3 mm) of a right dm₂ are preserved. This is associated with the complete crown and partial root (~1/3) of a left dm₂ preserved in its alveolus. The tooth crown is in fair condition. It exhibits a medium-sized fracture running bucco-lingually and smaller fractures running along the mesial lingual cusp.

The crown of the di¹ is short and flared. It exhibits mild labial curvature (ASUDAS grade 2), mild sagittal curvature, weak shoveling (ASUDAS grade 1) and weak gingival swelling. The labial surface is featureless. The di² is moderately convex both labially (ASUDAS grade 2) and sagittally. The lingual and buccal tooth surfaces are featureless.

Due to damage, the morphology of the right dm_2 cannot be observed. The dm_1 is a five-cusped tooth. Occlusally it exhibits a deep anterior fovea, which is set off distally by well-developed essential crests of the protoconid and metaconid. The tooth presents an X-groove pattern (the protoconid and hypoconid are in contact) and a moderately sized cusp 5 or hypoconulid (ASUDAS grade 4) that is centered distally. A weak occlusal ridge connects all cusps. The left dm_2 is a five-cusped tooth. Cusp 5 is well developed (ASUDAS grade 4) with a prominent transverse ridge that runs along the occlusal surface toward the talonid basin. Occlusally, it exhibits a high and prominent mesial marginal ridge and a deep anterior fovea. A small cuspule (0.9 mm wide) is enclosed in the anterior fovea. The buccal surface presents a small buccal pit (ASUDAS grade 1 protostylid).

Metrically, these teeth are unexceptional for an Upper Paleolithic human (Table 5).

The deciduous incisors exhibit minimal wear of the incisal edge, with slight dentin exposure on the di^1 but not on the di^2 . The cusps of the deciduous molars are unworn, and the absence of interproximal wear facets on the left dm_2 indicate that the tooth was recently erupted or in the process of eruption. Together, these indicate a young age for this individual, approximately two years postnatal (Smith, 1991).

There is no evidence of pathological alterations of these teeth.

Cisterna 4

The bone consists of the diaphysis of an immature metacarpal, from the broken flare for the base to portions of the distal metaphysis (Figure 8; Table 6). The maximum preserved length is 30.3 mm. The immaturity of the bone is based in part on its generally mild cortical bone porosity. In addition, there is a small 4.8 x 2.3 mm section of the distal metaphyseal surface along the dorsal half of the left distal edge.

	Cisterna 4	Cisterna 5	Cisterna 6
	Immature Metacarpal	Manual Proximal Phalanx 5	Pedal Proximal Phalanx 2-4
Articular length	—	(25.0)	(23.0)
Midshaft height	6.4	4.0	5.5
Midshaft breadth	5.2	7.3	5.8
Distal height	—	4.8	5.6
Distal maximum breadth	—	7.8	8.8
Distal articular breadth	—	7.3	8.3

Table 6 – Osteometrics of the manual and pedal remains. Measurements are in millimeters.

The metaphyseal surface appears straight and perpendicular to the diaphyseal axis. The right side of the diaphysis remains straight distally, but the left side

flares to the side. Since the distal radial side of immature metacarpals normally flares more than the ulnar side, the bone derives from the right side. There is a strong proximal to distal clockwise torsion of the shaft, between 30° and 33° depending upon whether the dorsal surfaces or the estimated dorsopalmar axes of the base and head are employed. The interosseous muscle lines are faint to absent along the diaphysis.

The degree of formation of the bone suggests a minimum age of about five years postnatal, whereas the absence of evidence of fusion of the metacarpal head epiphysis suggests a maximum age of about twelve years (Greulich & Pyle, 1959). It is difficult to be more precise as to its age-at-death.

Cisterna 5

The specimen consists of the complete head and diaphysis plus portions of the base of a fifth proximal hand phalanx (Figure 8; Table 6). The shaft and head are complete, with carbonate encrustations dorsally and palmarly on the diaphysis. The base retains a small dorsal left corner of the proximal articulation and the adjacent dorsal bone. The maximum preserved length is 25.4 mm. Based on its proximal-to-distal clockwise torsion, it is probably a right bone.

The diaphysis is smooth, with the flexor tendon sheath lines projecting less palmarly than the middle of the palmar diaphysis. The head is smooth with the tubercles projecting only slightly beyond the trochlea. The right (ulnar?) side of the trochlea is larger than the left (radial?) side. An index of robusticity ((shaft height x shaft breadth)^{1/2} / articular length) for the bone provides a value of ~21.6, which is similar to the values (19.7, 21.4, 21.5) for three EUP specimens providing sufficiently complete fifth manual proximal phalanges. A recent European sample provides similar values (21.4 ± 2.0, N = 38).

Cisterna 6

The Cisterna 6 phalanx is a proximal pedal phalanx from one of the three middle digits (Figure 8; Table 6). It retains the complete head, the complete shaft



Fig. 8 – Palmar/plantar (above) and right lateral (below) views, from left to right, of the Cisterna 4 right metacarpal diaphysis, the Cisterna 5 fifth proximal hand phalanx, and the Cisterna 6 proximal pedal phalanx. Scale in centimeters.

with dorsal encrustations, and the dorsal margin adjacent to the proximal joint capsule attachment area. The preserved length is 23.2 mm, and articular length is estimated at 23.0 mm. Since the head horizontal angle is $\sim 0^\circ$, side remains indeterminate.

The diaphysis is smooth with no indications for the flexor tendon sheaths. The head has a larger trochlear height on the right side, but the left side of the trochlea flares more than the right side. A robusticity index for the specimen (~ 24.6) compares to a EUP mean of 23.5 (± 1.9 , $N = 15$ specimens, 6 individuals) and one of 25.5 (± 1.4 , $N = 6$ from 2 individuals) for the available LUP sample. A recent European sample provides a slightly lower mean (21.2 ± 2.3 ; $N = 105$ bones, 35 individuals).

NUMBER OF INDIVIDUALS

The dental remains include a young child, a late juvenile and an adolescent/young adult. The Cisterna 4 metacarpal could well belong to the same individual as the Cisterna 1 dentition, based on age-at-death. Similarly, the Cisterna 5 and 6 phalanges could be associated with the Cisterna 2 teeth. This would place the minimum number of individuals at three.

SUMMARY

The Magdalenian human remains from the Galeria da Cisterna in the Gruta do Almonda represent relatively young individuals, with the oldest (Cisterna 2) probably being little older than the early third decade based on dental attrition. They show no evidence of either developmental or degenerative lesions. Their dentitions are large compared to recent Europeans and among the larger of the Late Upper Paleolithic Europeans. The three postcranial elements are unremarkable.

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