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PALEONTOLOGICAL AND STRATIGRAPHICAL RESEARCH IN LOUTRA ARIDEAS BEAR CAVE (ALMOPIA SPELEOPARK, PELLA, MACEDONIA, GREECE)

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ABSTRACT: Excavation in Loutra Arideas Bear Cave has yielded thousand of fossilized specimens, thus it can be considered one of the richest in Late Pleistocene paleontological material of Greece. The abundance of the cave bear remains is remarkable. The large mammalian associated fauna comprises of *Ursus ingressus, Crocuta crocuta spelaea, Panthera leo spelaea, Panthera pardus, Vulpes vulpes, Canis lupus, Meles meles,* mustelids, *Bos primigenius, Capra ibex, Cervus elaphus* and *Dama dama,* as well as of 25 species of micromammals, excluding bats. This excavation in the site during 1992-2006 involved in total: 90 participants (researchers, students and co-operators) in 12 systematic excavation seasons, 34 excavated squares with a total of 206 levels, resulting in 15 thousand specimens of large mammals and thousands of specimens of micromammals from the sieving procedure. The research on the cave bear continues with new techniques afforded by the use of the Scanning Electron Microscope (SEM) in milk carnassials, as well as in milk canines. The bear teeth and the metapodials are also discussed as well as comparisons between *Ursus ingressus* from Loutra and from Gamssulzen Cave in Upper Austria, the cave that is usually used as the standard for comparisons within the cave bear group.

Key words: Late Pleistocene Cave Fauna, Stratigraphy, Loutra Arideas, Macedonia, Greece.

INTRODUCTION

Location of the cave site

The cave-site of Loutrá (**LAC**: Loutrá Aridéas Caves) is located in northern Greece (Macedonia), NW of and about 120 km from Thessaloniki, 10 km from Aridéa and very near (2 km) Loutraki village, in the Almopia Speleopark (fig. 1). The co-ordinates of the site are: N 40° 58,267΄, E 021° 54,850΄.

The "Almopia Speleopark", the first speleological park in Greece, was named so by the speleologist J. Ioannou, in 1990. Administratively, it belongs to the Municipality of Aridéa, Prefecture of Pella, which has been named after the ancient Macedonian capital Pella, birthplace of Alexander the Great.

A system of caves has developed mainly on the northern slope of the V-shaped Nicolaou Rema gorge that is situated on the slopes of the Voras Mt. (2524 m), which is one of the highest mountains of Greece (the third one, after Olympus Mt., 2917 m and Smolikas Mt., 2637 m), very close to the border with former Yugoslavia. The Bear Cave or cave A is part of the "Almopia Speleopark" in the region of the Loutrá curative springs and spas. The Nicolaou Rema gorge consists of Mastrichtian limestone with intense karstic phenomena and the erosion resulted in a depth of about 150 m, to the bottom of which the Thermopotamos River flows. The temperature of the thermal water is about 37°C. Extended travertine occurrences characterize most of the Almopia broader area.

Both in the Speleopark caves or the broader area, calcareous sinter (calcium carbonate rock or deposits formed by precipitation from natural water, often from a hot or cold spring) is widespread. Their importance comes as a result of their quantity and quality as their

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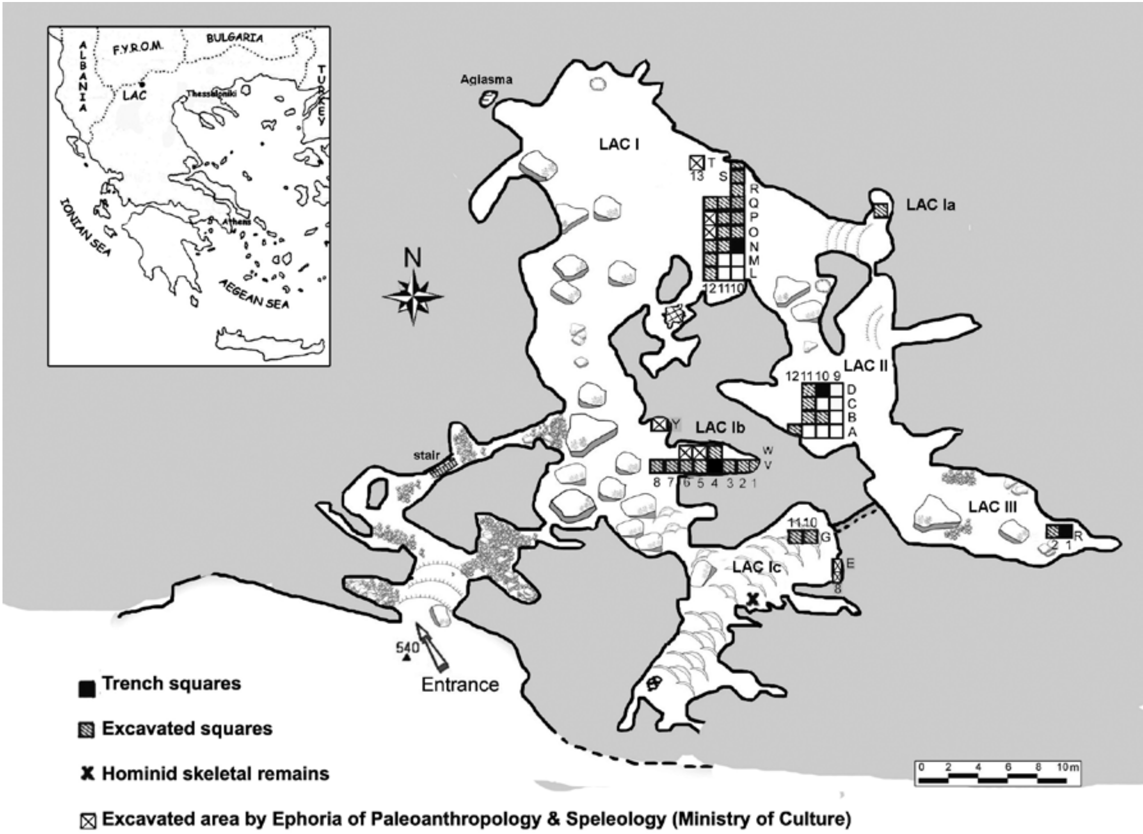


Figure 1. Ground plan of the Bear Cave with the excavating block of squares of the various chambers (1992-2006) [based on the topographic plan (Kambouroglou & Chatzitheodorou, 1999; Kambouroglou *et al.*, 2006, modified by G. Lazaridis and K. Chatzopoulou)].

clarity, the absence of xenoliths and fine crystallization are the major characteristics of them. The Almopia's travertine possesses the first position among the travertine deposits of Greece.

Historical overview

Paleontological research in the Speleopark started in 1990, when the late speleologist K. Ataktidis gave information to one of us (E.T.) about fossil bones of bear, which were brought to light by treasure seekers in the cave A or Bear Cave. It must be noted that in Z Cave of the Speleopark a fossilized maxilla bearing the broken left canine of the brown bear *Ursus* cf. *arctos* was found by the late K. Ataktidis. The first excavation face in the Bear Cave started in 1992 by the Geology School of Aristotle University, Thessaloniki (AUTH), under the supervision of the Ephorate of Paleoanthropology and Speleology (EPS, Ministry of Culture), in co-operation with Emer. Prof. G. Chourmouziadis of Archaeology, with the contribution of the late Prof. Eitan Tchernov (Jerusalem University). The excavations were continued in 1993-1994 in cooperation with EPS (Dr. E. Kambouroglou) and since 1996, 1999 till today the excavations have been carried out by Aristotle University, EPS, in co-operation with Prof. K. Kotsakis of Archaeology and Vienna University (Profs G. Rabeder, the late S. Verginis and their team) (Tsoukala, 1994; Tsoukala *et al.* 1998; 2001; Tsoukala & Rabeder, 2005). The research is still in progress.

Description of the Bear Cave - Methodology

To reach the Bear Cave, where the excavations have been carried out for twelve systematic excavation seasons, including micromammalian research, a narrow path with abrupt steps leads to the entrance of the cave. At the entrance of the cave there is a polished surface on a rock which may be due to chemical reasons or to the passing of many cave bears, which inhabited the cave. This is known reference to many bear caves in Europe, where there are polished surfaces in the narrow paths and passages of the caves too (Kurtén, 1976). Next

Figure 2. Right: The level of depth -(85-100) cm from the zero point of the square O10, excavated in 2000, was reconstructed exactly in the exhibition of the Aridéas Museum. The fossiliferous layer is rather homogenous and consists of brownish silty sediments of various thickness depending on the chamber (the thinner -about 40 cm- is in the main chamber and the thicker is about 140 cm in LAC Ic), deposited mainly under calm conditions of the paleoenvironment.
Left: The only pyrite artifact, found in 1993, in association with ursid remains of the third layer of B10 square, added another aspect to the excavations.

to the entrance, following a wooden staircase there is the first largest chamber - LAC I - of the cave, about 10 m in height, where the main excavation has been done (thirteen squares, the N10 being the trench square (fig. 1). The floor of this chamber is covered by bat guano resulting from the great number of bats which inhabit the cave. Many pottery and glass remains, from the Neolithic/Byzantine period up to the present are due to religious customs that concern a natural pool of water, called "Agiasma", in a small karstik basin, north of the chamber. The walls of the cave are grey-blackish, with "cave-corals", and less abundant, stalactite and stalagmite, fully developed speleothemes, as well as small gours (water pools).

Five smaller chambers present also special paleontological interest. The fossils are spread all over the floor of the cave. East of the main chamber there is the smallest chamber - LAC Ia, which is very difficult to reach, as it is more than 6 m above than the floor of the LAC I, on the top of a slippery rock. Ropes or stairs are necessary to visit this chamber, in which, a quick excavation in 1996, resulted in abundant material of macro- and micromammals of different taphonomy, probably of Holocene age.

In the small chamber LAC Ib, the V and W nine squares gave the most interesting material, from paleontological and taphonomical point of view. Large pebbles and stones, large ursid specimens, such as skulls, a complete pelvis, complete long bones and especially the majority of the hyaenid remains characterize this chamber. Unfortunately, two guide squares, which were left unexcavated for future reference and evidence for stratigraphy, were dug out by EPS of the Ministry of Culture.

In the gour area (chamber LAC Ic), calcite-covered recent cranial fragments and a mandible of a child were found. The sediments in this chamber include many pebbles and gravels, much more than in the other chambers. Only two squares were excavated in this chamber: the G10 that is a trench square and the G11. In the latter, the most complete, well preserved cranium of a bear was found in 2004.

The entrance of the second chamber LAC II is short, and about 70 cm in height. This chamber is much smaller, with no pottery remains on the floor.

It must be noted that in all chambers there are many disturbances caused by the treasure-seekers and many fossils had been destroyed or illegally collected.

The first excavations in this chamber started in 1992, due to fossils that were brought to light from the disturbances caused by the treasure seekers. The orientated block of squares and the datum (O) point were first fixed in this chamber, followed by the other chambers. Six squares have been excavated, the D10 being the trench square. In B10 square, very small juvenile metapodials, with no fusion of their epiphyses, were found in anatomical position. Finally, it must be noted that a stone artefact (fig. 2) was found in the same square, in association with the ursid remains. These findings added great taphonomical and archaeological interest to the excavations.

To the end of the easternmost branch of the cave, the third chamber LAC III has been almost destroyed by diggings of the treasure seekers. Only two squares (the R1 and R2, the former one being the trench square) have been excavated, characterized by thicker fossiliferous sediments with special micromammalian interest, but fewer large mammalian remains.

The excavation in the Bear Cave followed standard paleontological rules. After the definition of datum point, the three coordinates were measured of the bones. Photographs were taken for each layer (fig. 2), which was figured in mm paper and in the diary as well.

The sediments of each layer were collected, transported and washed separately through a double system of sieves, one for micromammals and smaller specimens

(0.8 mm) and the other (3 mm) for larger, mainly ursid remains including milk teeth. Concerning the large findings of the layers, they were carefully cleaned and consolidated. The classification of the bones and teeth in the archives of the excavation was recorded. All the paleontological material is stored in the Physiographical Museum of Loutra and the Natural History Museum of Aridea.

PALEONTOLOGY

The paleontological excavation and research during 1992-2006 in the Bear Cave of Almopia Speleopark has yielded more than 15 thousand fossil remains either from large or from small mammals. The major part of the large mammalian material belongs to the cave bear, while very little, but representative material belongs to eleven fossil species of carnivores and herbivores: the spotted cave hyaena, the cave lion, the leopard, the wolf, the fox, the badger, small mustelids, the red and the fallow deer, the auroch and ibex. The participation of the non ursid specimens per chamber are shown in fig. 9 and tab. 3. There are also thousands of deciduous teeth representing all the milk tooth-row, as well as of 25 species of micromammals-excluding bats.

Large mammals

Taxonomy

Order: CARNIVORA BOWDISH, 1821

Sub-order: Canoidea SIMPSON, 1931/Arctoidea FLOWER, 1969

Family: Ursidae GRAY, 1825

Genus: *Ursus* LINNAEUS, 1758

Ursus ingressus RABEDER, HOFREITER, NAGEL & WITHALM, 2004

Material-Description: Thousands of elements from the entire skeleton (bones and teeth): 3 skulls, 44 maxillary fragments, 93 mandibles and mandible fragments and many isolated teeth. Of the vertebras: 14 atlas, 9 epistropheus, 15 cervical, 34 thoracic, 25 lumbar, and 6 sacrals, many ribs, 9 sternum, 22 scapulae, 30 pelvis, 74 humeri, 98 femurs, 54 radii, 62 ulnae, 59 tibiae, 24 fibulae, 3 baculum, 208 ossa sesamoidea, 7 patellae, of the carpals: 25 pisiform, 21 scapholunatum, 15 pyramidal, 10 trapezium, 6 trapezoid, 14 magnum, 20 unciform. Of the tarsals: 25 astragali, 29 calcanei, 23 cuboid, 20 naviculars, 15 cuneiform 1, 8 cuneiform 2, 26 cuneiform 3, metapodials, 81 metapodial fragments, 332 first phalanges, 219 second phalanges, 175 third phalanges.

The bear remains are spread in all chambers, all over the cave floor. They represent few skulls, many mandibles, abundant isolated teeth and all elements of postcranial bones from animals of all ages. They mainly belong to very young animals or to juveniles as is commonly the case in bear caves.

The complete skulls are few (pl. 1.1), but there are enough complete or almost complete mandibles (pl. 1.2). The former are well preserved skulls of adults, found either in the main chamber LAC I and the most important skull, that shows clearly the characters of *U. ingressus* was found in G11 square of LAC Ic chamber (pl. 1.1), while a skull of a juvenile has been found at the end of chamber LAC Ib among other specimens of juveniles and subadults too. The abundance of the isolated teeth is remarkable and many of them have been found in all wear stages (unworn to completely worn- down to the middle of the root). Therefore the age structure of the cave bear population shows a variation with the extremes (very young and very old) predominating (pl. 1.3a-j).

The presence of both sexes has been established due to the sexual dimorphism either in the teeth (mainly canines) or in the postcranial skeleton, with a strong predominance of females over males (pl. 6.2).

The sex index (number of females/number of all canines x 100) is 77.14. More than three-quarters of canines are females (fig. 3).

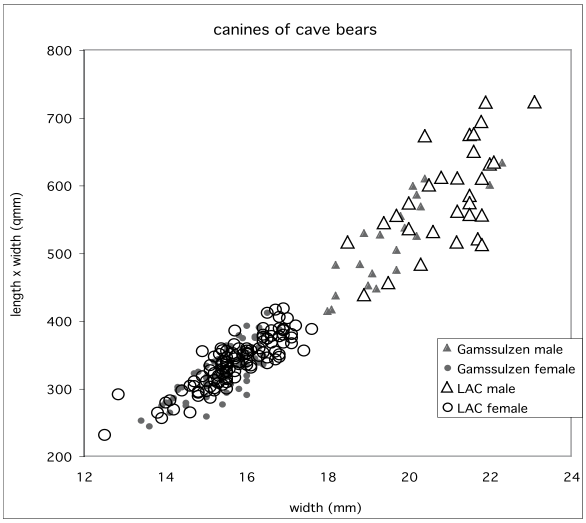


Figure 3. Scatter diagram of canine dimensions of LAC and Gamssulzen cave.

The dimensions of the teeth are relatively large. The means of length and width are similar to the values of Gamssulzen cave (RABEDER, 1995). A few means are a little smaller (I_1, I_3, premolars, M^1 and M_1) the other ones are a little bigger than the means of Gamssulzen bear.

The frequencies of morphotypes of the 4th premolars are:

Table 1.
Tooth measurements of *Ursus ingressus* from Loutra Arideas Bear Cave.

	mean	GS-standard	deviation	max	min	number
$I^{1,2}$ length	10.18	102.00	1.306	13.5	7.1	202
$I^{1,2}$ width	11.57	101.64	0.998	14.5	7.9	202
I^3 length	19.67	105.07	2.346	26.0	15.7	52
I^3 width	15.15	102.62	1.481	18.2	12.9	63
I^3 total height	50.90	103.47	3.916	57.9	41.3	23
I^3 calyx index	25.93	25.93	-	-	-	108
I_1 length	6.51	99.16	0.548	7.5	4.4	58
I_1 width	8.82	100.45	0.817	10.5	6.8	64
I_2 length	9.88	101.78	0.620	11.7	8.4	113
I_2 width	11.05	101.88	0.920	13.8	8.8	125
I_2 total height	38.45	104.88	2.262	44.0	35.7	28
I_3 length	12.66	95.88	0.987	15.0	10.5	107
I_3 width	11.82	94.97	1.009	14.1	9.0	124
I_3 total length	44.44	104.71	2.951	51.0	39.8	25
female canine length	21.71	106.42	1.592	28.5	18.2	111
female canine width	15.78	102.48	0.959	18.0	12.5	111
male canine length	27.67	109.80	2.829	33.0	23.2	30
male canine width	20.95	106.90	1.045	23.1	18.5	30
P^3 length	7.76	-	-	-	-	7
P^3 width	6.50	-	-	-	-	7
P^4 length	20.09	99.81	1.312	23.3	17.4	102
P^4 width	14.20	99.90	1.098	17.9	11.8	104
P^4 index	180.34	70.53	-	-	-	90
P4/4 index	**170.32**	**75.66**				
P_4 length	15.14	99.37	1.072	17.5	12.0	95
P_4 width	10.19	98.73	0.745	12.4	8.8	95
P_4 index	160.86	81.16				93
M_1 length	28.58	99.49	1.443	31.6	24.1	108
M_1 width	19.74	99.95	1.038	1.0	17.5	109
M_2 length	45.52	102.53	2.348	52.1	41.1	73
M_2 width	23.19	102.82	1.219	26.0	20.9	77
M_2 metaloph index	297.22	79.26	-	-	-	72
M_1 length	30.02	99.34	1.435	33.8	27.4	143
M_1 width	14.62	100.81	0.849	16.8	12.8	149
M_1 enthypoconid index	109.24	83.39	-	-	-	93
M_2 length	30.68	100.16	1.628	38.8	27.0	110
M_2 width	18.73	102.65	1.274	21.6	15.9	113
M_2 enthypoconid index	144.67	78.08	-	-	-	169
M_3 length	27.74	100.65	2.077	32.3	18.5	95
M_3 width	19.88	104.01	1.772	29.3	17.3	94

Table 2.
Measurements and indices of metapodial bones from Loutra Arideas Bear Cave.

Element	n	gl	pw	sdw	dw	dew	pd	sdd	dd	da	pa	sda	ip	K
Mc1	12	60.9	24.1	12.1	18.3	18.2	19.0	9.4	17.6	322.6	466.6	116.2	29.55	7.47
Mc2	17	76.6	18.7	17.7	21.4	25.0	28.3	12.4	21.1	466.6	540.6	220.7	32.15	6.97
Mc3	12	78.0	19.9	16.3	21.0	24.5	27.6	12.3	21.6	468.7	540.5	203.6	32.04	6.95
Mc4	9	82.2	21.4	18.0	23.0	27.1	31.5	13.4	23.7	522.1	549.1	215.8	31.53	6.92
Mc5	16	84.0	28.2	18.6	28.0	29.1	34.9	13.8	22.6	532.6	844.9	258.8	33.99	10.58
Mc	**66**	76.3	22.5	16.5	22.3	24.8	28.3	12.3	21.3	462.5	588.3	203.0	31.90	7.80
Mt1	14	52.1	20.8	11.0	16.3	16.4	23.3	9.0	15.6	264.2	492.5	101.2	30.83	9.59
Mt2	13	64.4	14.5	13.6	17.8	19.9	23.5	10.0	15.7	279.3	347.1	136.4	30.87	5.28
Mt3	16	75.3	18.6	14.8	18.4	21.2	29.3	10.4	18.1	353.5	560.6	152.1	28.20	7.40
Mt4	11	86.4	20.9	16.8	23.4	25.2	29.6	13.2	20.7	504.2	606.5	225.4	29.00	7.19
Mt5	15	87.5	27.3	13.7	23.6	23.5	28.8	12.0	17.6	408.3	819.0	175.7	27.04	9.23
Mt	**69**	73.2	20.4	14.0	19.9	21.2	26.9	10.9	17.5	361.9	565.1	158.2	29.20	7.70

gl: greatest length; pw: proximal width; sdw: smallest diaphyseal width; dw: distal width; dew: distal epicondyleal width; pd: proximal depth; sdd: smallest diaphyseal depth and dd: distal depth. Indices: da: distal area; pa: proximal area; sda: smallest diaphyseal area; ip: index of plumpness and K.

P^4: 4 A/D, 2 B, 13 B/D, 25 D, 8 D/F, 3 E, 1 E/F, 2 F. P4 sup., index: 180.34

P_4: 1 A, 2 B1/C1, 1 B1/C2, 1 B1/D1, 2 B1, 26 C1, 8 C1/C2, 15 C2, 2 D1/E1, 11 D1, 7 D1/d2, 8 D2, 1 D2/D3, 1 D3, 13 E1, p4 inf. Index: 160.86., P4/4 index 170.32 (standardised 75.66).

In both premolar groups the high developed morphotypes dominate. The simple forms A, A (B respectively A1, A1/B1, B1 are rare or missing.

All morphodynamic indices (M^2 metaloph, M_1 enthypoconid, M_2 enthypoconid, premolar indices) have evolutionary levels between 70 and 84% of Gamssulzen standard.

The bones are mostly well preserved, representing all biological ages (pl. 1.4). A few long bones are complete and very well preserved, the metapodials included.

Metapodial bones: There is only a small number of metapodial bones in Loutra Arideas Bear Cave (LAC), actual measurements of which were taken only from 66 metacarpals and 69 metatarsals and a few are still missing. So, the actual results are only preliminary ones. Eight measurements were taken according to Withalm (2001:175 ff.) and five indices were calculated (tab. 2).

When we take a closer look at the dimensions of metacarpus and metatarsus, we can see that the greatest length comes close to what is known from Gamssulzen Cave in Upper Austria, the cave that is usually used as a standard for comparisons within the cave bear group. The difference, on average, does not exceed 4 mm. The inner metacarpals and metatarsals (1-3) are smaller, whereas the outer ones are bigger than those from Gamssulzen bears.

The metapodial bones from LAC are in general less plump than their Austrian counterparts from Gamssulzen Cave. Whereas the metacarpals show a similar pattern to the Gamssulzen bears, the pattern diverges in the metatarsus as the 4th metatarsal is bigger than expected and thus produces a extra peak. It will be interesting to find out whether this is an artefact or a real difference that can probably be attributed to the different environmental conditions of the sites.

There are even bigger differences in the proportions of the smallest diaphyseal area. The sda in the metacarpus is in general smaller, with only one exception that shows a bigger value than the bears from Gamssulzen Cave is the 2nd metacarpal (tab. 2). This produces a different pattern in the diagram. The pattern of the metatarsus is more similar to those from Gamssulzen Cave but the 4th metatarsal shows a significantly higher value, whereas the 3rd metatarsals are significantly smaller than their counterparts.

Also the K-index is in general smaller than in the Gamssulzen bears and the patterns are more or less identical with a slight different trend in the three inner metacarpal bones (fig. 4-7).

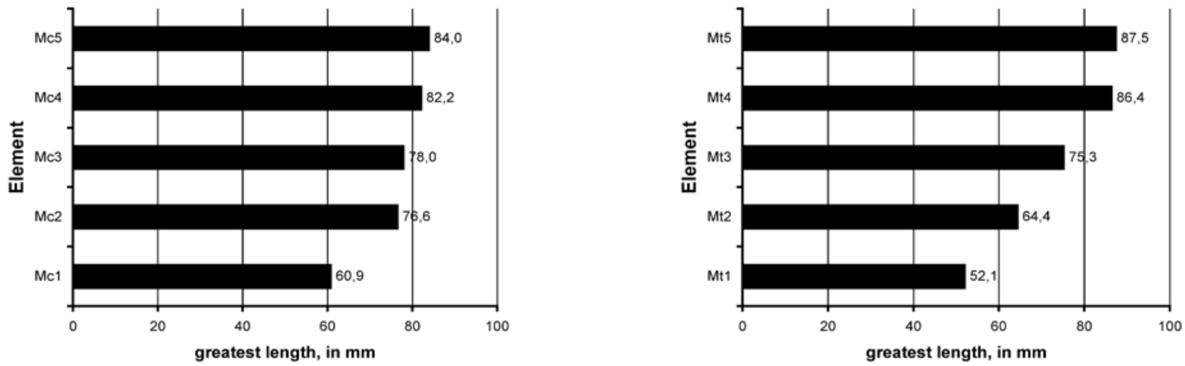


Figure 4. Proportions of metacarpus and metatarsus in respect of the greatest length (gl).

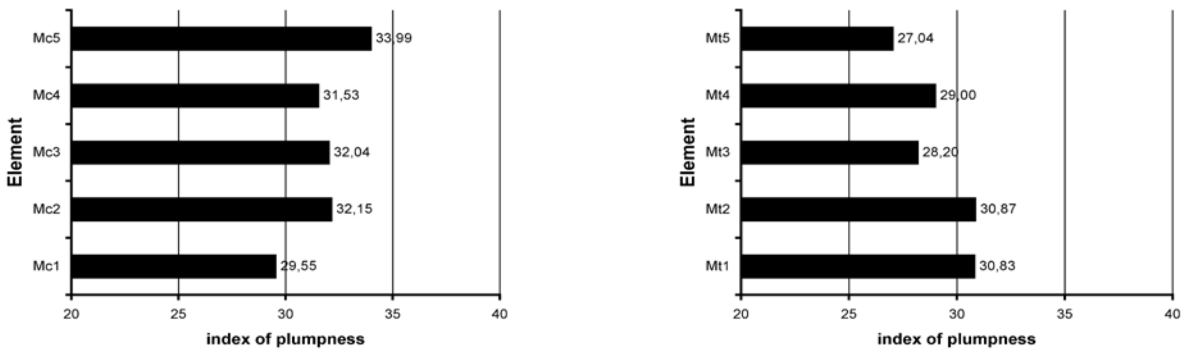


Figure 5. Proportions of metacarpus and metatarsus in respect of the index of plumpness (ip).

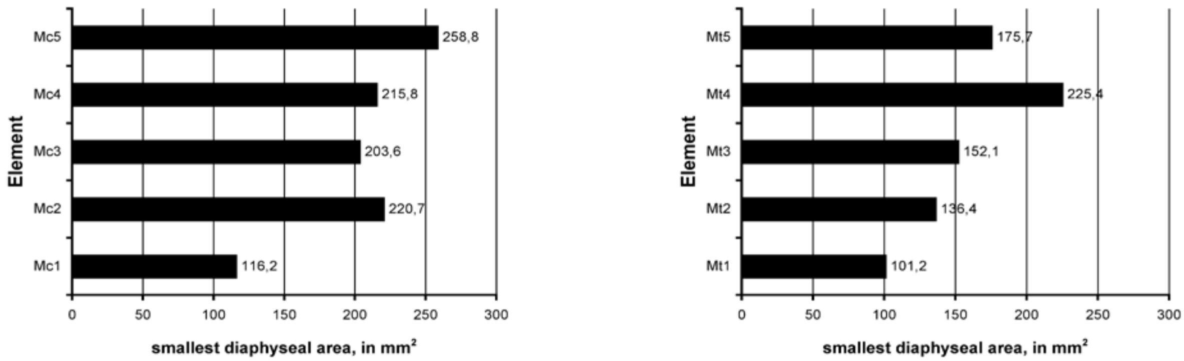


Figure 6. Proportions of metacarpus and metatarsus in respect of the smallest diaphyseal area (sda).

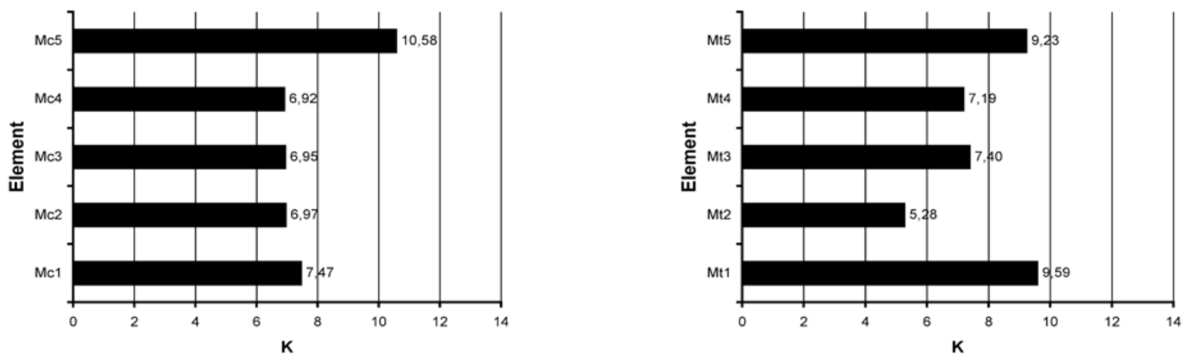


Figure 7. Proportions of metacarpus and metatarsus in respect of the index of K-index (K).

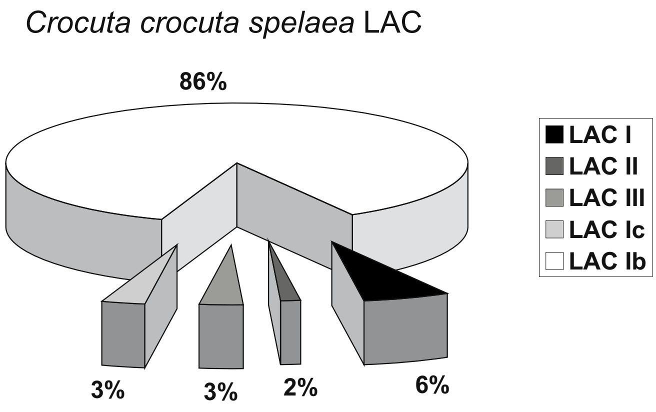


Figure 8. Loutra Arideas Bear Cave: The percentage of the cave hyena specimens in each chamber of the cave (see plan of the cave in fig. 1).

Overall there is a similar pattern in the metacarpus and metatarsus of the bears from LAC with those from Gamssulzen cave. There are also some differences that are probably local variations. The K-index of the 2nd metatarsal bone is 5.28 and is consistent with the picture that we already have.

We do have to bear in mind that there is only a small number of metapodial bones and that this deficit affects the reliability of the analysis. Further research on more complete material will certainly shed more light on metacarpus and metatarsus of this population.

Family: Canidae GRAY, 1821

Genus: *Canis* (LINNAEUS, 1758)

Canis lupus (LINNAEUS, 1758)

Material, Description: In the Bear Cave the Pleistocene wolf is very poorly represented by a right upper slightly worn carnassial (P^4), the protocone of which is missing (pl. 2.1, tab. 4). It was found in the small LAC Ib chamber.

Genus: *Vulpes* FRISCH, 1775

Vulpes vulpes (LINNAEUS, 1758)

Material, Description: The Pleistocene fox is poorly represented by few teeth: an upper left slightly worn canine (chamber LAC Ic) and two molars (M^2 chamber LAC I and M_2 chamber LAC II). Also, few post cranial bones are preserved: proximal fragments of humeri, metapodials and first phalanges (chambers LAC I, Ic and III). (pl. 2.2, tab. 4).

Family: Mustelidae FISCHER, 1817

Genus: *Meles* LINNAEUS, 1758

Meles meles LINNAEUS, 1758

Material, Description: Among the mustelid remains found in the cave (chambers LAC I, II, III and Ib), the badger is represented only by a left maxilla fragment with P^2-P^4 present, slightly worn and few post cranial bone fragments (chamber LAC III). The P^2 and P^3 are simple conical teeth, while the triangular carnassial has a prominent little worn blade with a large paracone, an ill-defined metacone and a well defined cingulum around the base of the crown. The foramen infraorbitale is well developed (Dmax=9.00, Dmin=7.57mm) (pl. 2.3, tab. 4).

Suborder Feloidea SIMPSON, 1931

Family: Hyaenidae GRAY, 1869

Genus: *Crocuta* KAUP, 1828

Crocuta crocuta spelaea (GOLDFUSS, 1832)

Material, Description: The cave spotted hyaena is the most abudant non-ursid material represented by 66 specimens. These comprise of canines, incisors, cheek teeth and many post cranial bones, such as vertebras, scapula, humerus, femur, radius, ulna, tibia carpals, tarsals, metapodials and phalanges, some of them with unfussed epiphyses.

The specimens are spread all over the five chambers of the cave; the percentage is shown in fig. 8. The animal probably lived in the cave for a short time and there are remains of juveniles, coprolites and typical food remains of this scavenger (pl. 2.4, tab. 4). On some bear bones there are bite traces marks of this scavenger (pl. 6.2). No significant diversion in size has been noted in comparison with the Petralona Middle Pleistocene and the Agios Georgios Kilkis Late Pleistocene crocuta. The cave hyena had a very large distribution area in the whole of Eurasia. Recent analyses allowed some discussion about different migration waves from Africa. The body size of these animals follow the Bergmann rule but there is also a decline in size till the end of the Pleistocene.

Family: Felidae GRAY, 1821

Genus: *Panthera* OKEN, 1816

Panthera pardus (LINNAEUS, 1758)

Material, Description: The cave leopard is well represented by ten specimens (chambers LAC I, II and Ic);

Table 3.
Loutra Arideas Bear Cave: the participation of the non ursid specimens per chamber

Taxa	Number of specimens	LAC I	LAC Ib	LAC Ic	LAC II	LAC III
Ursus	thousands	+	+	+	+	+
Crocuta	66	4	57	2	1	2
Panthera	10	3		6	1	
Panthera leo	1	1				
Vulpes	6	2		2	1	1
Canis	1		1			
Meles	1					1
Mustelidae	7	2	1		1	3
Bos	1		1			
Capra	16	4	6	3	3	
Cervus	4	1		3		
Dama	1		1			
TOTAL Non ursid	114	17	67	16	7	7

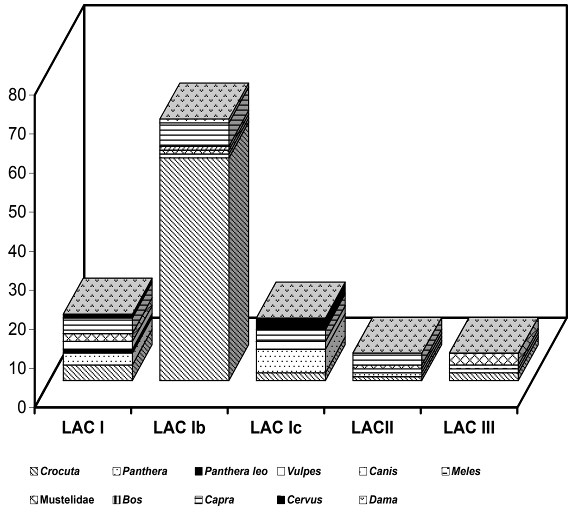


Figure 9. Loutra Arideas Bear Cave: Histogram with the participation of the non ursid specimens per chamber.

a right maxilla with P^3 that bears a large anterior and posterior accessory cusps, as well as a small posterior cingulum. The foramen infraorbitale is well developed (Dmax=11.11, Dmin= 8.45 mm). The canine is little worn with well distinguished labial and lingual longitudinal flutes. The root is well preserved. Of the post cranial bones the complete left radius is well preserved while the proximal fragment is a lesser degree. Of the left ulnas, two proximal parts with the olecranon are preserved (DTolecr.=15.18, DAPolecr.=33.84, DTprox.art.=21.90 and 26.49 mm). Of the carpals, a trapezium with dimensions 16.26 X 9.32 X 9.67 mm and of the tarsals a cuneiform 3 with dimensions 13.53 X 14.89 X 27.06 mm and the two phalanges, Ph I and Ph II, are well preserved (pl. 2.5, tab. 4). Knowledge of the leopard exists since the Middle Pleistocene when it migrated from Africa to Europe and co-existed with the European jaguar (*P. onca gombaszögensis*). In contrast to the latter, it survived even the last glacial maximum but retreated during historical time from Europe.

Panthera leo spelaea (OWEN, 1848)

Material, Description: The cave lion is poorly represented only by an upper canine found in the central chamber (LAC I). It is well preserved, complete and there is an intense longitudinal sulcus posterior of the root. The base of the crown is of circular shape and the typical flutes of the crown are well distinguished. It is rather slender, probably of a female individual (pl. 2.6, tab. 2). The cave lion is known from several European sites. It took over the ecological niche as a top predator from *P. onca gombaszögensis*. Findings from archaeological sites indicate a historical distribution of the lion but it is also possible, that this animal was traded from Asia or Africa.

Order: ARTIODACTYLA
Family: Bovidae GRAY, 1821
Subfamily: Bovinae GILL, 1872
Genus: *Bos* LINNAEUS, 1758
Bos primigenius BOJANUS, 1827

Material, Description: The aurochs is poorly represented by a first phalange: Ph I (chamber LAC Ib). A hole through the distal part of the bone shows a mark of carnivore canine (pl. 2.7, tab. 5).

Subfamily: Caprinae GILL, 1872
Genus: *Capra* LINNAEUS, 1758
Capra ibex LINNAEUS, 1758

Material, Description: The ibex is represented only (chambers LAC I, Ib and Ic) by two lower incisors, and an upper premolar), one carpal (os hamatum), a metacarpal Mc 3+4 of a male juvenile with infused epiphyses (both of the same individual), a metatarsal Mt 3+4 of a female juvenile, also with infused epiphyses, 2Ph I, Ph II (pl. 2.8, tab. 5).

Family: Cervidae GRAY, 1821
Genus: *Cervus* LINNAEUS, 1758
Cervus elaphus LINNAEUS, 1758

Material, Description: The Almopia Pleistocene red deer is represented only by three phalanges: 2 Ph2 and Ph3 of the same individual (chambers LAC I and Ic). They are robust and well preserved (pl. 2.9, tab. 5)

Genus: *Dama* FRISCH, 1775
Dama dama (LINNAEUS, 1758)

Material, Description: The Almopia Pleistocene dama is represented only by a scapula fragment (pl. 2.10, tab. 5).

The milk teeth from the Loutra Arideas Bear Cave

During Pleistocene many of the caves served as lairs for cave bears for many years. An analysis of thousands of milk teeth from the Loutra Arideas Bear Cave gives us a picture of the dynamics of the bear population, of its balance between births and deaths as well as of their taphonomy. The sieving process and the systematic collection of the milk teeth from the washed sediments from both sieves with a mesh of 0.8 mm and of 3 mm started in 1993, and it has been continued up to now. All deciduous incisors, canines and premolars of *Ursus ingressus* RABEDER *et al.*, 2004, have been studied, drawn and measured; their occlusals have been described in detail, as well as their root structure (Pappa *et al.*, 2005, Pappa *et al.* in press). New techniques in the research of the milk teeth afforded by the use of the Scanning Electron Microscope (SEM).

Material: Among the 3260 specimens of juvenile and young bears, the complete mandibles are rare: a right mandible fragment with slightly worn dC_i, the lower milk carnassial D_4 and the germ first molar M_1 unerupted (pl. 3.1) and the mandible with I_3, C, M_1, M_2 and M_3 unerupted belongs to a bear of sixteen months old (after Dittrich in Andrews & Turner, 1992) (pl. 3.2). Also there are mandible fragments with unerupted C_i, with well preserved condylus or processus angularis. In certain mandibles of young bears, the distal corpus is intensely curved beneath M_2. The abudance of the isolated teeth is remarkable: 12 dI^1, 105 dI^2, 695 dI^3, 6 D^2, 26 D^3, 240 D^4, 52 dI_1, 29 dI_2, 180 dI_3, 7 D_2, 62 D_3, 285 D_4 and 1600 dC.

Abbr.: dI: deciduous incisor, dC: deciduous canine, D: deciduous premolar.

Description and Discussion

The dI^1 is a small and slender tooth. There is a well developed palatinal cingulum and the root is elongated, conical and slightly curved (pl. 3.3). The dI_1 is a very small tooth, with a small crown and a cylindrical root, the end of which is slightly convex (pl. 3.4). The dI^2 is much stronger than the first milk incisor, and also bears a well developed palatinal cingulum. The crown is curved and the conical root is anteriorly flattened. The dI_2 is more robust than the dI_1, with triangular shaped crown and elongated root. The second upper and lower milk incisors can be attributed to three categories according to the main attribution of the milk canines after Kurtén (1968; 1976). For the former there are a few germs consisting by an enamel cap and a root that has barely started to form (pl. 3.5a), few complete teeth with unworn occlusal and fully formed roots (pl. 3.5b) and finally a few teeth bearing very large crop of shed, the root of which seems to be dissolved completely (pl. 3.5c). For the latter, the three categories are: few germs consisting by an enamel cap up to almost complete root (pl. 3.6a), few complete teeth (among them unworn teeth) with fully formed roots (pl. 3.6b), and finally few teeth with a very large crop with dissolved root (pl. 3.6c). The dI^3 has a convex crown and intense palatinal cingulum and resembles closely the milk canine. It is the largest and most abundant among the milk teeth, after the milk canines. Four categories are distinguished: few germs consisting by an enamel cap and a root that has barely started to form (pl. 3.7a), few complete teeth (among them unworn teeth) with fully formed roots (pl. 3.7b), few complete teeth with roots showing resumption marks (pl. 3.7c), a preliminary stage of which being shed as the root is gradually dissolved by the osteoclast (Koby, 1952) and finally many teeth with a very large crop with completely dissolved root (pl. 3.7d). The dI_3 is the largest lower milk incisor with crown of triangular shape and well developed root. There are two lingual accessory cuspids, jointed with a small cingulum. Two categories can be distinguished: few germ teeth consisting by an enamel cap and a root that has barely started to form (pl. 3.8a, b) and very few teeth with completely dissolved root (pl. 3.8c).

The milk canines are long and flattened teeth, abundant in the LAC material, far more numerous than the other milk teeth. There are more than 1600 specimens of these pointed teeth. It is difficult to distinguish between maxillas and mandibles, thus both are described as dC *sensu lato*. They are distinguished in various wear stages according to Kurtén (1976), (Andrews & Turner, 1992): In a) unerupted, consisting by an enamel cap and a root that has barely started to form (unborn or newborn cubs), b) erupted complete teeth with unworn occlusal and fully formed roots, c) unworn complete teeth with root showing resumption marks d) slightly worn with

Table 4
Loutra Arideas Bear Cave: measurements of bones and teeth of the non ursid carnivores.

Canis lupus

LP^4	23.79
BP^{4}mts	11.77

Meles meles

LP^2	4.43
BP^2	3.12
LP^3	5.69
BP^3	3.80
LP^4	8.28
BP^4	7.68
L P^2 -P^4	18.29

Vulpes vulpes

LC^s	6.88
BC^s	4.59
HC^s	29.69
LM^2	9.76
BM^2	5.89
LM$_2$	8.35
BM$_2$	6.14

Panthera leo spelaea

LC^s	20.00
BC^s	17.92
HC^s	113.75
H crown	46.00
L root	27.65
B root	19.85

Crocuta crocuta spelaea

	C^s	C$_i$	I^1		I^2	I^3	dI^3	P$_4$
L	15.90	15.79	7.56	7.40	9.20	11.20	8.00	23.00
B	13.40	12.77	6.15	5.90	6.37	11.68	6.00	14.52
H	62.00	61.00				43.00		
H crown	28.38	28.30				15.65		

	Calcaneus	Scaphoid	Cun3	Cuboid	Capitatum	Pyramidal	Lunatum	Hamatum
L	60.52	13.34	15.80	22.57	17.35	13.96	24.00	19.85
DT	27.67	28.63	14.15	20.42	14.25	13.65	40.00	18.90
DAP	29.10	23.54	26.12	19.86	26.93	23.21	25.00	23.65

Panthera pardus

	Radius		Ph1	Ph2
L	196.00	-	36.29	30.43
DT pr.	24.73	24.23	12.34	12.79
DAP pr.	16.59	18.45	12.00	13.28
DT dia.	18.83		8.55	7.37
DAP dia.	12.47		-	7.79
DT dis.	36.29		10.46	11.12
DAP dis.	20.61		9.00	8.50
DT d.art.	29.78			
DAP d.art.	18.27			

Mx + P^3	
LP^3	17.16
BP^3	8.39
L I^1-P^4 alv.	86.81
L diast.	4.30
L P alv.	50.51

Canine	
LC$_i$	(13.5)
BC$_i$	10.70
HC$_i$	(62.00)
L root	16.52
B root	13.06

Crocuta crocuta spelaea

	Radius	Tibia
L	229.00	192.00
DT pr.	30.85	(50.00)
DAP pr.	20.72	56.00
DT dia.	23.57	18.85
DAP dia.	13.71	22.19
DT dis.	42.38	39.00
DAP dis.	26.04	27.00
DT d.art.	35.10	

Crocuta crocuta spelaea

	Mc2	Mc3	Mc4		Mc5	Mt3		Mt4		Mt5
L	79.61	93.99	93.23	92.12	69.73	82.64	79.11	82.43	82.26	68.81
DT pr.	15.55	16.58	12.77	13.00	12.37	14.52	-	10.95	11.87	12.22
DAP pr.	19.00	21.64	19.26	18.23	18.87	21.15	19.86	18.00	20.20	18.60
DT dia.	11.93	12.19	12.00	11.90	8.51	11.29	12.46	10.96	11.55	8.97
DAP dia.	9.68	10.35	9.32	9.41	11.31	10.16	11.80	9.53	10.00	10.68
DT dis.	16.59	16.51	15.43	15.54	12.87	15.00	14.35	13.68	14.10	12.07
DAP dis.	15.86	16.33	15.38	15.58	13.38	14.45	13.45	13.74	13.98	13.14

Ph1									
L	33.40	33.36	33.62	29.49	30.44	32.00	30.00	32.00	30.31
DT pr.	15.36	15.44	16.00	13.95	13.55	14.21	13.19	-	13.47
DAP pr.	14.46	13.87	14.82	13.00	12.26	13.19	12.10	12.25	12.30
DT dia.	11.00	10.69	11.16	10.00	9.73	9.83	8.85	9.83	8.90
DAP dia.	8.87	7.73	8.67	9.00	8.35	7. 66	7.90	8.30	7.90
DT dis.	13.45	13.30	13.55	14.00	11.90	12.73	11.00	12.67	11.54
DAP dis.	9.60	9.40	9.41	9.00	7.96	8.39	8.21	8.27	7.96

Ph3			
L	22.92	20.00	22.34
DT	13.82	10.75	12.90
H	15.57	12.40	14.85

Table 5
Loutra Arideas Bear Cave: measurements of bones and teeth of herbivores

	Bos primigenius	*Capra ibex*									
		Ph1			**Ph2**		**Radius**	**Mc3+4 ♂**	**Mt3+4 ♀**	**Os hamatum**	
L	74.50	45.47	45.33	45.07	32.27	34.11	228.00	-	-	L	13.95
DT pr.	35.72	18.48	17.12	16.62	13.50	14.67	45.27	35.92	24.76	DT	17.43
DAP pr.	41.84	20.34	17.49	17.38	14.00	16.33	22.16	23.94	23.25	DAP	23.19
DT dia.	33.85	15.09	14.57	14.90	9.02	10.51	27.94	(26.36)	(15.00)		
DAP dia.	29.38	15.74	15.60	15.22	-	-	17.71	(17.43)	(12.00)		
DT dis.	33.28	17.56	17.03	16.04	9.89	10.44	41.12				
DAP dis.	25.82	15.69	15.68	14.14	11.85	13.33	24.10				

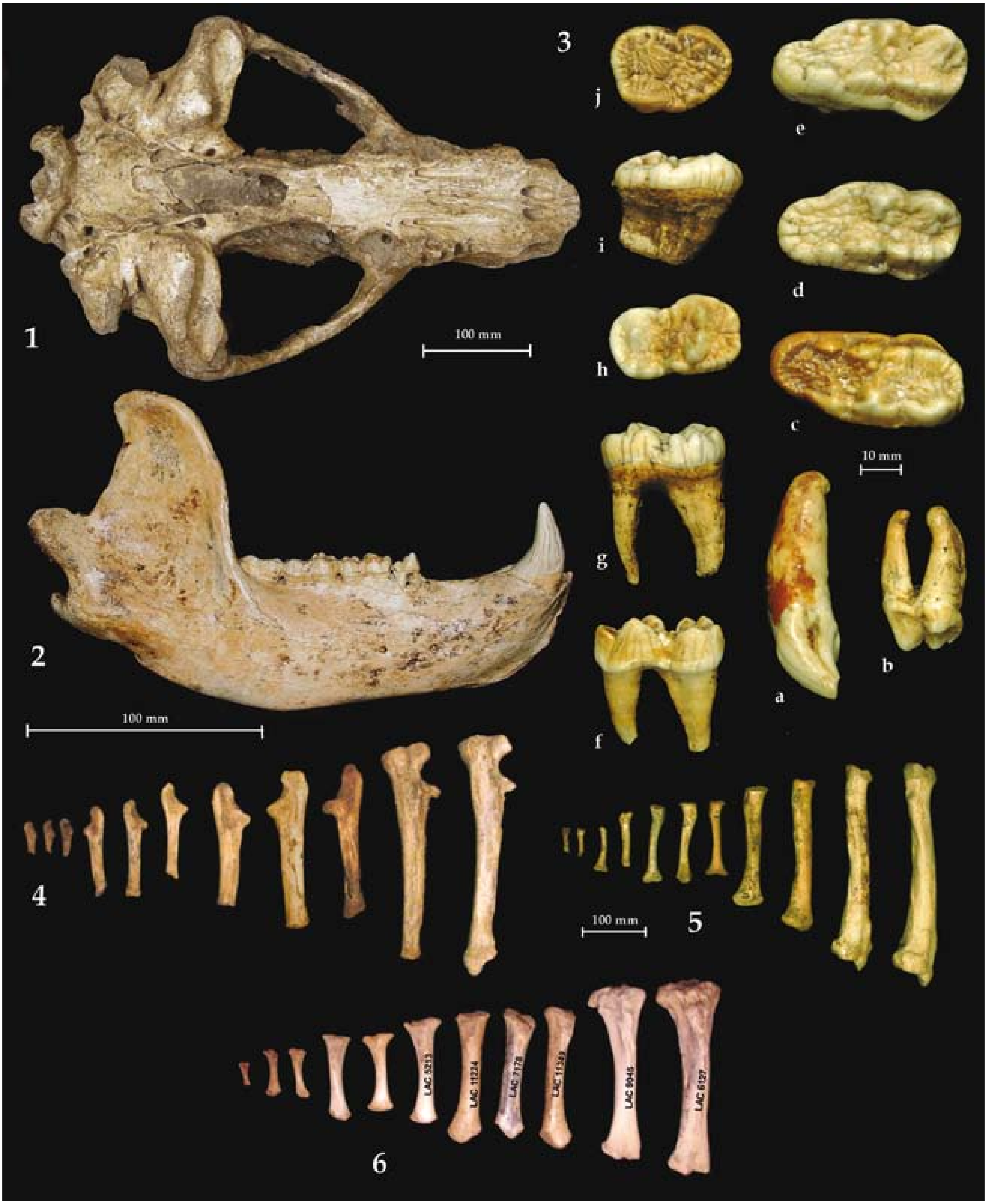
Cervus elaphus				
	Ph2		**Ph3**	
L	43.41	45.20	L	52.19
DT pr.	22.77	25.14	H	31.74
DAP pr.	27.52	30.40	DT	18.67
DT dia.	18.34	19.36	Dart.max	28.26
DAP dia.	24.11	22.67	Dart.min	17.68
DT dis.	19.84	20.83		
DAP dis.	28.91	27.67		

a very large crop of shed milk canines in which the root has dissolved completely, e) heavily worn, that includes the heavy wear stage of deciduous teeth and f) worn with resorbed root. Concerning the LAC milk canines, they can be attributed to: a) 132 unerupted (pl. 3.9a), b) 500 erupted (pl. 3.9b), c) 83 unworn in a preliminary stage to the tooth being shed and as the root is gradually dissolved by the osteoclast (pl. 3.9 c), d) 130 slightly worn (pl. 3.9d), e) 600 heavily worn and f) 155 worn (after Koby, 1952 whose hypothesis on the milk teeth has still to be tested as the research is still in progress).

The second premolars are the smallest of the cheek milk teeth and the less differentiated, the root of the D^2 being small and conical and the D_2 with inclined, growth (pl. 3.10 and 11). The D^3 is more differentiated with developed talon and two roots (pl. 3.12). The D_3 is of elongated crown, with two roots that are well separated or fused in some specimens Radulescu & Samson (1959) (pl. 3.13). The upper milk carnassial D^4 is the most important tooth because it contributes to the study of the evolutionary stage according to its morphotype (Rabeder, 1983; 1991; 1999). It is molar like and has one palatinal and two labial roots. The occlusal shape is rounded and sometimes there is a palatinal cuspid-like cingulum (pl. 3.14). The lower carnassials D_4 are much more various than that of the maxilla one, with crown bearing at least 5 cusps and two roots (pl. 3.15). The milk carnassials D^4 and D_4 are the most important deciduous teeth as the study of the morphotype can give evidence for their evolutionary stage (Rabeder, 1983). The D^4 LAC is molar like with one palatinal and two labial roots. The occlusal shape is rounded and sometimes there is a palatinal cuspid-like cingulum. The paracone is well developed and the metacone bears longitudinal palatinal crest. There is small parastyle while there is a trace of cingulum like metastyle. Finally there is a crest-like hypocone. The lower milk carnassials D_4 LAC are much more variable than those of the upper ones, with crown bearing at least 5 cuspids. Paraconid, metaconid and protoconid are well developed. There is a small hypoconid and endoconid.

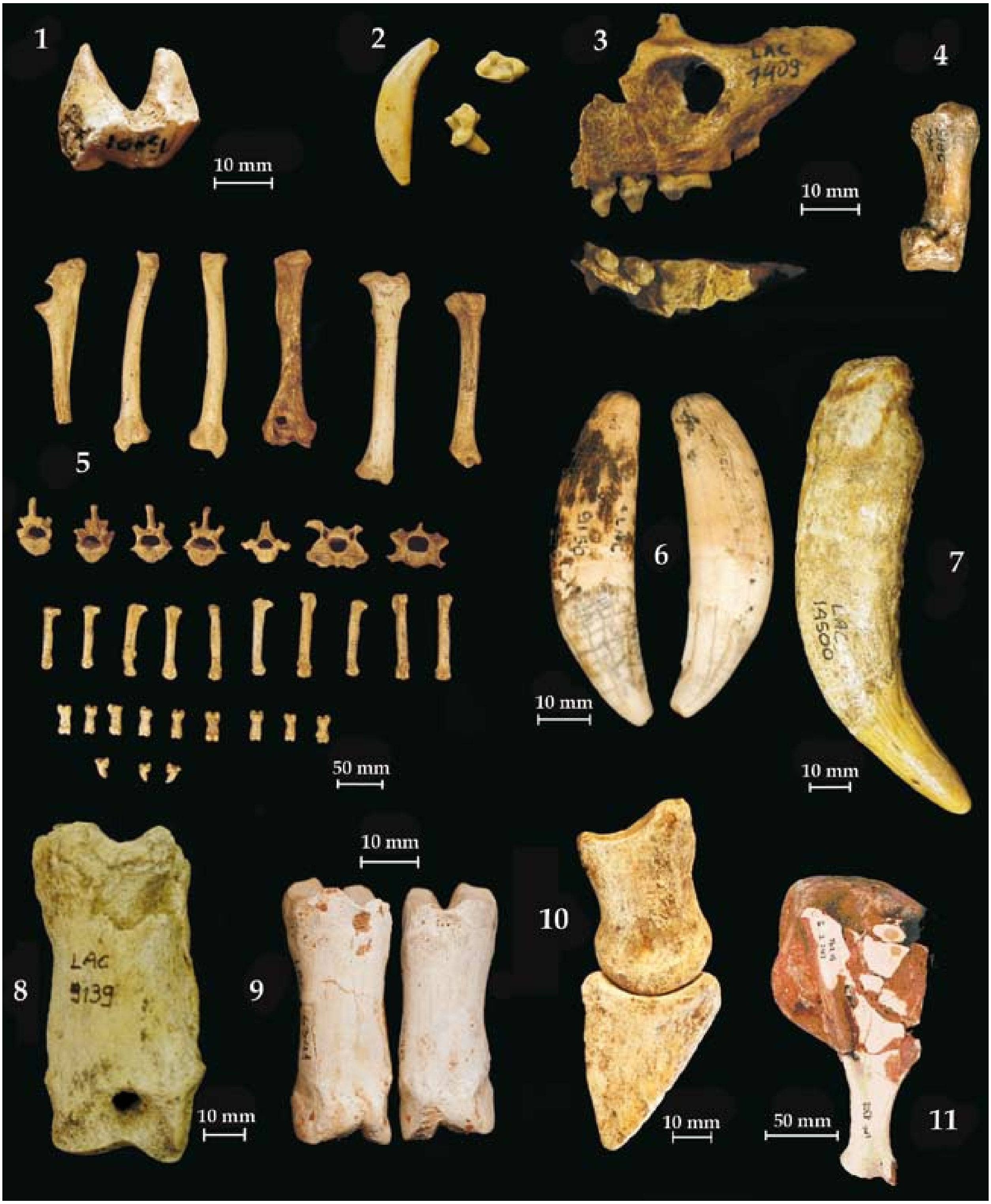
Research on the LAC cave bear continues with the upper and lower milk carnassials, as well as with the milk canine through the implementation of new techniques afforded by the use of the Scanning Electron Microscope (SEM). The aim is to document different modes of chewing and to remark the chemical analysis of various parts of the milk teeth. The digestion of food is the way animals acquire energy, and the organs involved with feeding are fundamental for survival. Existing literature points out that tooth wear is produced by two types of masticating behaviour (by Kay & Hiiemae, in Pinto *et al.*, 2005). Foodstuffs may be pulped through a series of cycles (puncture-crushing) that do not involve tooth to tooth contact, and this may result in an abrasive wear. Subsequent tooth to tooth contact produces attritional wear. The micrograph analysis in D^4 LAC 14600, showed the presence of: relatively intense accessory cusps focusing in metacone (pl. 4.1a), robust denticulate cingulum (pl. 4.1b), microscratches (with ~100μm analysis)(pl. 4.1c) and microprotuberances, the chemical analysis of which, by the

Plate 1



Ursus ingressus LAC: 1. Skull of an adult bear, basal view; 2. Mandible of a male with C_i, P_4-M_3 dex; 3. Isolated teeth: a) I^3 sin, b) P^4 dex, c,d) M^2 dex, e) M^2 sin, f) M_1 sin, g,i) M_2 sin, j,k) M_3 sin. Post cranial bones of various ages from very juvenile to fully adult: 4. ulnae; 5. radii; 8. tibiae.

Plate 2

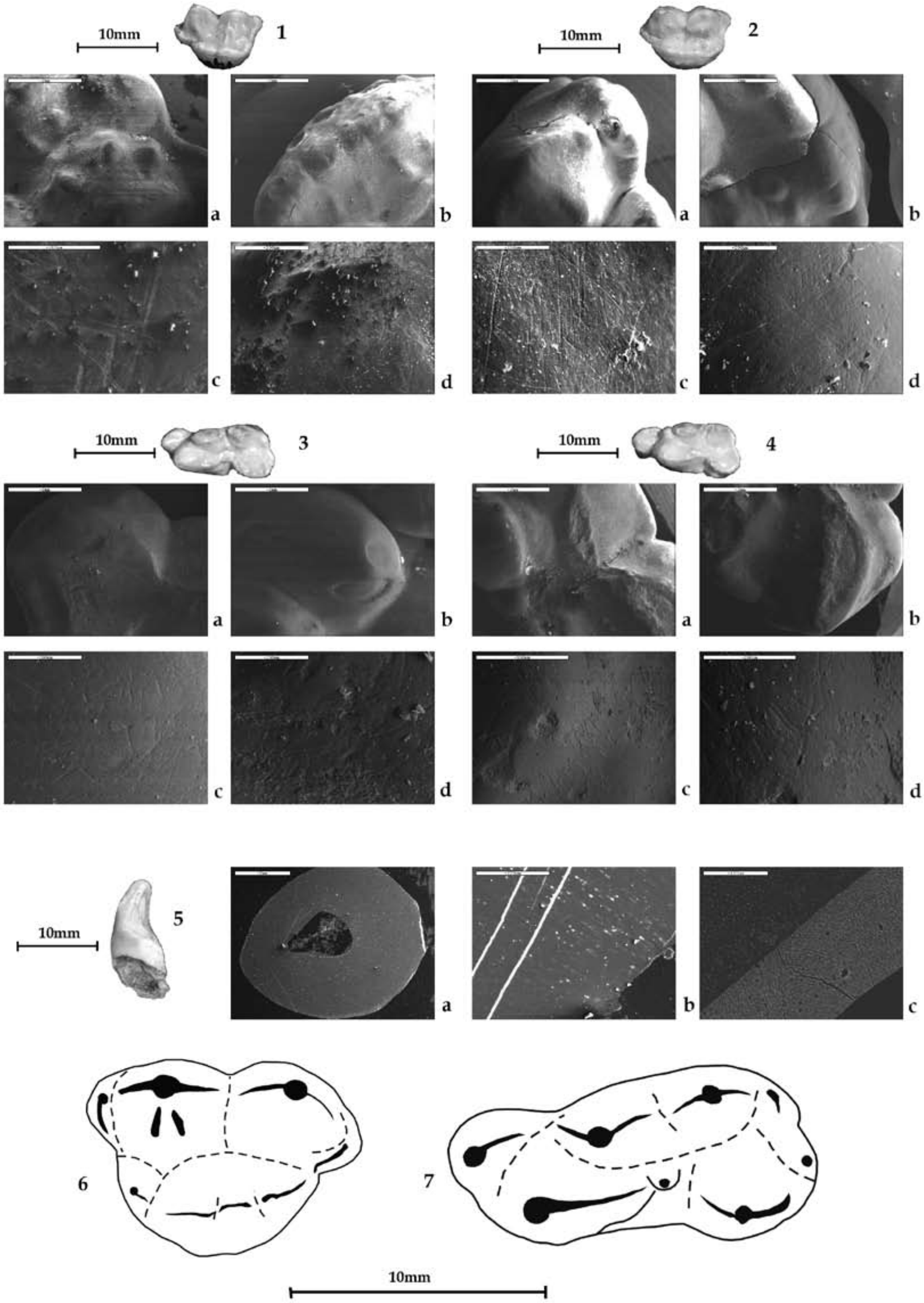


Loutra Arideas Bear Cave, non ursid mammalian remains: 1. *Canis lupus,* P^4 dex; 2. *Vulpes vulpes,* C^s sin, M^2 dex, M_2 sin; *3. Meles meles,* maxilla frag. with P^2-P^4 sin; 4. *Panthera pardus* Ph 2; *Crocuta crocuta spelaea:* 5. postcranial bones (vertebras, metapodials, Ph 1 and Ph 3) and 6. C^s sin; 7. *Panthera leo spelaea* C^s sin; 8. *Bos primigenius,* Ph I; 9. *Capra ibex,* Ph I; 10. *Cervus elaphus,* Ph 2 and Ph 3 and 11. *Dama dama,* scapula fragment.

Plate 3

Ursus ingressus LAC, milk teeth: 1. Right mandible fragment with a slightly worn dCi, D_4 and the germ M_1 unerupted; 2. Mandible with I_3, C, M_1, M_2 and M_3 unerupted; 3. dI^1; 4. dI_1; 5. dI^2 (a-c: various categories); 6. dI_2 (a-c: various categories); 7. dI^3 (a-d: various categories); 8. dI_3 (a-c: various categories); 9. dC (a-d: various categories); 10. D^2; 11. D_2; 12. D^3; 13. D_3; 14. D^4; 15. D_4. For the various categories see in the text.

Plate 4



Ursus ingressus LAC, Scanning Electron Microscope (SEM): 1. Micrograph of D^4 LAC 14600. 1a. Metacone and accessory cuspids, 1b. Cingulum, 1c. Microscratches, 1d. Micro-protuberances; 2. Micrograph of D^4 LAC 14601. 2a. Paracone, 2b. Paracone and cingulum, 2c. Microscratches with ~100μm resolution, 2d. Microscratches with ~200μm resolution; 3. Micrograph of D_4 LAC 14603. 3a. Slightly worn hypoconid and endoconid, 3b. Protoconid, 3c. Microscratches with ~100μm resolution, 3d. Microscratches with ~200μm resolution; 4. Micrograph of D_4 LAC 14604. 4a. Completely worn hypoconid, 4b. All cuspids are worn, 4c. Microwear such as pits, 4d.Microscratches; 5. Micrograph analysis in dC LAC 14602. 5a. Section at the base of the crown, 5b. Close up to the dentine. 5c. Difference between dentine and cementum; 6. Morphology of the occlusal D^4 LAC 12557; 7. Morphology of the occlusal D_4 LAC 12560. The SEM photos were kindly provided by Dr. Labrini Papadopoulou.

Table 6
Chemical analysis of some micro-protuberances on the occlusal of D^4 LAC by the use of Scanning Electron Microscope (SEM)*.

Elmt	Spect Type	Element %	Atomic %	Nos. of ions
Mg K	ED	0.55	0.53 MgO	0.22
P K	ED	20.29	15.60 P_2O_5	6.55
Cl K	ED	0.68	0.45	0.19
Ca K	ED	36.64	21.77 CaO	9.14
			Cation sum	15.98

Table 7
Chemical analysis of cementum and dentine of dC LAC by the use of Scanning Electron Microscope (SEM)*.

Cementum				Dentine			
Elmt	Spect Type	Element %	Atomic %	Elmt	Spect Type	Element %	Atomic %
O K	ED	44.25	64.11	O K	ED	44.84	64.76
Na K	ED	0.64	0.64	Na K	ED	0.44	0.45
Mg K	ED	0.29	0.28	Mg K	ED	0.48	0.45
P K	ED	18.97	14.20	P K	ED	17.61	13.14
Cl K	ED	0.35	0.23	S K	ED	0.39	0.28
Ca K	ED	35.41	20.48	Ca K	ED	36.01	20.76

* The samples were analyzed by Dr. Labrini Papadopoulou.

tooth (pl. 4.1d, tab. 6). The micrograph analysis in D^4 LAC 14601 showed the paracone in detail (pl. 4.2a), the lesser intense cingulum (pl. 4.2b), microscratches on the paracone, with ~100μm (pl. 4.2c) and ~200μm analysis (pl. 4.2d). The micrograph analysis in D_4 LAC 14603, showed: slightly worn hypoconid and endoconid (pl. 4.3a), the tip of the protoconid greatly rounded, with a wear facet on the top and pit (pl. 4.3b), microscratches on the protoconid, with ~100μm (pl. 4.3c) and ~200μm analysis (pl. 4.3d). The micrograph analysis in D_4 LAC 14604 showed: eroded hypoconid (pl. 4.4a), completely worn cuspids (pl. 4.4b) as well as all the types of microwear such as pits (pl. 4.4c), polished surfaces and microscratches (pl. 4.4d). The micrograph chemical analysis by the use of SEM in dC LAC 14602 (cross section at the base of the crown is shown in pl. 4.5 a,b) showed slight divergence of cementum and dentine (pl. 4.5c, tab. 7).

Concerning the occlusal morphology of the milk carnassials D^4 (LAC 12557) and D_4 (LAC 12560), they are more similar to those from Gamssulzenhöhle (Rabeder, 1983) (pl. 4.6, 4.7).

The micromammals from the Loutra Arideas Bear Cave

The study the micromammalian fauna from the chosen squares N10 (LAC I), V4 & W4 (LAC Ib), B11 & D10 (LAC II) and R1 (LAC III) followed several steps. The sediments were first put into water and perhydrol and then all the material was washed through a double system of sieves, one for micromammals (0.8 mm) and the other (3 mm) for larger, mainly ursid remains. The total sediment that was washed through the sieves and collected in the second one, with a mesh of 0.8 mm for the study of the small mammals weighed 2000 kg. Then the material was dried, packed up and transported to the Aristotle University's labs for sorting, the teeth were placed in special plates and they were listed. The measurements of the teeth were taken using a WILD Photomakroskop M400 stereoscope. The teeth were figured in the Aristotle University. All the material is stored both in the Aristotle University of Thessaloniki and the local Physiographical Museum of Almopia.

The LAC assemblage consists of four orders of micromammals. The faunal list shows a remarkable abundance of the small mammals: 25 species belonging to 12 families, 18 of which identified at the species level (Chatzopoulou *et al.*, 2001; Chatzopoulou, 2003; 2005). The material presented in this research yielded a rich microfauna based on more than 1500 specimens. The material from LAC III shows the most remarkable diversity of taxa and great abundance of bones and teeth remains in the cave regarding micromammals. The assemblage of LAC II is relatively rich. In LAC I, the number of teeth and bones is reduced, while the material from LAC Ib is very poorly represented. Few complete mandibles were found up to now, as it is fragmentary material, bearing few teeth.

The insectivores are represented by two families, Erinaceidae and Soricidae. The remains of the former family confer to *Erinaceus* cf. *europaeus* (pl. 5.1). The structure of two isolated teeth of the upper jaw, found in the Bear Cave is exactly as in recent specimens of *E. europaeus.*

Soricidae are differentiated in two subfamilies Soricinae and Crocidurinae by the tooth pigmentation. Soricinae have red teeth. The mandible from LAC (pl. 5.4a-b) is attributable to the genus *Sorex* because the buccal cingulum is narrow, the talonid of M_1 is slightly shorter than trigonid and the mental foramen is placed below the trigonid of M_1 (Reumer, 1984). The large size (*S. araneus* group) and the morphological characteristics conform rather well to *S. araneus* (Reumer, 1996). Nevertheless, the study of a single specimen does not allow a secure identification at the species level. A small-sized representative of the genus *Sorex* was also recorded in the material of LAC III. The mental foramen, that is indicative for this species, is not visible because the mandible is damaged. The study of the LAC specimen (pl. 5.5a-b) showed that the size and the morphological characteristics conform rather well to *S. minutus* (Reumer, 1984). However, as the material is so extremely scanty, the LAC material is referred as *S.* cf. *minutus*.

Crocidurinae have white teeth. The lower incisor is acuspulate (pl. 5.3), in the lower molars the buccal reentrant valley opens high above the cingulum, the entoconid crest is low to nearly absent (pl. 5.2b), the buccal cingulum is narrow but well pronounced and undulating in M_1 (pl. 5.5a). These characteristics determine the genus *Crocidura* (Reumer, 1984). No P^4 has been preserved in the LAC material in order to define the species.

A small-sized representative of Sciuridae has been also recorded. The high protocone and the U-shaped occlusal surface of upper molars (pl. 5.7) as well as the strong entoconid and the presence of trigonid basin in M_3 (pl. 5.8), conform to the genus *Spermophilus* [=*Citellus*] (Miller, 1912). Distinction of small-sized species is based on the number of roots of P_4. Since this tooth has not been found up to now, therefore, LAC remains are attributed to *Spermophilus* sp.

Two isolated teeth found in LAC III belong to the genus *Sicista*, which is characterized by brachyodont molars with simple morphology (pl. 5.6) (Koliadimou, 1996). *S. subtilis* shows a low degree of enamel folding. Its simple molar structure and its dimensions, which are considerably variable in size in recent *S. subtilis*, characterize the LAC material.

The remarkable abundance of arvicolids is described by six different species. The large-sized hypsodont molars (pl. 5.29a) belong to the genus *Arvicola*. The symmetry and the simple structure of the anteroconid of M_1 (Chaline, 1974) conform to *Arvicola terrestris* (pl. 5.29b).

The best-represented *Microtus* is *M. nivalis*. The M_1s have four closed triangles and the shape of the anteroconid looks like a shaft (pl. 5.30-31). The M^3s are massive and show simple structure (pl. 5.32). Lots of arvicolid teeth are attributed to *Microtus arvalis* or *M. agrestis* due to the structure of the anteroconid of the M_1. Differentiation between the latter of the voles is problematic since their structure and dimensions overlap to a large extent. Among the teeth attributed to *Microtus arvalis* (pl. 5.34-35), there are specimens whose length of M_1 is more than 3.10mm (pl. 5.33). According to Nadachowski (1982) these specimens belong to *M. agrestis*.

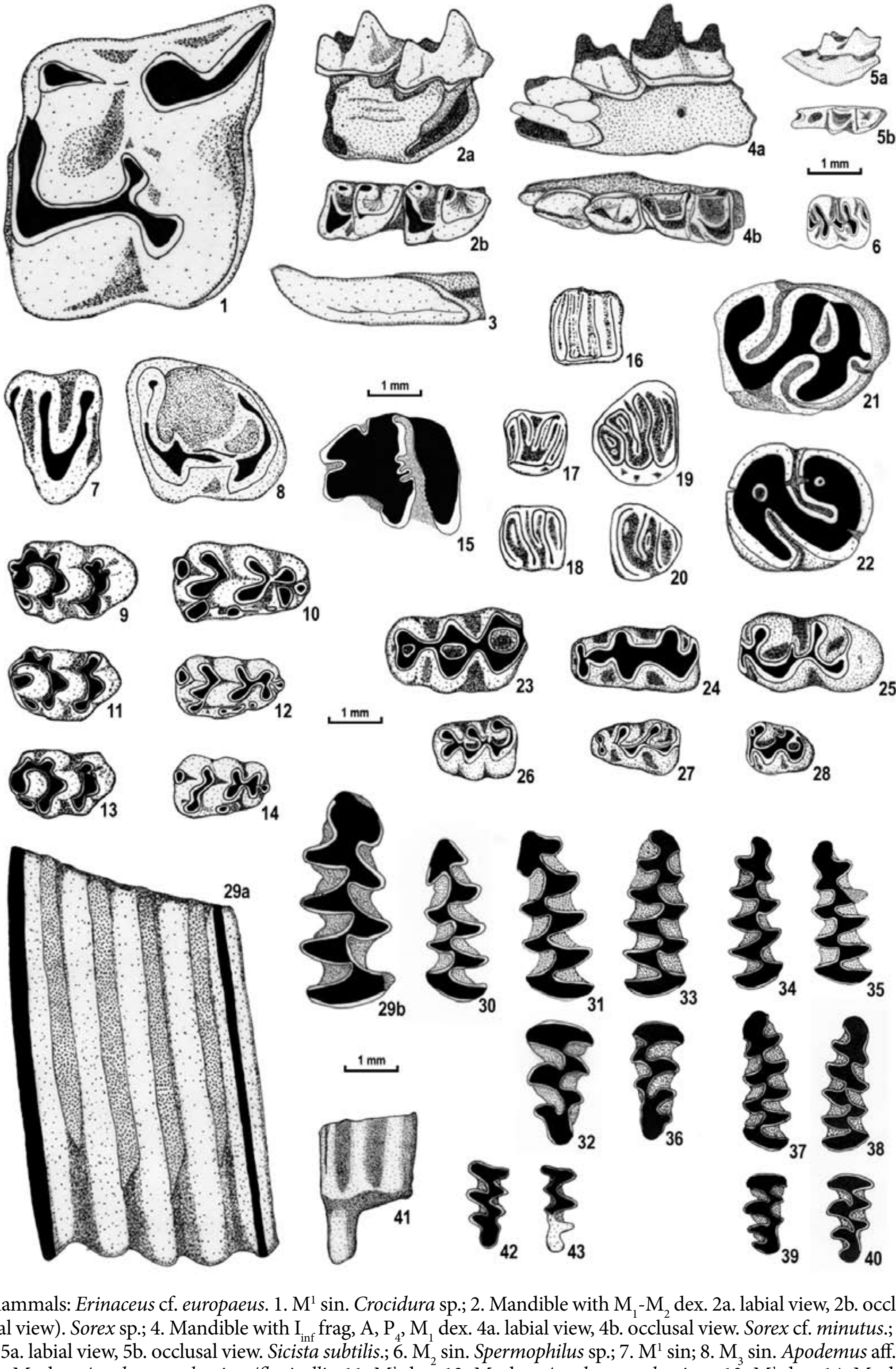
The distinction between *Microtus (Pitymys) multiplex* and *Microtus (Pitymys) subterraneus* is based on the structure of the anteroconid of M_1 (Chaline, 1972). The LAC specimens have an open connection between the anteroconid and triangles T6 and T7. In 57% of the M_1 T9 is well developed. These characteristics conform to *M. (P.) multiplex* (pl. 5.37-38). The arvicolid molars bearing roots and having a more slender structure (Miller, 1912) are attributed to the genus *Clethrionomys*. Since the LAC material is poor, it is identified as *Clethrionomys* sp (pl. 5.41-43).

The murids are very prevalent and are represented by three different species. The large-sized teeth attribute to *Apodemus mystacinus* (pl. 5.9-10). Nevertheless their size is considerably smaller than that of other *A. mystacinus* populations. The small-sized *Apodemus* teeth are attributed to the group *Apodemus sylvaticus/flavicollis* (pl. 5.11-12) since the distinction between these species is difficult. Some M^1 and M_1 (pl. 5.13-14) are very small and can be assigned to *A. sylvaticus*.

Two hamsters have been recorded in LAC material. The small-sized cricetid (pl. 5.26-28), which is morphologically similar to recent *Cricetulus migratorius*, is slightly smaller than other *C. migratorius* from the Balkans. The large-sized teeth (pl. 5.23-25) fall within the range of *Mesocricetus newtoni*. The Romanian Hamster, which probably originated in the Middle East, is assumed to have crossed the Bosporus at the lowest sea level stand during the last glaciation (Santel & Koenigswald, 1998).

The glirids are represented by three species. The most abundant of all, *Dryomys nitedula* is characterized by the prominence and the number of the main ridges of the molars (pl. 5.17-18). *D. nitedula* in Greece shows an average-complexity of the occlusal surface (Daams, 1981). The complex morphology and the large size of the occlusal surface of the LAC specimens conform to *Glis glis* (pl. 5.19-20). The long transversal, continuous ridges of LAC material conform rather well to recent *M. avellanarius* (Storch, 1978). However, as the material is extremely scanty, the LAC material is referred to as *M.*cf. *avellanarius* (pl. 5.16).

Plate 5



LAC micromammals: *Erinaceus* cf. *europaeus*. 1. M^1 sin. *Crocidura* sp.; 2. Mandible with M_1-M_2 dex. 2a. labial view, 2b. occlusal view; 3. I^{sup} dex (lateral view). *Sorex* sp.; 4. Mandible with I_{inf} frag, A, P_4, M_1 dex. 4a. labial view, 4b. occlusal view. *Sorex* cf. *minutus*.; 5. Mandible with M_2 dex. 5a. labial view, 5b. occlusal view. *Sicista subtilis*.; 6. M_2 sin. *Spermophilus* sp.; 7. M^1 sin; 8. M_3 sin. *Apodemus* aff. *mystacinus*; 9. M^1 dex; 10. M_1 dex. *Apodemus sylvaticus/flavicollis;* 11. M^1 dex; 12. M_1 dex. *Apodemus sylvaticus*; 13. M^1 dex; 14. M_1 dex. *Lepus* cf. *europaeus;* 15. P_3 sin. *Muscardinus* cf. *avellanarius*; 16. M^2 dex. *Dryomys nitedula*; 17. M^1 dex; 18. M_2 dex. *Glis glis*; 19. M^3 dex; 20. P_4 dex. *Spalax leucodon*.;21. M^1 dex; 22. M_1 dex. *Mesocricetus newtoni*; 23. M^1 sin; 24. M_1 sin; 25. M_3 sin. *Cricetulus migratorius*; 26. M^1 sin; 27. M_1 sin; 28. M_3 sin. *Arvicola terrestris*; 29. M_1 sin. 29a. lingual view, 29b. occlusal view. *Microtus nivalis*; 30. M_1 sin; 31. M_1 sin; 32. M^3 sin. *Microtus agrestis*; 33. M_1 dex; 34. M^3 dex. *Microtus arvalis*; 35. M_1 dex; 36. M_1 sin. *Microtus (Pitymys)*cf. *multiplex*; 37. M_1 sin; 38. M_1 dex; 39. M^3 sin; 40. M^3 sin. *Clethrionomys* sp.; 41. M^2 dex (lingual view); 42. M^3 sin; 43. M^3 dex.

Table 8
Presence of the mammalian remains in the four chambers of the Loutra Arideas Bear Cave.

	Chiroptera	*Erinaceus* cf. *europaeus*	*Sorex* sp. (group *S. araneus*)	*Sorex* cf. *minutus*	*Crocidura* sp.	*Spermophilus* sp.	*Sicista subtilis*	*Arvicola terrestris*	*Microtus arvalis/agrestis*	*Microtus nivalis*	*Microtus (Pitymys)* cf. *multiplex*	*Clethrionomys* sp.	*Apodemus* aff. *mystacinus*	*Apodemus sylvaticus/flavicollis*	*Cricetulus migratorius*	*Mesocricetus newtoni*	*Dryomys nitedula*	*Glis glis*	*Muscardinus* cf. *avellanarius*	*Spalax leucodon*	*Lepus* cf. *europaeus*
LAC I	+	-	-	-	+	-	-	+	+	+	+	-	+	+	+	+	+	-	-	+	-
LAC Ib	+	-	-	-	+	+	-	-	+	+	-	-	+	+	+	+	-	-	-	+	-
LAC II	+	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
LAC III	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

The mole-rats are represented by *Spalax leucodon*. The LAC assemblage is characterized by the relatively simple morphology, the medium size of the occlusal surface and the diagonal position of the labial loops (pl. 5.21-22) (Kowalski & Nadachowski, 1982).

Hares are scarce, as only one lower third premolar indicates accurately its presence in the assemblage of Bear Cave. The margin of the P_3 from LAC is an intermediate form between the elongated *L. timidus* (Fladerer, 1992) and the rounded *L. europaeus* (Palacios & Lopez-martinez, 1980). The structure of P_3 found in the Bear Cave resembles to recent specimens of *L. europaeus* (pl. 5.15). Therefore, the LAC material is referred to as *L.* cf. *europaeus*. In the microfauna, chiropters (*Rhinolophus* sp., *Myotis* sp. and *Miniopterus* sp. were identified preliminarily by G. Rabeder) as well as amphibians, reptiles and fish were also found.

Discussion

The LAC assemblage shows a remarkable abundance of the small mammals: 25 species belonging to 12 families, 18 of which identified at a species level. According to the ecology of each animal, the micromammals from the Bear Cave were divided into three groups: A) animals that live in open dry environment [*M. nivalis*, *A. mystacinus*, *M. newtoni*, *C. migratorius*, *Spermophilus*, *S. leucodon* and *Sicista subtilis*], B) animals that inhabit forest [*A. sylvaticus*, *A. flavicollis*, *Clethrionomys*, *D. nitedula*, *G. glis* and *M. avellanarius*] and C) animals that can adjust to various environments [*E. europaeus*, *Sorex*, *Crocidura*, *A. terrestris, M. arvalis*, *M. agrestis*, *M. (P.) multiplex* and *L. europaeus*]. A pie diagram of the environmental distribution (fig. 10) was constructed based on the minimum number of individuals for each micromammal. The LAC fauna contains predominantly species that are associated with open vegetation (50%). 24% of the micromammals indicate the presence of deciduous and mixed forests, while the rest (26%) live in various climatic conditions. The surroundings of the Bear Cave are geomorphologicaly very complex; forest peaks, rocky slopes, vast fields and mountain plateaus alternate in a small area. Just like today, geomorphological density had to result in vegetational and faunal variety.

The presence of *Arvicola terrestris,* as well as the taxon range zones of the micromammals of the Eastern Europe-MNQ 26 after Guérin (Guérin & Patou-mathis, 1996), implies a Late Pleistocene to Holocene age for the fauna of the Bear Cave. The majority of the species also shows an advanced evolutionary stage.

The presence of *M. arvalis, Pitymys, Clethrionomys, M. avellanarius, G. glis, Crocidura,* as well as the small size of *A. mystacinus* (Bergman's rule) indicate a rather temperate climate. The study of seeds found during sieving, which are typical Mediterranean plants (Tsoukala *et al.*, 2001), confirms this conclusion. During the colder phases of Würm, while central Europe was covered with ice, it seems that the Balkans was a refuge for many animals (Pradel, 1989).

The material from LAC III shows the most remarkable diversity of taxa, and great abundance of bones and teeth remains in the cave regarding micromammals (tab. 8). The assemblage of LAC II is relatively rich. In LAC I the number of teeth and bones is reduced, while the material from LAC Ib is very poor. Moreover, some teeth and bones of both macro and micromammals show traces of transportation by water (pl. 6.3). This observation related to the taphonomy of the macromammals could be the result of the increase of water mass surface flowing inside the cave. A rock shelter, 50 m west of Bear Cave, at the same altitude, presents a cohesive conglomerate,

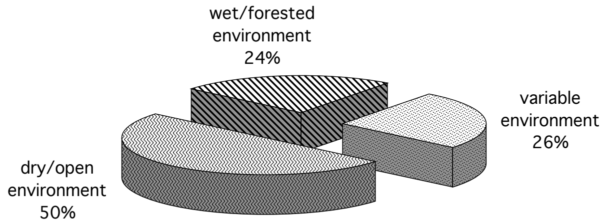


Figure 10. Pie diagram of the enviromental distribution based on the minimum number of individuals of the micromammals of the Bear Cave.

remains of an old river-bed. During Late Pleistocene the Thermopotamos stream was probably flowing 80 m above its today's level. It is likely that during floods of the river, micro and macromammalian remains were scattered inside the cave or entered the cave. Heavier material (long bones, skulls and large pebbles) was deposited close to the supply of the sediments in the cave, while lighter fine-grained assemblages (sediments and micromammalian remains) were transported into deeper parts of the cave.

Micromammals could be the food remains of various predatory-owls and others raptors that primarily feed on small mammals hunting over a variety of habitats and returning to the cave to digest and regurgitate their meals, and mammal carnivores which carried carcasses of their pray into the cave. Among the numerous bones and teeth, there were sometimes more or less complete mandibles, but no complete skull is found, which is characteristic for owl pellets (Andrews, 1989). This source of origin is also supported by the presence of erosion on the enamel and dentine in many teeth due to indigestion by predatory birds (pl. 6.3).

STRATIGRAPHY AND SEDIMENTS OF THE BEAR CAVE

The study of a stratigraphical column provides important information about the taphonomy and the circumstances, such as environment and climate that occurred in the area and aims to collect data regarding the composition and the formation of the sediments of the cave, as well as their depositional conditions. The aim of the research is to correlate the sediments and the paleontological material of all chambers. During the excavation's progress, all observations were continuously marked, the layers were drawn and photographed and samples of the sediments were collected. Every change in the color, the composition and the cohesion of the sediment grains was noted. The excavation proceeds in predefined levels, consulting these remarks. All columns from chambers LAC Ic, LAC Ib, LAC I, LAC II and LAC III have been described by Chatzopoulou (2001; 2003; 2005).

Chamber LAC Ic. The chamber of gours is situated very close to the today's cave entrance. The floor is covered with gour structures and it is situated at the highest level among all chambers. The reddish and gray sterile sediments overlie the fossiliferous beds. The fossiliferous stratum layer appears to be the thickest (~140 cm) among all chambers, although the fossil material is relatively scarce. A great number of middle-sized pebbles were observed throughout the brownish layer although there are fewer and smaller ones to the bottom of it. The external surface of the stones of the lower fossiliferous beds shows an alteration probably due to weathering. A sequence of thin sinter layers with gray sand underlies the fossiliferous layer. All beds show a slight SW inclination towards the center of the chamber. All the sediments of this chamber are penetrated by plant roots probably due to its closeness to the open-air slope of the gorge.

Chamber LAC Ib. It is the smallest excavated chamber of the cave. Actually, it is an extension of the main chamber showing great paleontological interest regarding the abundance of large mammal bone remains among them non ursids (tab.1, fig. 4). The sedimentation is mainly clastic. All beds display the maximum thickness at V4 square and they are wedging out towards the walls of the cave and the connection to the main chamber (LAC I). The reddish and gray sediments that overly the fossiliferous beds are similar to those of LAC Ic (G10 square). A great accumulation of large stones and pebbles of different lithological composition was observed at the superior beds of the fossiliferous layer in V4. The fossiliferous layer is relatively thin (~40 cm). Thick gray sterile micaceus sand underlies the fossiliferous layer.

Chamber LAC I. The central chamber is the larger one, while the level of the floor is the lowest in the cave. The diversity of sediments makes it the most remarkable of all chambers. In trench-square N10, the clastic material dominates, although there are four thin sinter layers interposed. The sediments are mainly brownish and small grained (clay and silt). Below 250 cm from the reference-zero point, a sandy layer with many pebbles seems to be the deepest one in the entire cave. The fossiliferous layer is very close to the surface (<20 cm). It is thin (~25 cm) and the upper beds are consolidated to crust, sometimes with enclosed fossils.

Chamber LAC II. The alternation of clastic and chemical sediments is evident in D10. The sinter layers (fig. 11, oblique stripes) were deposited during warm and humid intervals, while the clastic sediments (sand, clay and silt) were accumulated during colder periods. The study of the small grain size of the clastic sedimentation of the floor of the Bear Cave is evidence of slow water flow in the deposition site. This is the result of the surface increase of water mass flowing inside the cave, as well as of probable climatic changes from wet to dry (Tsirambides, 1998). The surface beds, fig. 11, (above the dotted line) are disturbed by unauthorized diggings, resulting in an unequal thickness (25-60 cm) of the fossiliferous layer.

Chamber LAC III. This chamber is the deepest area of the cave, although there is a passage that links LAC III with the gour chamber (LAC Ic) (fig. 11). At first, the trench square R1 was excavated. The sedimentation is mainly clastic and rather monotonous. The fossiliferous layer appears to be very thick (~120cm). It is mainly a brownish sandy clay dotted with white calcareous pebbles and gravels. Some blackish lenses appear close to the surface of the column. The fossiliferous layer ends on the bedrock of the cave. The small mammals in this square are abundant (Chatzopoulou, 2005), while the remains of large mammals are scarce and poorly preserved. The excavation of R2 added new data when a series of layers were revealed. All beds show a SW inclination (dip angle 30°) and they are wedging out towards the walls of the cave. The fossiliferous layer is less extended, ending on a sinter. This crust represents a paleo-floor of the cave since a stalagmite *in situ* (consolidated to the upper part of the crust) is preserved. The fossiliferous beds must have filled this part of the cave subsequently at a later stage. The gray and reddish sterile sediments underlying the fossiliferous beds show no similarity to those of other chambers. Sedimentation ends on the limestone (bedrock) of the cave.

In conclusion, it is obvious that the fossiliferous layer in the stratigraphical columns from the trench-squares G10, V4, N10, D10 and R2 of the chambers LAC Ic, LAC Ib, LAC I, LAC II and LAC III respectively (fig. 11) is placed at the same depth (-130cm) in the cave, despite the distinctly different sedimentation and the deviation in thickness. The only safe chronological and sedimentological correlation of the five trenches is the fossiliferous layer that is characterized by the presence of *Ursus ingressus* (Tsoukala & Rabeder, 2005). The accumulation of sediments in the cave was in cyclic intervals (clastic and chemical sediments). During warm and humid intervals, sinter layers were deposited, while during colder periods clastic sediments were accumulated. The alternation of the sediments is more evident in chamber LAC II, while clastic sedimentation dominates in LAC Ic and LAC Ib. Chambers LAC I and LAC III stand in between. The lithological composition of the fine-grained depositions as well as the pebbles of the cave represents the eroded rocks of the surrounding area (limestones, dolomites, marbles, schists, phyllites, ophiolites).

CONCLUDING REMARKS AND TAPHONOMY

The Loutrá Aridéas Bear Cave is an important site with very rich paleontological material. The research over 16 years and the excavations in the site followed the paleontological rules strictly, and today it can be considered as the biggest systematic excavation with cave bear remains in Greece. Since 1990, twelve excavating seasons took place in 34 squares with total 206 levels and approximately 15000 specimens (mostly indeterminable) were brought to light. Twelve species of large mammals and 25 taxa of small mammals were determined, the latter derived from the washed sediment that weighted two tons. Furthermore, in Z Cave of the Speleopark a fossilized maxilla with a broken left canine of *Ursus* cf. *arctos* was found.

- The large mammalian fauna consists of: *Ursus ingressus*, *Crocuta crocuta spelaea, Panthera leo spelaea, Panthera pardus, Vulpes vulpes, Canis lupus, Meles meles,* mustelids, *Bos primigenius, Capra ibex, Cervus elaphus* and *Dama dama.*
- The small mammalian fauna consists of insectivores, rodents, lagomorphs and bats. Insectivora: *Erinaceus* cf. *europaeus*, *Sorex* sp. (cf. *araneus*), *Sorex* cf. *minutus, Crocidura* sp. Rodents: *Spermophilus* sp., *Arvicola terrestris, Microtus arvalis & agrestis, Microtus nivalis, Microtus (Pitymys)* cf. *multiplex, Clethrionomys* sp., *Apodemus* aff. *mystacinus*, *Apodemus sylvaticus* & *flavicollis, Cricetulus migratorius, Mesocricetus newtoni, Dryomys nitedula, Glis glis, Muscardinus* cf. *avellanarius, Sicista subtilis, Spalax leucodon*, lagomorpha: *Lepus* cf. *europaeus*, Chiroptera: *Rhinolophus* sp., *Miniopterus* sp., *Myotis* sp.
- Carnivores are scarcely despersed, but ursids are extremely abundant.
- The study of the best preserved bone fragments and teeth of the bears i.e., the most representative, showed the presence of the *U. ingressus* for first time in Greece. Its position in the evolutionary tree of the bears during Quaternary is shown in fig. 12.
- The complete skulls are few, but there are enough complete or almost complete mandibles. The former are well preserved skulls of adults, found either in the main chamber LAC I. The most important skull that shows clearly the characters of *U. ingressus*, was found in G11 square of LAC Ic chamber, whereas a skull of a juvenile has been found at the end of chamber LAC Ib among other specimens of juveniles and sub-adults.
- Concerning teeth, in both upper and lower fourth premolar groups the high developed morphotypes

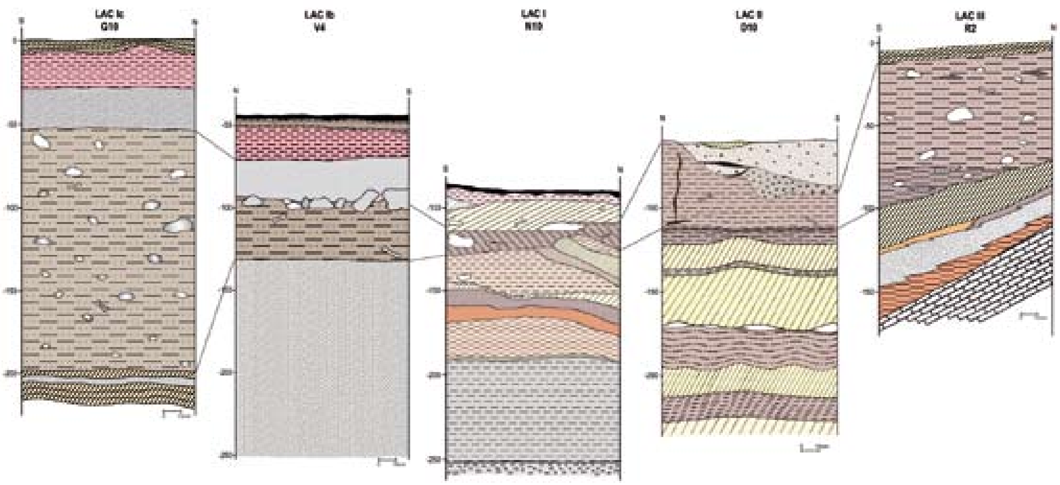


Figure 11. Stratigraphical columns of trench-squares G10 (LAC Ic), V4 (LAC Ib), N10 (LAC I), D10 (LAC II), and R2 (LAC III). The depth in all the sections is considered from the reference-zero point of the cave and it is counted in cm. The fossiliferous layer appears to be thicker in G10 (~140cm). Despite the distinctly different sedimentation in the five square-trenches and the variation in thickness, the fossiliferous layer is found at the same level (-130cm) in the cave (CHATZOPOULOU, in press).

are dominating. All morphodynamic indices (M^2 metaloph, M_1 enthypoconid, M_2 enthypoconid, premolar indices) have evolutionary levels between 70 and 84% of Gamssulzen Cave (Upper Austria) standard.

- Concerning metapodials from Bear Cave there is a similar pattern in the metacarpus and metatarsus with those of the bears from Gamssulzen Cave. There are also some differences that are probably local variations.
- The bones are mostly well preserved, representing all biological ages. Few long bones are complete and very well preserved.
- Many isolated teeth have been found of all wear stages (unworn to completely worn- down to the root) therefore the age structure of the cave bear population shows a variability with the extremes - very young and old- predominating (pl. 6.1).
- The majority of the tooth and bone remains belong to juveniles and sub-adults, while very few belong to very old individuals and few to adults, indicating thus an extremely high incidence of juvenile and neonate mortality. There are many bear carcasses as a result of death during hibernation. The abundance of the milk teeth, in spite of their fragility, is very remarkable thus the Loutrá Arideas site can be considered as the most important place of Greece where so abundant and well stratified cave bear deciduous teeth have been collected from 206 excavated layers.
- The Bear Cave is very rich in ursid milk teeth and the MNI (minimum number of individuals) of the juveniles, based on the left dI^3, is calculated to 355 individuals.
- The morphotypes of D^4 and D_4 seem to be similar to those of *U. ingressus* from Gamssulzenhöhle (Austria) and the analysis from the micrographs by the use of the Scanning Electron Microscope (SEM) of the occlusal microwear showed polished surfaces, microscratches and pits.
- All ages from juvenile to senile individuals are present. Among the material there are many postcranial bones, including metapodials, with their epiphyses unfused.
- Milk teeth that have just been substituted show clearly that the bears used occasionally the cave as a den. The study of the milk teeth showed also the presence of unborn bears. All this evidence supports the hypothesis that the cave was inhabited by bears. Also, many milk teeth as well as teeth of micromammals were transported into the cave along with the sediments.
- A few bones bear traces of large carnivore teeth and this can be explained either by the presence of other carnivores (felid, hyaenid, canid) or by cannibalism (pl. 6.2).
- In some bones gnawing marks appear, which are probably due to many rodents. On certain micrommamal bones corrosion has been noted due to action of water, and stomach liquids of animals that diggested them (pl. 6.3).

- The rounding and abrasion of some bones such as metapodials, phalanges and patellas also establish the action of flowing water. The poor preservation of certain remains, as well as their orientation within the sediments, indicate a moderate water flow as few were found in situ over the deposit.
- Very few bones, such as metapodials with unfused epiphyses, found in anatomical position, in B10 square (LAC II chamber) but the majority has been found scattered, and this is due either to animals activity or to the action of flowing water (pl. 6.4).
- The presence of corrosion on the enamel and dentine of many of the teeth under study due to digestion by raptors implies that some small mammals comprised the meal of predators that visited the cave. Bats must have inhabited the cave.
- The presence of both sexes has been established due to the sexual dimorphism either of the teeth (mainly canines) or of the postcranial skeleton, with a strong predominance of females over males (fig. 3, pl. 6.5).
- Paleopathologies are evident on certain bones, especially on metapodials.
- The micromammalian fauna shows a remarkable diversity of taxa and a great abundance of bones and teeth remains implying a Würmian (Late Pleistocene) age (tab. 8, pl. 6.6).
- The age of the paleofauna according to the radiometric data is estimated to 37.880 years before present (Rabeder *et al.,* 2006).
- During washing of the sediments from the various excavating squares, seeds were collected by the floatation method, which the late archaeologist Maria Mangafá identified as: *Rumex crispus*, *Picris echioides, Matricaria chamomilla (Chamomila recutita)*, and Compositae. All seem recent, typical Mediterranean plants. The first one is the most common and loam, clay and nutrient indicator. The second is a stony waste land indicator and the third one indicates fresh or sandy loams, rich in nutrients and saline soils.
- The fauna of the Bear Cave lived during a milder episode of the last glacial period or Würmian glacial period that was not so severe in Greece. The presence of small mammals that are indicators of temperate climate and the typical Mediterranean flora confirm that during the colder phases of Würm, the Balkans was a refuge for many animals, while central Europe was covered by ice.
- The paleoenvironment seems to be predominantly open with deciduous and mixed forests. The surroundings of the Bear Cave are geomorphologicaly very complex-forest peaks, rocky slopes, vast fields and mountain plateaus alternating in a small area. Just like today, in the Late Pleistocene geomorphological density had to result in certain vegetational and faunal variety.

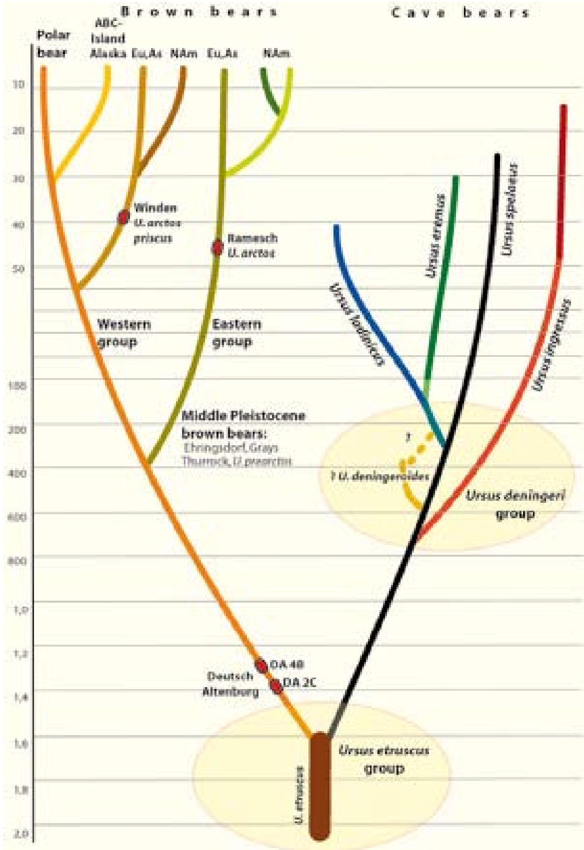
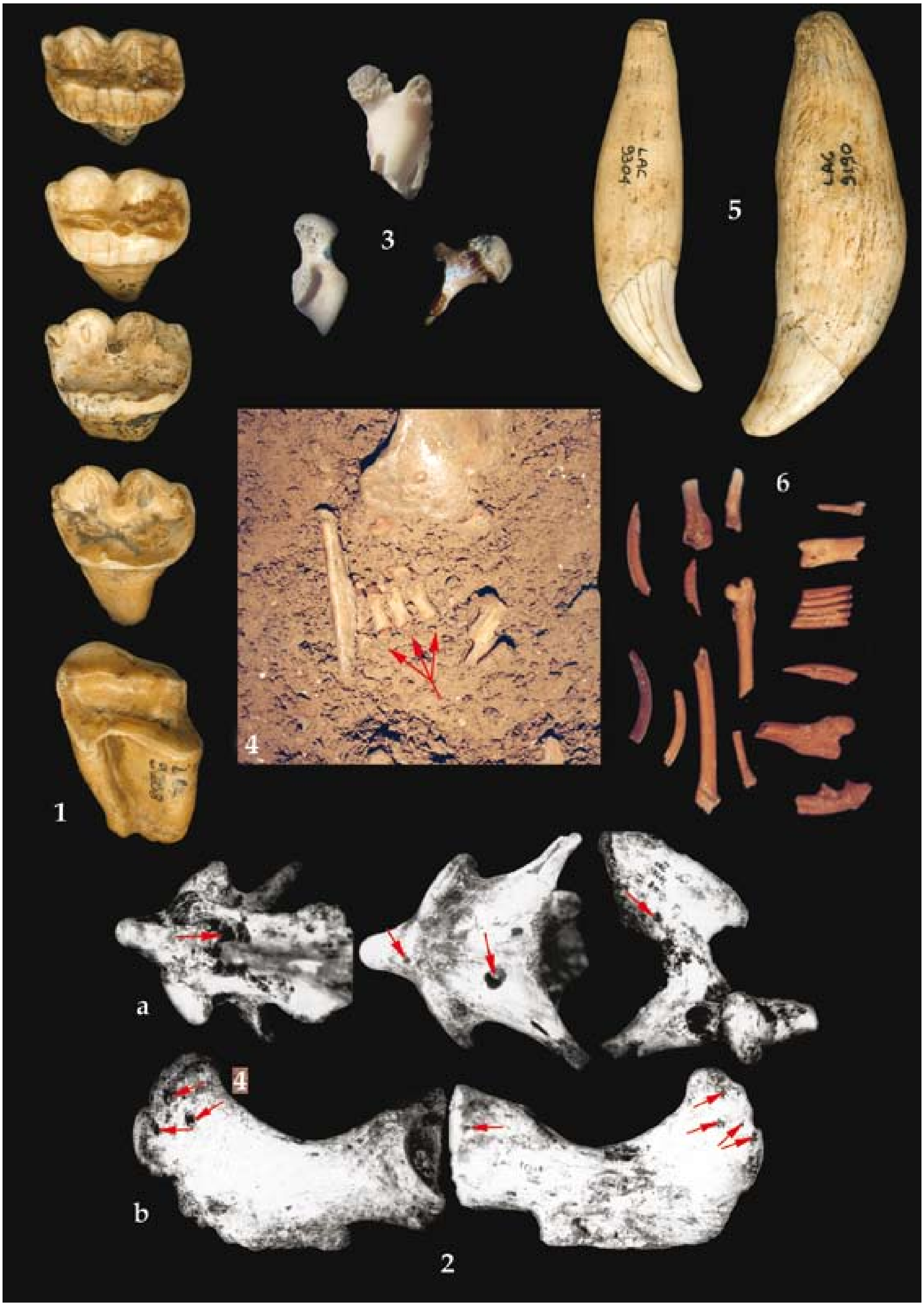


Figure 12. *Ursus ingressus*: its position according to the special taxonomy of the cave bears based on their genetics, morphology and chronology is given by RABEDER & HOFREITER (2004).

- The paleogeomorphology of the surroundings of the Bear Cave were very complex: forest peaks, rocky slopes, vast fields and mountain plateaus alternate in a small area. There were shrubs and mixed woods. The climate appears to be relatively arid. Nevertheless, there were streams that attracted many animals'. The thermal springs possibly affected the local climate by making it more tolerable.
- The cave does not seem to have been used by humans, as only one lithic (pyrite) artifact has been found up to now, in B10 square of LAC II chamber. Neolithic period is also evidenced by the presence of burned wood or of pottery remains in V8 square of LAC Ib chamber.

Plate 6



Ursus ingressus LAC: 1. M[1] of various wear stages; 2. Axis (epistrophaeus) (a) and pelvis (b) with bite marks by a scavenger; 3. Micrommamal bones with corrosion due to action of water and stomach liquids of animals that diggested them; 4. Metapodials in anatomical position of a juvenile with unfused epiphyses, in B10 square; 5. Canines of a male (right) and female (left) showing the sexual dimorphism in the Loutra material; 6. Paleopathology on the metapodials; 7. Bones and teeth of micromammals are of great abundance among the LAC material.

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