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General Paleontology (Taphonomy and Fossilization)

Cave bears (*Ursus spelaeus*) from the Peştera cu Oase (Banat, Romania): Paleobiology and taphonomy

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Abstract

The 2002 discovery of the earliest European modern humans in the Peştera cu Oase (Romania) has led to systematic excavations of a bone bed (two levels), containing principally the remains of cave bears (ca. 5000 bones) and dated between 50 and 40 ka cal BP. The thanatocenosis corresponds mainly to a subadult and adult male utilization of the cavity. Levels 1 and 2 are distinguishable by different conservation processes demonstrating respectively low- and high-energy hydraulic transports. The heavy component of cannibalism may indicate bone processing for trace elements and/or a more omnivorous diet than is usually ascribed to cave bears. ***To cite this article: J. Quilès et al., C. R. Palevol 5 (2006)***.

Résumé

Les ours des cavernes (*Ursus spelaeus*) de Peştera cu Oase (Banat, Romanie) : paléobiologie et taphonomie. La découverte, en 2002, des plus anciens hommes anatomiquement modernes du continent européen à Peştera cu Oase (Roumanie) a conduit à la fouille systématique d'un lit d'ossements (deux niveaux), contenant principalement des restes d'ours des cavernes (~5000 restes), et datés entre 50 et 40 ka cal BP. La thanatocénose correspond majoritairement à une utilisation de la cavité par des mâles subadultes et adultes. Les niveaux 1 et 2 se distinguent par des processus de conservation différents, démontrant respectivement des transports hydrauliques de basse et haute énergie. La forte composante de cannibalisme pourrait indiquer la recherche d'oligo-éléments et/ou un régime plus omnivore qu'habituellement décrit pour l'ours des cavernes. ***Pour citer cet article : J. Quilès et al., C. R. Palevol 5 (2006)***.

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Introduction

La mandibule humaine découverte en février 2002 dans la grotte de Peştera cu Oase (Anina, Caraş-Severin, Banat, Roumanie, Fig. 1) constitue la plus ancienne trace directe d'homme anatomiquement moderne du continent européen [7,18–21,24]. En juin 2003, le travail de terrain dans la *Panta Strămoşilor* livre de larges fragments d'un crâne humain. En 2004 et 2005, de nouvelles portions du crâne sont mises au jour dans ce qui apparaît être principalement un site à ours des cavernes. Disposant d'un large canevas de datations radiométriques et de fouilles en coordonnées et en stratigraphie, les premiers résultats taphonomiques et paléobiologiques obtenus sur le riche assemblage d'ours des cavernes (environ 5000 ossements) sont présentés ici.

Géomorphologie et stratigraphie

Peştera cu Oase est la partie haute d'un vaste réseau karstique (Fig. 1), constitué par la *Galeria Culcuşurilor* (galerie des Bauges), la *Panta Strămoşilor* (pente des Ancêtres) correspondant au lieu des fouilles, la *Sala Mandibulei*, la *Galeria Lungă* (galerie Longue) et la *Galeria celor Trei Cranii* (galerie des Trois-Crânes) [24]. La stratigraphie de la Panta Strămoşilor comporte deux niveaux (**1** et **2**), différenciés par leur structure sédimentaire (dépôt hydraulique de basse énergie en **1** et de haute énergie en **2**). Aucun témoignage archéologique n'est présent dans la grotte.

Matériel faunique et chronologie

La liste faunique se compose d'*Ursus spelaeus*, *Capra ibex*, *Cervus elaphus*, *Vulpes vulpes* et *Canis lupus*. Le spectre quasiment monospécifique (94,1% d'ours des cavernes, Tableau 1) constitue un argument fort de caractérisation de la grotte en tanière d'ours. Calibrées à l'aide de CalPal 2005 [23] et de son modèle d'âge SMCP [17], les datations AMS ^{14}C sur ossements d'ours et TIMS *uranium-series* sur stalagmites encadrent le remplissage (niveaux **1** et **2**) entre 50 et 40 ka cal BP. L'analyse morphodynamique des quatrièmes prémolaires d'ours des cavernes est une méthode de datation biochronologique fiable, basée sur une forte corrélation entre datations radiométriques et variations morphologiques [11,16]. Elle permet d'estimer un âge d'environ 48 ka BP (Fig. 2), qui concorde avec l'intervalle de dates calibrées.

Bioglyphes

À Peştera cu Oase, douze bauges d'ours sont conservées en surface du niveau 1 (Fig. 1). Leurs dimensions moyennes s'intègrent à la variation connue pour l'ours brun et des cavernes [3]. Trois bauges présentent une petite taille et semblent correspondre à l'installation de femelles. La spatialisation des nids d'ours révèle une nette préférence pour l'installation dans la *Panta Strămoşilor* et la *Galeria Culcuşurilor*, à l'abri de la lumière, des variations de température et des percolations d'eau (Fig. 1). La distance entre chaque paire de bauge adjacente est très différente du modèle classique d'installations bord à bord et sans recouvrement, généralement observé chez l'ours des cavernes [3]. Pour la première fois, un comportement d'hibernation en bauges isolées est mis en évidence chez cet animal.

Structure des thanatocénoses

Établies par calcul du NMI sur dix classes d'âge [12,15], les courbes de mortalité des niveaux **1** et **2** ne présentent pas de différences notables (Tableau 1, Fig. 3). En combinant cette répartition avec le *sex ratio* défini par analyse des mélanges [13,14], ces thanatocénoses correspondent principalement à une utilisation de la cavité par des mâles subadultes et adultes (Fig. 3). L'abondance des subadultes âgés de 5 à 14 mois suggère que la grotte a fonctionné comme tanière l'hiver et comme abri durant le reste de l'année.

Modifications osseuses

Des traces de carnivores sont présentes sur 12,5% des ossements (dents isolées exclues) et sur 23,7% des ossements immatures (Tableau 1). La localisation, la morphologie et la taille des traces relèvent clairement d'une action par l'ours [2,4,6,9]. Ce cannibalisme est lié, soit à un besoin en oligo-éléments, soit à un régime plus omnivore que généralement admis pour l'ours des cavernes, en se basant sur son anatomie dentaire [11] ou

sur la teneur en isotopes stables du collagène osseux [1, 5,8,22]. La fréquentation durant le printemps, l'été et l'automne (période d'alimentation), plus importante dans le niveau **2**, concorde avec la plus forte proportion d'os rongés dans ce niveau (Tableau 1).

Le niveau **1** comporte une forte proportion de squelette axial, alors que le niveau **2** est riche en dents isolées et éléments roulés par l'eau (Tableau 1). Le niveau **1** résulte d'un faible transport hydraulique, probablement depuis le haut de la Panta Strămoşilor. Le niveau **2** présente une dispersion plus importante et un classement des ossements par taille et densité. Visible uniquement sur la zone fouillée, la position d'origine de cet assemblage reste hypothétique, peut-être depuis la *Sala Mandibulei* et/ou des zones adjacentes dans les deux galeries latérales, les distances de transport étant nettement supérieures que pour le niveau **1**.

Conclusions

Datations radiométriques et biochronologie concordent pour situer les occupations par les ursidés entre 50 et 40 ka cal BP. Mortalité et *sex ratio* figurent d'une utilisation de la cavité par des mâles subadultes et adultes, comme tanière pendant l'hiver (12 bauges) et comme abri le reste de l'année. Les traces de rongement montrent un important cannibalisme. La représentation squelettique définit le mode de mise en place des dépôts entre niveau **1** (transport de basse énergie) et niveau **2** (dispersion et classement par taille lié à un transport hydraulique de forte énergie). Ces premières observations sur l'ours des cavernes de Roumanie viennent compléter celles effectuées en Europe du Sud-Ouest. L'abondance de cavités pour ces zones d'Europe de l'Est fortement karstifiées préfigure une riche collecte de données taphonomiques et paléobiologiques sur cet animal.

1. Introduction

The February 2002 discovery of the Peştera cu Oase (Anina, Caraş-Severin, Banat, Romania, Fig. 1) in a complex karstic system resulted in the immediate discovery of a complete human mandible (Oase 1), on the surface adjacent to the abundant remains of cave bears (*Ursus spelaeus*) and several other large-bodied Pleistocene mammals. The subsequent direct AMS ^{14}C direct dating of the human mandible [> 35 200 years BP (OxA-11711) and 34 290, +970, –870 years BP (GrA-22810), which together provide a finite age of 34 950, +990, –890 years BP] established Oase 1 as the oldest modern human currently known within Eur-

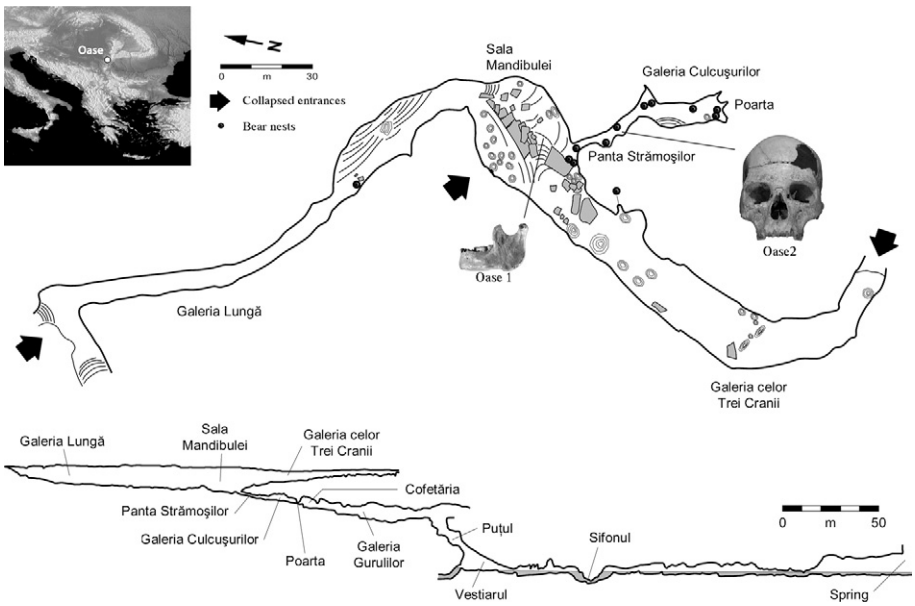

Fig. 1. Localization (after [24]) and topography of Peştera cu Oase (after R. Rodrigo, Ş. Milota, L. Sarcină, M. Gherase, F. Marta) with localization of bear nests (after J. Quilès, C. Petrea). Pictures by E. Trinkaus.
Fig. 1. Localisation (d'après [24]) et topographie de Peştera cu Oase (d'après R. Rodrigo, Ş. Milota, L. Sarcină, M. Gherase, F. Marta), avec localisation des bauges d'ours (d'après J. Quilès, C. Petrea). Photos par E. Trinkaus.

ope [7,18–21,24]. June 2003 fieldwork yielded portions of an early modern human cranium (Oase 2), additional portions of which were discovered in 2004 and 2005. Given the resultant paleoanthropological interest in the Peştera cu Oase discovery, mapping of the cave and excavation of the bone bed that had yielded the human remains were undertaken in 2004 and 2005. In addition to largely completing the Oase 2 cranium and providing a geological and chronological context for the human remains, this fieldwork has produced a systematically documented palaeontological assemblage, the overwhelming majority of which represents *U. spelaeus* (ca. 5000 bones).

Given the fact that the cave bear remains' location was recorded according to a Cartesian excavation grid system, and that they are associated with extensive radiometric dating of the palaeontological and geological remains, both being exceptions for cave-bear bone accumulations, it is appropriate to present here a preliminary assessment of the cave bear assemblage.

2. Geomorphology and stratigraphy

The karstic system, of which the Peştera cu Oase is a portion, is composed of several levels, from the modern river course at the bottom and the galleries of the Peştera cu Oase at the top, immediately below the modern plateau and adjacent to numerous dolinas (or collapses). The exceptional preservation of the Peştera cu Oase has been made possible due to the current difficulty of access, which involves 200 m of wading neck-deep in the underground river, a scuba-assisted 30 m dive through a siphon, and then a progression of ca. 300 m up ca. 60 m to the mouse-hole (the Poarta) that gives access into the chambers of the Peştera cu Oase.

Adjacent to the Poarta, the 'Galeria Culcuşurilor' (Gallery of the Nests) provides access to the 'Panta Strămoşilor' (Slope of the Ancestors), the primary area of excavation focus (Fig. 1). The 'Sala Mandibulei' is located immediately above the 'Panta Strămoşilor', and it gives access to the 'Galeria Lungă' (Long Gallery) to the north and the 'Galeria celor Trei Cranii' (Gallery of the Three Skulls) to the south.

In the 'Panta Strămoşilor', the following stratigraphy was observed: surface, bones deposited on and among the uppermost bones of Level 1; Level 1, a superficial deposit rich in fine sediments with some small pebbles; Level 2, a dense assemblage of pebbles and cobbles in a coarse sandy matrix. The two levels have been principally recognized on the sedimentary structure (i.e. low-energy water deposit for Level 1 and high-energy for Level 2). No archeological evidence has been found in the cave. Using a low-frequency radio transmitter-receiver device, it has been possible to precisely locate, on the plateau above, the principal portions of the upper galleries. From this and from geological observations within the cave, it is apparent that there are three original but now sealed (through collapse and/or sedimentation) entrances to the cave system, one each at the ends of the 'Galeria Lungă' and the 'Galeria celor Trei Cranii' and one from a dolina adjacent to the 'Sala Mandibulei' (Fig. 1). From the geology and the distribution of species within the cave, it is likely that the three entrances served as access at different times for the bears, but that the non-cave dwellers entered the cave through the opening into the 'Sala Mandibulei'.

3. Faunal material and chronology

In the excavation area, the recovered faunal remains represent: *Ursus spelaeus*, *Capra ibex*, *Cervus elaphus*, *Vulpes vulpes*, and *Canis lupus*. Surface findings of an entire skull of *Panther (Leo) spelaea* in the middle part of the 'Galeria Lungă', and of a domestic goat (*Capra hircus*) from ca. A.D. 1800 in the upper 'Galeria celor Trei Cranii', have also to be mentioned. The spectrum found in the Peştera cu Oase is almost monospecific, since 94.1% of bones derive from cave bear (Table 1). The non-bear vertebrate remains are mostly from the surface or Level 1. Consequently, Level 1 contains slightly fewer bear bones (91.5%) than Level 2 (96.7%).

The currently available AMS radiocarbon dates on bones, converted to calendar years using CalPal 2005 [23] and its SMCP age model [17], indicate that the bones from within Levels 1 and 2 are indistinguishable in age given their apparently close proximity in time and the relatively large errors for radiocarbon dates in this age range. One of the bones on the surface of Level 1 is capped with a stalagmite, the basal level of which has provided a TIMS uranium-series date of 41.8 ± 2.9 ka cal BP (PPL6b/1), providing an upper age limit for the bone bed. The topmost crust of a fallen stalagmite located right underneath the bone bed yielded a U-series alpha-spectrometric date of 45.4 (+3.35; –3.25) ka cal BP (PPL6a), while the base of another stalagmite grown over the same bone bed (PPL9) has been dated to 47.32 (+3.43; –3.32) ka cal BP. Thus, the time range of the age of the bones broadly extends within the interval between ca. 50 and 40 ka cal BP. Only the human mandible, the *C. hircus* bone, and the *C. ibex* remains from the surface provide

Table 1
Synthesis of major taphonomical indices characterizing the cave bear bone assemblage of Peştera cu Oase (* Total represents the sum for levels 1and 2, and indeterminate level bones)
Tableau 1
Synthèse des principaux indices taphonomiques caractérisant l'assemblage osseux d'ours des cavernes de Peştera cu Oase (* Total représente la somme des niveaux 1 et 2, ainsi que des ossements sans indication stratigraphique)

	Level 1		Level 2		Total*	
		%		%		%
% NISP bear / NISP total	2185/2387	91,5	2456/2540	96,7	4805/5104	94,1
% MNI females / MNI (males+females)	7/29	24,1	3/14	21,4	11/47	23,4
% MNI immature / MNI aged teeth	36/52	69,2	44/62	71,0	80/116	69,0
% NISP carnivore damage / (NISP total - teeth)	165/1692	9,8	227/1492	15,2	413/3309	12,5
% Carnivore damage on immature bones in NISP	74/376	19,7	129/481	26,8	218/921	23,7
% NISP isolated teeth / NISP total	493/2185	22,6	964/2456	39,3	1496/4805	31,1
% NISP axial skeleton / NISP total	630/2185	28,8	319/2456	13,0	970/4805	20,2
% Weathering in NISP (without teeth)	106/1692	6,3	53/1492	3,6	166/3309	5,0
% Smoothing in NISP (without teeth)	133/1692	7,9	277/1492	18,6	423/3309	12,8
% NISP entire bones / NISP total (without teeth)	862/1692	50,9	957/1492	64,1	1879/3309	56,8

more recent radiocarbon ages, the last falling within OIS 2.

For comparison, a morphodynamic dating method has been applied to the *U. spelaeus* fourth premolars (P^4 and P_4). The method is based on the evolutionary trends in dental shape determined from radiometrically dated sequences at diverse regional sites. The morphotype indices are strongly correlated with radiometric dating, and they have been shown to be a reliable biochronological tool in Austria [16], Italy and southern France [11]. Applied to the separate Peştera cu Oase stratigraphic levels, morphotypes indices are unreliable within the time resolution of the method, given the sample sizes available. However, for the pooled Level 1 and 2 samples, a biochronological estimate at around 48 ka BP is obtained (Fig. 2), corresponding closely to the time interval of radiometric dating.

4. Bioglyphes

Bioglyphes represent all living bear activities such as nesting, scratching and wall polishing. Depending on cave situations, all or some of them are conserved. In the Peştera cu Oase, 12 bear nests are observable, all on the surface of Level 1, and they show a clear preference for denning in 'Panta Strămoşilor' and 'Galeria Culcuşurilor' (Fig. 1). There is a close proximity with the cave walls (mean distance of 27.8 cm). This spatial distribution results from the physiological necessities of protection from wind, light, temperature variation and water percolation.

Mean values of length (112.9 cm), width (96.3 cm), depth (20 cm) and vault height (160.6 cm) correspond to available data on both brown and cave bear nests [3]. Two size groups are identifiable in nest measurements. Three beds possess small dimensions (length under 1 m and width under 90 cm) that could correspond to female installations. Based on tooth dimensions analyzed by mixture statistical test, the bear remains from Level 1 provide a female ratio of 24.1% (7 out of 29, see below), which corresponds closely to the size-based inference that 25% of the nests derive from smaller females. If this is the case, then the sex ratio of nesting bears corresponds closely with the mortality sex ratio, and it is possible that most of the original beds formed on the cave surface extant at the time of the last use of the site are preserved.

The average distance between each pair of adjacent nests (294.4 cm) is very different from the usual pattern for cave bear nests: concentrated and side-to-side. The more widely spaced pattern seen in the Peştera cu Oase has been thought to be characteristic of brown bear hibernations [3], and its presence here documents it for the first time for cave bears.

5. Thanatocenosis structure

The mortality distribution is calculated by the MNI (Minimum Number of Individuals) count over ten age

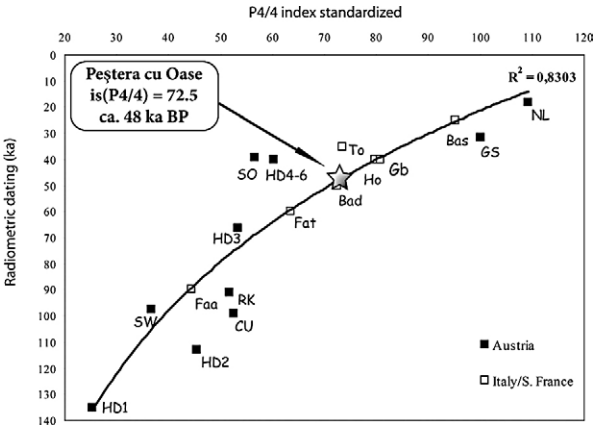

Fig. 2. Radiometric dating as a function of the cave bear standardized P4/4 index (percentage of P4/4 index for Gamssulzen site, noted is(P4/4)) for Austria (SW: Schwabenreith, HD1: Herdengel 420–380, HD2: Herdengel 360–380, HD3: Herdengel 330–360, HD4–6: Herdengel 200–330, Cu: Conturines, RK: Ramesch, SO: Salzofen, GS: Gamssulzen, NL: Nixloch; after [16]), Italy and southern France (Faa: Fate archaic form, Fat: Fate typical form, To: Tournal, Ho: Hortus, Bas: Basura, Bad: Badalucco, Gb: 'Grotte Blanche'; after [11]), with the resultant position of Peştera cu Oase cave bears' is (P4/4) (n P_4 = 61, n P^4 = 50).

Fig. 2. Datations radiométriques en fonction de l'indice P4/4 standardisé (pourcentage de l'indice P4/4 du site de Gamssulzen, noté is(P4/4)) pour l'ours des cavernes d'Autriche (SW : Schwabenreith, HD1 : Herdengel 420–380, HD2 : Herdengel 360–380, HD3 : Herdengel 330–360, HD4–6 : Herdengel 200–330, Cu : Conturines, RK : Ramesch, SO : Salzofen, GS : Gamssulzen, NL : Nixloch ; d'après [16]), d'Italie et du Sud de la France (Faa : Fate forme archaïque, Fat : Fate forme typique, To : Tournal, Ho : Hortus, Bas : Basura, Bad : Badalucco, Gb : Grotte Blanche ; d'après [11]), avec la position résultant de l'is(P4/4) pour l'ours des cavernes de Peştera cu Oase (n P_4 = 61, n P^4 = 50).

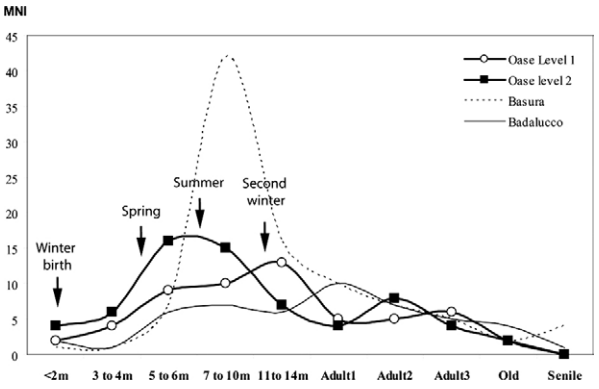

Fig. 3. Mortality curves for Levels 1 and 2 of Peştera cu Oase cave bears with seasonality indications and comparisons with data from the Basura and Badalucco cave bear caves (after [12]); 'm' is the abbreviation for month.

Fig. 3. Courbe de mortalité de l'ours des cavernes des niveaux 1 et 2 de Peştera cu Oase avec légendes de saisonnalité et comparaisons avec les données des grottes à ours des cavernes de Basura et Badalucco (d'après [12]) ; « m » est l'abréviation de mois.

classes, obtained by combined observations on tooth formation and wear stages [12]. For non-adult individuals, a calibration employing extant brown bear deciduous dentition formation provides a fine chronology and permits seasonality studies [15]. These age-at-death data are combined with sex assessments based on a mixture statistical analysis using lower canines (n = 31) and upper second molars (n = 49) [13,14], where only six teeth (7.5%) were non-sexable.

Results of the age distribution reveal a slight difference between Levels 1 and 2 (Table 1, Fig. 3). In the Peştera cu Oase, the low frequency of females (23.4% of sexable specimens) does not correspond with the high percentage of young specimens (69%). Oase's thanatocenosis is mostly a subadult and adult male den, similar to Badalucco (Italy), as opposed to the classic nursery den figured by Basura (Italy) [12]. Considering the high proportion of 5- to 14-month-old individuals (Fig. 3), the cave seems to have been occupied all year long, by at least subadults. The resultant mortality pattern could be the result of disease, injuries and/or male predation on cubs. Moreover, as mentioned above, the sex ratio of Level 1 is similar to the proportion of female attributed nests, suggesting that the original positions and number of nesting beds is preserved.

6. Bone modifications

Carnivore consumption affects 12.5% of bones excluding isolated teeth, and 23.7% when only immature bones are considered (Table 1). Gnawing marks are mostly located on the epiphyses of long bones and on soft (and/or thin) zones of flat bones (e.g.: scapula blade, ilium tuberosity). Pits (66.3%) and punctures (21.8%) are largely dominant, as opposed to scores and furrows on both adult and immature remains, and they correspond to the size and morphology described for bears [2,4,6]. The localization pattern of damage traces is particular to bear consumption of carcasses and distinguishable from the more extensive damage of bone consumers such as wolves and hyenas [4,6,9].

The scavenging activity could result from bone consumption for trace elements or carcass eating. As already mentioned in Spain [9], the latter would suggest a more omnivorous dietary regime than commonly suggested by teeth morphology [10], and confirmed by stable isotope analysis of bone collagen (see [1,5,8,22] and associated bibliography for details). The difference

between the Level-1 and -2 percentages, with the latter showing a higher rate of damage (15.2% against 9.8% for all bones and 26.8% against 19.7% for immature bones), seems to be linked to the seasonality of occupations. Compared to the winter lethargic period during which bears do not feed, the frequentation of the cave during spring (awaking period), summer and fall (fatting period) is higher in Level 2 than in Level 1 (38 dead individuals versus 32).

The skeletal representation and bone surface traces follow the two different processes of transport apparent in Level 1 and 2. Level 1 shows an important proportion of the axial skeleton, suggesting a light displacement, whereas Level 2 is richer in isolated teeth (Table 1). Bone elements are bigger in Level 1 (entire crania, scapulae, pelves, long bones, etc.) than in Level 2 (teeth, metapodials, phalanges, etc.). Weathering on long bones is only significant in Level 1, whereas smoothing on bone surfaces is much more common in Level 2. The general fragmentation of bones (without isolated teeth) highlights a better representation of entire specimens in Level 2, richer in highly conservable bones (i.e. compact bones).

Summarizing these observations, the assemblage of Level 1 appears to have been moved from higher in the Peştera cu Oase, perhaps the upper 'Panta Strămoşilor' or the 'Sala Mandibulei', by low-energy hydraulic transport. In contrast, the Level-2 assemblage presents a greater degree of dispersal and more density/size sorting, implying a higher-energy water transport and a greater distance of movement. As Level 2 has only been exposed in the excavation zone of the 'Panta Strămoşilor', the original position of the thanacenosis cannot be precisely determined (from 'Sala Mandibulei' and/or parts of the two upper galleries). The Level-2 bones also have excellent organic preservation, in contrast to the generally leached condition of the Level 1 and surface bones, indicating that the Level-2 assemblage was sealed in sediment soon after its transport occurred. There is no evidence of the trampling observed recurrently in other cave bear caves [12], perhaps due to the displaced positions of the assemblages.

7. Conclusions

The recently discovered Peştera cu Oase, because of its protection within its karstic context and continued difficulty of access, provides abundant data on its prehistoric denizens, especially the Late Pleistocene cave bears, whose remains make up the overwhelming majority of the contained paleontological assemblage. Even though the site has attracted attention for yielding the earliest diagnostic and directly dated modern humans in Europe, it is principally an ursid denning site. There is no evidence of human activity within the cave, and all of the osteological arrangements can be attributed to hydraulic processes within the karstic system and/or normal behaviors of cave bears. Radiometric dating of stalagmites and bones, in combination with a biochronology using P4 morphotypes, places the bear accumulation between approximately 50 and 40 ka cal BP.

The cave bear assemblage consists of surface bones (many arranged around a dozen preserved hibernation nests), a superficial excavated assemblage (Level 1) of large and small bones transported by low energy water into the 'Panta Strămoşilor', and a deeper stratigraphically sample (Level 2) of smaller bones transported by higher-energy water into the 'Panta Strămoşilor'. The sex ratio strongly favoring adult males, the size distribution of nests among which three quarters are for larger animals (males), and the abundance of immature individuals argue in favor of a subadult and adult male den. Moreover, there is abundant evidence of con-specific cave bear consumption of bones, for dietary trace elements or a more omnivorous diet than has been frequently documented for *U. spelaeus*.

These preliminary observations on the paleontological assemblage from the Peştera cu Oase complement growing data on Late Pleistocene cave bears from central and western Europe, and provide a window on these mammals in eastern Europe. Given the abundance of cave bear sites in the Carpathians (few of which have been excavated systematically), it is hoped that this is the beginning of a more fruitful investigation of these animals in this region.

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References

[1] H. Bocherens, Cave bear palaeoecology and stable isotopes: checking the rules of the game, in: M. Philippe, A. Argant, J. Argant (Eds.), 9th International Cave Bear Symposium, Cahiers scientifiques, hors série No. 2, Lyons, France, 2004, pp. 183–188.

[2] M. Dominguez-Rodrigo, A. Piqueras, The use of tooth pits to identify carnivore taxa in tooth-marked archaeofaunas and their relevance to reconstruct hominid carcass processing behaviours, J. Archaeol. Sci. 30 (2003) 1385–1391.

[3] P. Fosse, J.-P. Besson, H. Laborde, F. Thomas-Cantie, G. Cazenave, M.-C. Delmasure, T. Lévêque, F. Laudet, J. Quilès, Denning behaviour of 'modern' brown bear (*U. arctos* L.) in caves: biological and paleontological considerations from French Pyrenean sites, in: M. Philippe, A. Argant, J. Argant (Eds.), 9th International Cave Bear Symposium, Cahiers scientifiques, hors série No. 2, Lyons, 2004, pp. 171–182.

[4] G. Haynes, A guide for differentiating mammalian carnivore taxa responsible for gnaw damage to herbivore limb bones, Paleobiology 9 (1983) 164–219.

[5] K. Liden, A. Angerbjörn, Dietary change and stable isotopes: a model of growth and dormancy in cave bears, Proc. R. Soc. Lond. 266, 1999 (pp. 1779–1783).

[6] S. Lolliot, M. Philippe, Note préliminaire sur les traces de charognage affectant les ossements d'ours des cavernes, *Ursus spelaeus*, de la Balme à Collomb (Entremont-le-Vieux, Savoie) : un exemple, le cas des fémurs, in: M. Philippe, A. Argant, J. Argant (Eds.), 9th International Cave Bear Symposium, Cahiers scientifiques, hors série No. 2, Lyons, France, 2004, pp. 115–120.

[7] O. Moldovan, Ş. Milota, L. Sarcina, E. Trinkaus, I. Băltean, A. Soficaru, G. Rajka, The oldest modern humans in Europe, Theor. Appl. Karstol. 16 (2003) 77–81.

[8] D.E. Nelson, A. Angerbjörn, K. Liden, I. Turk, Stable isotopes and the metabolism of the European cave bear, Oecologia 116 (1998) 177–181.

[9] A.C. Pinto Llona, P.J. Andrew, Taphonomy and palaeoecology of *Ursus spelaeus* from northern Spain, in: M. Philippe, A. Argant, J. Argant (Eds.), 9th International Cave Bear Symposium, Cahiers scientifiques, hors série No. 2, Lyons, France, 2004, pp. 163–170.

[10] J. Piveteau (Ed.), Ursinae. Traité de paléontologie, tome 1 : Mammifères, origine reptilienne, évolution, 6, Paris, 1961.

[11] J. Quilès, Analyse morphodynamique de l'ours des cavernes (Carnivora, Ursidae) de cinq sites du pourtour méditerranéen, in: M. Philippe, A. Argant, J. Argant (Eds.), 9th International Cave Bear Symposium, Cahiers scientifiques, hors série No. 2, Lyons, 2004, pp. 149–161.

[12] J. Quilès, Tanières d'ours des cavernes (Carnivora, Ursidae) du pourtour méditerranéen : étude taphonomique et paléobiologique de huit assemblages du Pléistocène supérieur, Paleo 16 (2004) 171–192.

[13] J. Quilès, H. Monchot, *Sex ratio* et analyse des mélanges d'*Ursus spelaeus* (Carnivora, Ursidae) du gisement Pléistocène supérieur de Fate (Ligurie, Italie) : implications paléobiologiques, Ann. Paleontol. 90 (2004) 115–133.

[14] J. Quilès, H. Monchot, M. Pacher, Mixture analysis: application to cave-bear sex-ratio determination, in: P. Fosse, J. Quilès (Eds.), 10th International Cave Bear Symposium. Bull. Soc. Hist. nat., Toulouse Midi-Pyrenees 141, 2005, pp. 29–37.

[15] J. Quilès, E. Crégut, P. Fosse, Dental age determination on fossil brown bear cubs: the contribution of Holocene material from Mont Ventoux 4 (Vaucluse, France), Zool. J. Linn. Soc. (2006) (submitted).

[16] G. Rabeder, Die Evolution des Höhlenbärengebisses, Mitteilungen der Kommission für Quartärforschung der Österreichischen Akademie der Wissenschaften 11, Vienna, 1999.

[17] N.J. Shackleton, R.G. Fairbanks, T. Chiu, F. Parrenin, Absolute calibration of the Greenland time scale: implications for Antarctic time scales and for delta ^{14}C, Quat. Sci. Rev. 23 (2004) 1513–1522.

[18] E. Trinkaus, O. Moldovan, Ş. Milota, A. Bîlgar, L. Sarcină, S. Athreya, S.E. Bailey, R. Rodrigo, M. Gherase, T. Higham, C. Bronk Ramsey, J. van der Plicht, An early modern human from the Peştera cu Oase, Romania, Proc. Natl. Acad. Sci. USA 100 (2003) 11231–11236.

[19] E. Trinkaus, Ş. Milota, R. Rodrigo, M. Gherase, O. Moldovan, Early modern human cranial remains from the Peştera cu Oase, Romania, J. Hum. Evol. 45 (2003) 245–253.

[20] E. Trinkaus, I.C. Băltean, S. Constantin, M. Gherase, V. Horoi, Ş. Milota, O. Moldovan, C. Petrea, J. Quilès, R. Rodrigo, H. Rougier, L. Sarcină, A. Soficaru, J. Zilhão, Asupra oamenilor moderni timpurii din Banat: Peştera cu Oase, Banatica 17 (2005) 9–27.

[21] E. Trinkaus, J. Zilhão, H. Rougier, R. Rodrigo, Ş. Milota, M. Gherase, L. Sarcină, O. Moldovan, I. Băltean, V. Codrea, S.E. Bailey, R.G. Franciscus, M. Ponce de León, C.P.E. Zollikofer, The Peştera cu Oase and early modern humans in southeastern Europe, in: N.J. Conard (Ed.), When Neanderthals and Modern Humans Met, Kerns Verlag, Tübingen, Germany, 2006, pp. 145–164.

[22] M. Vila Taboada, D. Fernandez Mosquera, A. Grandal D'Anglade, Cave bear's diet: a new hypothesis based on stable isotopes, Cadernos do Laboratorio xeoloxico de Laxe 26 (2001) 431–440.

[23] B. Weninger, O. Jöris, The Cologne Radiocarbon Calibration and Paleoclimate Research Package, 2005; http://www.calpal.de.

[24] J. Zilhão, E. Trinkaus, S. Constantin, Ş. Milota, M. Gherase, L. Sarcină, A. Danciu, H. Rougier, J. Quilès, R. Rodrigo, The Peştera cu Oase people, Europe's earliest modern humans, in: P. Mellars, C. Stringer, O. Bar-Yosef, K. Boyle (Eds.), Rethinking the Human Revolution: New Behavioural & Biological Perspectives on the Origins and Dispersal of Modern Humans, McDonald Institute of Archaeology Monographs, Cambridge, 2006 (in press).