

THE HOLOCENE *URSUS ARCTOS* FROM "ABISSO ORIANO COLTELLI" CAVE (APUAN ALPS, TUSCANY, CENTRAL ITALY)

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ABSTRACT: The study of a prime adult female skeleton of brown bear, *Ursus arctos*, found in "Abisso Oriano Coltelli" cave is here reported. A new bone formation on the thoracic vertebrae was investigated by x-ray examination suggesting a longitudinal ligament injury caused by a circumscribed trauma, with ossified hematoma. The specimen was dated providing a conventional age of 6480 ± 40 ¹⁴C ka BP (Holocene). The bear died from non-violent causes, probably during hibernation. The "Abisso Oriano Coltelli" mammal assemblage also includes *Capra hircus*, *Martes foina* and indeterminate small mammals. Standard archaeozoological parameters (NISP, MNI) have been used to calculate the relative frequency of each taxon identified in the faunal assemblage.

Keywords: Mammals, Brown bear, Tuscany, Central Italy, Holocene

1. INTRODUCTION

The fossil record of Ursidae from the Apuan Alps (northern Tuscany) includes the exceptionally rich amount of Late Pleistocene remains of *Ursus spelaeus* from Equi cave (Ghezzi et al., 2014) and from Wind cave (Piccini et al., 2003). The "Abisso Oriano Coltelli" cave ($44^{\circ}05'35,0$ N, $10^{\circ}14'47,0$ E, labelled T/Lu 642 in the Tuscan register of caves) (Fig.1) opens 1209 m a.s.l on the western slope of "Monte Alto di Sella" (Apuan Alps). The cave was explored in 1976 to a depth of 730 m by the speleological and archaeological group of Leghorn and by the speleological group of Lucca. In the early 1990's the speleological and archaeological group of Leghorn explored new branches of this cave and in July 1994 they found the mammal assemblage studied in this paper.

The topographic survey of "Abisso Coltelli" revealed that the extremity of one of its newly explored branches was very close to the exterior of the cave. This new branch was opened in 1998 at 1305 m a.s.l. (Fig. 2) and the fossil material was collected in the August of 1998.

In this paper the study of the brown bear (*Ursus arctos*) remains retrieved from "Abisso Coltelli" is presented.



Fig.1 - Map of the Tuscany. The symbol * represent the geographic position of the "Abisso Coltelli" cave

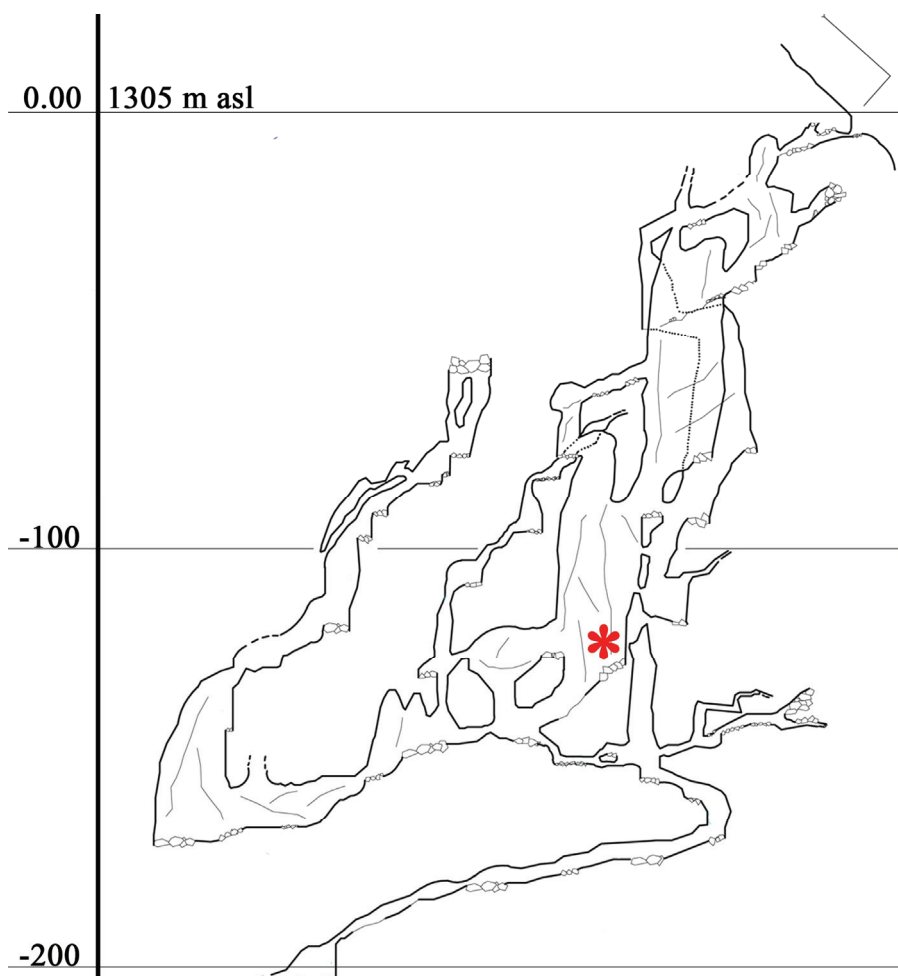


Fig. 2 - Longitudinal section of "Abisso Coltelli" cave. The symbol * represent the point where the faunal assemblage was discovered.

2. MATERIALS AND METHODS

The material is housed at the Natural History Museum of the University of Pisa and consists of 486 investigated specimens, 127 of which belong to an individual skeleton of *Ursus arctos*. The lists of the studied specimens and of the measurements are reported in Tables (1-4). The number of specimens is reported in parenthesis. The tables report also the side of the bones (Right / Left) and the preservation (Complete / Incomplete / Fragment). The measurements (in mm), with the exception of the ulna, tibia and fibula of the brown bear, have been taken on the right bones. The standard quantification units NISP (Number of Identified Specimens) and MNI (Minimum Number of Individuals) (Lyman, 1994; Lyman, 2008; Reitz & Wing, 2008) have been calculated to evaluate the relative frequency of each taxon identified in the faunal assemblage. MNI was assessed both on post-cranial and cranial specimens, taking into account age and size. The measurements of the mammal bones were taken adopting the measuring points indicated by von den Driesch (1976). The legend for abbreviations of the measurements are the following: Lcr: length of the cheektooth row; Lmr: Length of the

molar row; Lrt: length of the tooth row from canine to the first molar; GB: greatest breadth; GL: greatest length; H: greatest height; LAPa: greatest length of the arch including the processus articulares caudales; LCDe: greatest length of the body including the dens; GLP: Greatest length of the processus articularis; HS: Height along the spine; Bp greatest breadth of the proximal end; Bd: greatest breadth of the distal end.

In the 2000 a specimen of *Ursus arctos* was sent to Beta Analytic Inc. Laboratory (Miami, Florida, USA) for radiometric dating. The collagen was extracted using alkaline solutions. The specimen was subjected to Accelerator Mass Spectrometry (AMS) analysis. Both the conventional and the calibrated radiocarbon datings that were obtained are reported in the text. The conversion from conventional to calibrated ages was accomplished following Stuiver et al. (1998).

To assess the ontogenetic age of the brown bear we used the age-scoring technique proposed by Stiner (1998). The age-scoring technique is an eruption and wear scheme based on cheek teeth. The scheme recognises nine successive stages of crown growth and wear. Stiner (1998) advised clustering the eruption-wear stages into three age categories, juveniles (stages I -

Specimen	R/L side	Com/Inc/Fr	Lcr	Lmr	GB	GL	H	LAPa	LCDe	GLP	HS	Bp	Bd
Skull (1)		Inc	93	54									
Mandible (1)		Com											
Lower canine tooth (1)		Fr											
Atlas (1)		Com			135	67							
Axis (1)		Com					66	77	65				
Cervical vertebrae (5)		Com											
Thoracic vertebrae (13)		Com											
Lumbar vertebrae (6)		Com											
Sacrum (1)		Com											
Ribs (33)		Com (7)/Inc (11)/Fr (11)											
Sternal bones (5)		Com (1)/ Fr (4)											
Pelvis (1)		Inc											
Scapulae (2)	R(1)/L(1)	Com								64.5	223		
Humeri (2)	R(1)/L(1)	Com				298						59	81
Radii (2)	R(1)/L(1)	Com				273						34	49
Ulnae (2)	R(1)/L(1)	Inc/Com				309							
Femora (2)	R(1)/L(1)	Com				348						8	72
Tibia (1)	L	Com				259						75	65
Fibulae (2)	R(1)/L(1)	Inc/Com				241							
Metacarpals (7)	R(3)/L(4)	Com											
Carpal bones (8)	R(2)/L(6)	Com											
Metatarsal (1)	R	Com											
Tarsal bones (2)	R(1)/L(1)	Com											
Proximal phalanx (9)		Com											
Middle phalanx (6)		Com											
Distal phalanx (9)		Com											
Sesamoids (3)		Com											

Tab. 1 - List of *Ursus arctos* specimens from "Abisso Oriano Coltelli" cave with the side, the state of preservation, and measurements (in mm) (explanation of the symbols in text).
 Metacarpals: II, IV and V right and II, III, IV and V left; Metatarsal: V right.
 Carpal bones: left trapezoid, left capitate, left pisiform, left pyramidal and left scapho-lunate bone, right trapezium, right and left uncinate.
 Tarsal bones: left navicular bone, right intermediate cuneiform bone.

Specimen	R/L side	Com/Inc/Fr	Lrt
Skull (4)		Com (1)/ Inc (3)	29
Mandible (3)	R(2)/L(1)	Inc	
Atlas (2)		Com	
Axis (2)		Com	
Cervical vertebrae (8)		Com	
Thoracic vertebrae (14)		Com	
Lumbar vertebrae (19)		Com	
Sacrum (2)		Com	
Caudal vertebrae (9)		Com	
Ribs (38)		Com (34)/Inc (4)	
Pelvis (3)	R(2)/L(1)	Com	
Scapulae (4)	R(2)/L(2)	Com	
Humeri (4)	R(2)/L(2)	Com (3)/Fr (1)	
Radii (4)	R(2)/L(2)	Com	
Ulnae (5)	R(2)/L(3)	Com	
Femora (5)	R(3)/L(2)	Com (3)/Inc (2)	
Tibia (6)	R(2)/L(4)	Com (4)/Inc (1)/Fr(1)	
Fibulae (3)	R(2)/L(1)	Com (2)/Inc (1)	
Calcanei (4)	R(2)/L(2)	Com	
Astragali (3)	R(2)/L(1)	Com	
Metapodials (23)		Com	
First phalanx (7)		Com	

Tab. 2 - List of *Martes foina* specimens from "Abisso Oriano Coltelli" cave.

Specimen	R/L side	Com/Inc/Fr	GB	GL	Bp	Bd
P ² (1)		Com				
Lumbar vertebrae (2)		Inc				
Sacrum (1)		Com				
Pelvis (1)	L	Inc				
Femora (2)	R/L	Inc/Fr				
Tibia (3)	R(2)/L	Inc (2)/Fr(1)				
Calcaneus (1)	R	Com	26			
Metatarsal (2)	R/L	Com/Inc		143	27	33
Tarsal bones (1)	R	Com				
First phalanx (1)		Com				

Tab. 3 - List of *Capra hircus* specimens from "Abisso Oriano Coltelli" cave.

ORDER	SPECIES	NISP	MNI
Carnivora	<i>Ursus arctos</i>	127	1
	<i>Martes foina</i>	172	4
Artiodactyla	<i>Capra hircus</i>	15	1
total values		314	6
only anatomically determined specimens		6	
total determined specimens		320	

Tab. 4 - NISP and MNI of identified taxa present in the "Abisso Coltelli" faunal assemblage.

III), prime adults (stages IV - VII), and old adults (stages VIII - IX).

The vertebral column of the brown bear studied here presents new bone formation on the 4th and the 11th thoracic vertebrae. The latter in particular shows two lesions, whose features were investigated with X-ray techniques.

3. RESULTS

The mammal assemblage includes a single individual of *Ursus arctos* (Tab. 1), 4 individuals of *Martes foina* (Tab. 2), and a single individual of *Capra hircus* (Tab. 3). The NISP and MNI counts are reported in Tab. 4. Of the 486 specimens examined here, 6 could be determined only anatomically. The indeterminate fragments are 166 and 88 of them belong to rodents.

3.1. *Ursus arctos*

The sagittal crest of the brown bear skull is weak and limited to the nuchal region. The temporal windows are small in size and the zygomatic bones are slender. These characteristics are consistent with a female individual.

Based on the dental wear stage, the individual is a prime adult (stage VI) (Figs. 3-4). The skull is fractured in the nuchal region, lacking part of the right frontal and parietal bones (Fig. 5). Based on the jagged edges of the fractures surface, the bones were broken in a dry state (Villa & Mathieu, 1991), suffering a post mortem damage. The postcranial bones are unaltered.

The 11th thoracic vertebra shows two elongated, symmetrical lesions, located on the outer-ventral face of the vertebral body. There is evidence of an ossified hematoma (Fig. 6). Hence, there was ligament injury, caused by a circumscribed trauma. The X-ray examination (Figs. 7-8) also revealed bone thickening near the neighbouring vertebral endplates, which can be interpreted as a probable reparative bone sclerosis.

Similarly to the other mammal remains from the cave, the skeleton of the female bear shows no evidence of carnivore ravaging. Hence, the animal was not killed during hibernation or transported into the cave by other predators.

The specimen (Sample Beta-143383) sent for radiometric dating gave a conventional radiocarbon age of $6,480 \pm 40$ ¹⁴C ka BP (7445-7310 cal ka BP). The ¹³C/¹²C ratio was -20.3‰.

3.2. *Capra hircus* and *Martes foina*

The most diagnostic bones that permitted to attest the presence of a single individual of *Capra hircus* are the right metatarsal and the right calcaneus. The metatarsal is short and relatively broad (Tab. 3) and the sagittal ridges of the distal articular surface converge, whereas in the sheep they run practically parallel (Prummel & Frisch, 1986). In the right calcaneus, the corpus calcanei is straight to convex and between the sustentaculum tali and the medial articular surface of the processus anterior the



Fig. 3 - *Ursus arctos* L. Ventral Dorsal view of the skull. The scale bar is 5 cm.



Fig. 4 - *Ursus arctos* L. Dorsal view of the mandible. The scale bar is 5 cm.



Fig. 5 - *Ursus arctos* L. Dorsal view of the skull. The scale bar is 5 cm.



Fig. 6 - *Ursus arctos* L. Ventral A and posterolateral B and C views of the 10th- 12th thoracic vertebrae segment. The scale bar is 5 cm.

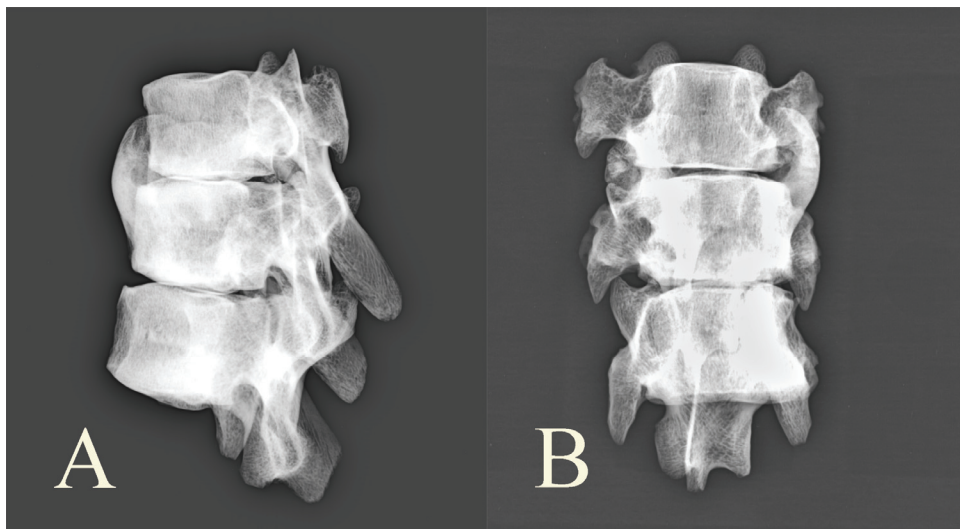


Fig. 7 - *Ursus arctos* L. X-ray (ventral B and lateral A view) of the 10th- 12th thoracic vertebrae segment.

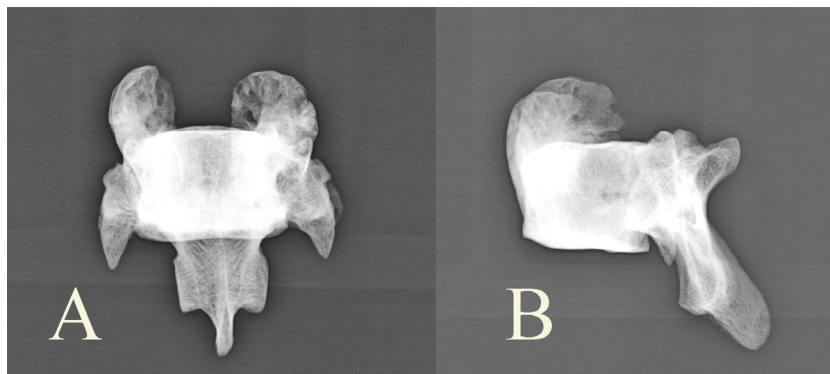


Fig. 8 - *Ursus arctos* L. X-ray (ventral A and lateral B view) of the 11th thoracic vertebra.

two articular surfaces are fused with each other (Prummel & Frisch, 1986).

The identification of the beech marten was based on the postcranial bones (Baumann & Gornetzki, 2017). In particular the shape of the atlas, where both Processus transversales were tapered cranially, the axis, where the processus spinosus is markedly thickened and the scapula, where the shape of the metacromion is significant thicker in comparison with the one of the pine marten.

The postcranial bones of the goat and the beech marten individuals are unaltered.

4 - DISCUSSION AND CONCLUSION

Based on its radiocarbon dating the female prime adult brown bear carcass from "Abisso Coltelli" is of early Holocene age. Similarly to the *Ursus spelaeus* from Chiostraccio cave (Martini et al., 2014) the Abisso Coltelli bear died from non-violent causes, either trapped in the cave, as probably happened also to the other associated mammals, or during hibernation. In the first option, the absence of fractures in the postcranial bones of the bear as well as in those of the other associated species suggests that the animals did not fall into the cave and that the latter was easy to penetrate. The lesion on the 11th thoracic vertebra is an injury that the bear had sustained in the past, but healed before the death in the cave. It was therefore not caused by a fall from height. The absence of carnivore ravaging evidence on the bones gives weight to the second hypothesis, in spite of Stiner's (1998) warning that hibernation-related deaths in wear stages V and VI are usually rare. In this case the young bear would have died from starvation, or disease.

The associated occurrence of *Martes foina* and *Capra hircus* indicates that the mammal association was probably accumulated attritionally over a certain period of time. In fact bears make considerable effort to keep secret their hibernation lairs to reduce the risk of intrusion and any minimal disturbance will draw a bear away (Stiner, 1998). Under this perspective, the goat and marten individuals died the same way as the bear.

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REFERENCES

- Baumann C., Gornetzki K. (2017) - Postcranial differences in sex and species of pine marten (*Martes martes* L., 1758) and beech marten (*Martes foina* Erxl., 1777). *Palaeodiversity*, 10(1), 7-23.
- Ghezzi E., Palchetti A., Rook L. (2014) - Recovering data from historical collections: stratigraphic and spatial reconstruction of the outstanding carnivoran record from the Late Pleistocene Equi cave (Apuane Alps, Italy). *Quaternary Science Reviews*, 96, 168-179.
- Lyman R. L. (1994) - Vertebrate taphonomy. Cambridge Manual in Archaeology, USA, pp. 524.
- Lyman R. L. (2008) - Quantitative Paleozoology. Cambridge Manual in Archaeology, USA, pp. 348.
- Martini I., Coltorti M., Mazza P.P.A., Rustioni M., Sandrelli F. (2014) - The latest *Ursus spelaeus* in Italy, a new contribution to the extinction chronology of the cave bear. *Quaternary Research*, 81, 117-124.
- Prummel W., Frisch H.J. (1986) - A guide for the distinction of species, sex and body side in bones of sheep and goat. *Journal of Archaeological Science*, 13(6), 567-577.
- Piccini L., Borsato A., Frisia S., Paladini R., Salzani R., Sauro U., Tuccimei P. (2003) - Concrezionamento olocenico e aspetti geomorfologici della Grotta del Vento (Alpi Apuane - Lucca): analisi paleoclimatica e implicazioni morfogenetiche. *Studi Trentini Scienze Naturali, Acta Geologica*, 80, 127-138.
- Reitz E.J., Wing E.S. (2008) - Zooarchaeology. Cambridge Manual in Archaeology, USA, pp. 533.
- Stiner M.C. (1998) - Mortality analysis of Pleistocene bears and its paleoanthropological relevance. *Journal of Human Evolution*, 34(3), 303-326.
- Stuiver M., Reimer P.J., Bard E., Beck J.W., Burr G.S., Hughen K.A., Kromer B., McCormac G., van der Plicht J., Spurk M. (1998) - IntCal98 radiocarbon age calibration, 24,000-0 cal BP. *Radiocarbon* 40 (3), 1041-1083.
- Villa P., Mahieu E. (1991) - Breakage patterns of human long bones. *Journal of Human Evolution*, 21, 27-48.
- von den Driesch A. (1976) - A guide to the measurement of animal bones from archaeological sites. Peabody Museum of Archaeology and Ethnology Harvard University, USA, pp.137.

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