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Holocene Brown Bears (*Ursus arctos* L.) in natural traps : exceptional sites of Mont Ventoux (Vaucluse, France)

Osos Pardos holocenos en trampas naturales: los yacimientos excepcionales de Mont Ventoux (Vaucluse, Francia)

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ABSTRACT

On the northern face of the mountain Mont Ventoux (Vaucluse, Southeastern France), a dozen cavities and traps (called MV1, 2, 3, 4 (= Aven du René-Jean), 5, 6 …) have been recently discovered by speleologists, yielding rich Holocene faunal remains. Two sites (MV2 and MV4, figure 1) have been excavated for 3 years (1997-1999) and appear to be exceptional places for their archaeological records, containing both numerous remains of brown bears and charcoal. These remains seem to have been accumulated during a short time (Bronze Age ? to late Antiquity).

Here are presented some results of our first field investigations. Although these do not strictly concern cave bears, they may be useful to paleontologists, archaeologists, taphonomists and biologists working on (Pleistocene) bears.

Key words: ***Ursus arctos*, Holocene, natural traps, France**

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THE MONT VENTOUX SITES : A BRIEF PRESENTATION

The MV2 and MV4 sites are found at a high altitude (1,650 m) and were formed in Urgonian bioclastic limestone. However, there are important topographical differences between the two sites: MV2 has a long and narrow entrance gallery (60 m long) leading to a deep hole (28 m deep), whereas the entrance of MV4 is a small and narrow place (3 m long x 1-0.5 m width) which leads directly to a vertical hole of 17 m depth (figure 2). The base of the hole is a small trapezoidal room (10 x 5 m), containing thousands of faunal remains.

Excavations have mainly concerned MV4 site, where deposits have been exposed 1.50 m deep. Three stratigraphical levels have been recognized:

• An upper level (average depth: 20-30 cm), composed of medium sized limestone gravel and without *fine-grained* sediment, yielding numerous brown bear remains. Skeletons are completely disarticulated and most of them belong to adults;

• An intermediate level (70 cm) with limestone gravel and black small sized

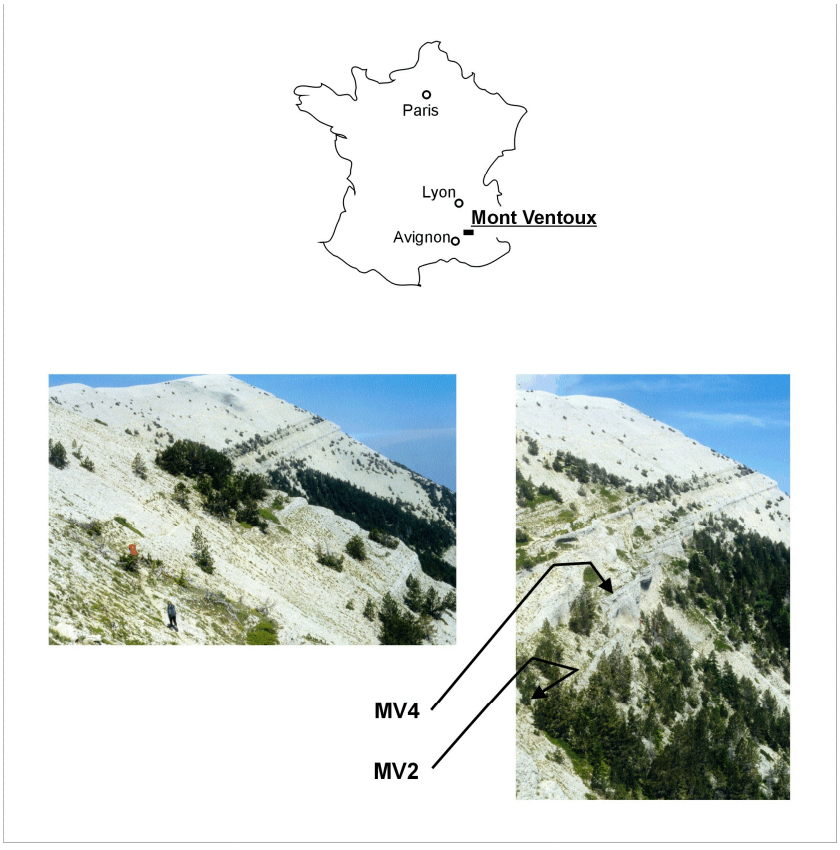

Figure 1. Location of Mont Ventoux natural traps. (Photos: Philippe Fosse)

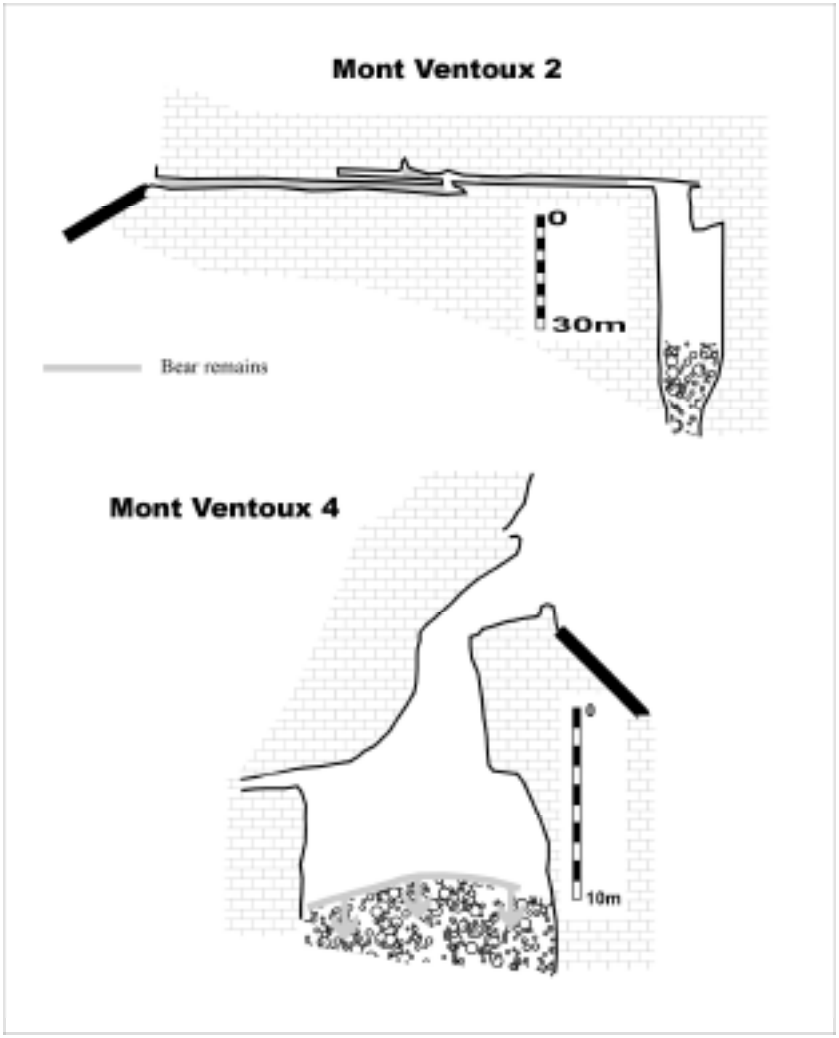

Figure 2. Topography of Mont Ventoux natural traps. (redrawn from EVIN 1996 (MV2) and BOUCHET 1997 (MV4)).

sediments. This level yields both paleontological material (essentially brown bear and bats) and abundant charcoal. Most of the bear skeletons belong to young individuals and have been discovered along the walls, often covering major concentrations of charcoal. Some of the thin bones (skulls, scapulae) have been broken by rockfalls;

• A lower level (30-40 cm deep) containing only large sized limestone gravel. This level has so far not yielded any brown bear remains.

MORPHOMETRICAL CHARACTERS OF BROWN BEAR REMAINS

In each site, the brown bear (*Ursus arctos* L.) is the commonest species (table 1) and has been found in unexpected quantity, especially in the MV4 locality. In a surface of 12 square meters, 6000 bones and teeth belonging to 120/150 individuals have been discovered; an estimate of 300/500 bears is possible for the complete sequence. A major concentration of bones is noticeable, especially in the northern squares.

By the morphological characteristics of both cranial and postcranial elements (shape of skulls, presence of premolar raws, slenderness of long bones), the bear at the Mont Ventoux sites is identified as a medium-sized *Ursus arctos*, similar to modern southern European specimens. Skulls of adult individuals (n=7) present a regular profile and not a strongly vaulted forehead as found often in *Ursus spelaeus* (figure 3). Variability in form and profile of the skulls is noticeable, in accordance with descriptions from modern samples (ERDBRINK, 1953; COUTURIER, 1954; KOHL & SEPSI, 1997; CHESTIN & MIKESHINA 1998 …). Other phenetic parameters, such as presence/absence of some premolars can be observed but without any precise subspecific or biochronological information. Upper and lower

Species	MV1	MV2	MV4	MV5	MV6	MV9
Homo sapiens		×			×	
Canis lupus		×				
Canis familiaris			65 / 1			
Vulpes vulpes		×				
Ursus arctos	×	2000	65-42 / a 1 60	×	×	×
Mustela nivalis		×				
Martes foina		×	1 / 1	×	×	
Equus (caballus form)		×			×	
Equus asinus					×	
Sus scrofa	×	×			×	
Rupicapra rupicapra		×		×		×
Capra ibex		×	65 / 1		×	
Capra ibex ibex		×				
Ovis aries		×	1 / 1			
Capreolus capreolus		×				
Lepus europaeus		×	1 / 1	×	×	×
Sciurus vulgaris		×				
Talpa europea		×				×
Sorex araneus		×	×			×
Myotis myotis		×	×			
Myotis myotis/oxy			×			
Rhinolophus euryale		×	×	×		
Talpa cf europea			1 / 1			
Felis silv			6 / 1			
Columba oenas			1 / 1			
Columba sp.			×			
Aegypius monachus					±	

Table 1. Faunal list of Mont Ventoux (=MV) natural traps. X = presence ; NISP/MNI. Identifications made by E. CREGUT (ungulates and carnivores), C. MOURER-CHAUVIRE (birds) and P. MEIN (bats).

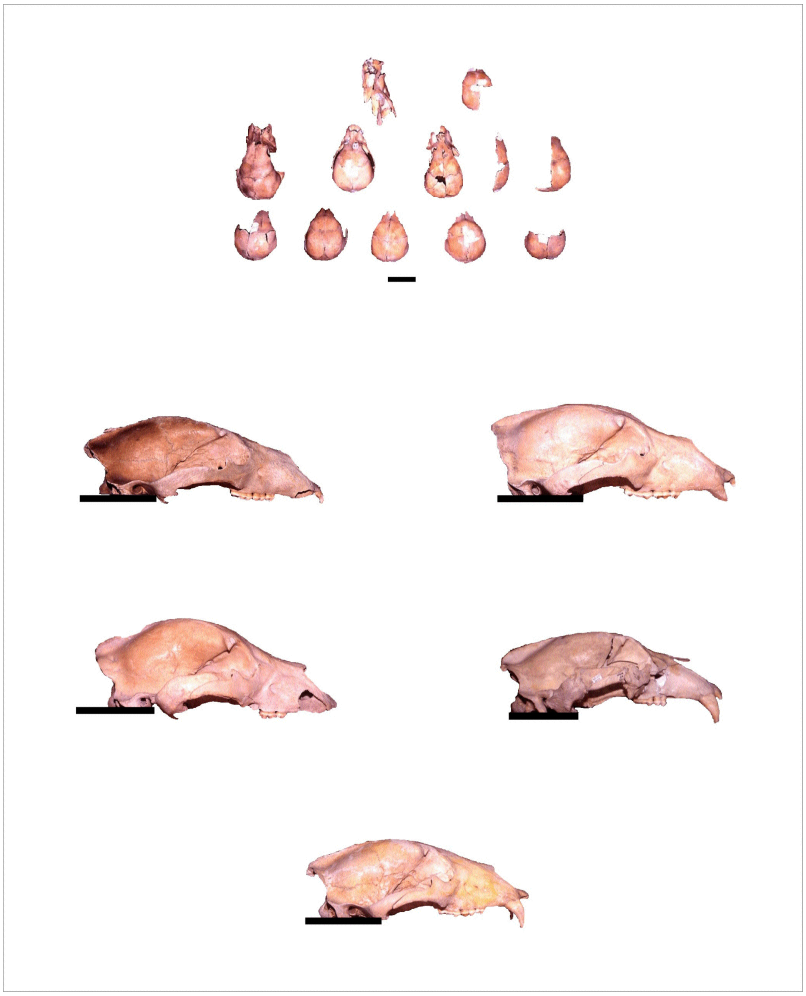

Figure 3. Adult and non adult skulls from Mont Ventoux natural traps. Scale = 10 cm. (Photos : Philippe Fosse).

first and third premolars are present (indicating an attribution to *Ursus arctos*) but in different proportions (tables 2-3). These differences might be interpretated either as standard intrapopulational variability (BALLESIO, 1983: 12) or the presence of two sub-diachronic populations. However, the lack of teeth series for most of the Pleistocene and early Holocene brown bear populations (Taubach: KURTEN, 1977; Jaurens: BALLESIO, 1983; Biache-Saint-Vaast: AUGUSTE, 1996) does not allow a closer analysis of the evolutionary significance in relation to the presence or absence of premolars. One might hypothe-

Gis.	Nº	Gis.	P1/	P2/	P3/	P/1	P/2	P/3
MV4	204/01	L				+	-	-
		R				?	-	-
MV4	204/02	L	-	-	+			
		R	?	?	+	+	-	-
MV4	204/03	L	+	-	+			
		R	+	+	+			
MV4	204/04	L				+	-	-
MV4	204/05	L				+	-	-
MV4	204/06	R				+	-	+
MV4	204/07	L				+	-	-
MV4	204/08	L	+	-	+			
MV4	204/11	R	+	-	+			
MV4	FGD	R	+	-	+	+	+	-
MV4	Mel 41	R				+	-	-
MV2	203/07	L				+	-	+
MV2		R				+	-	+
MV2	203/08	R				+	+	-
MV2	203/09	L				+	-	-
MV2	203/10	L	+	-	+	-	-	+
		R	-	-	-	+	-	+
MV2	203/11	L	-	-	+	+	-	+
		R	-	-	-	+	-	+
MV2	203/12	L	+	-	+	-	-	-
		R	+	-	+	-	-	-
MV2	203/13	R				+	-	-
MV2	203/15	L	+	+	+			
		R	+	-	+	+	-	+
MV2	203/16	L	-	-	+	-	-	-
		R	-	-	-			

Table 2. Presence (+) absence (-) of premolars in brown bear maxillae and mandibles from Mont Ventoux natural traps. Data from DONAT-AYACHE (1997).

Site	Frequency	Source	P1/	P2/	P3/	P/1	P/2	P/3
Modern samples	% (n=514/5)	(1)	36,3		100	100		35,4
Hol, MV4	%		33,3	16,7	100	100	11,1	11,1
Hol, MV2	%		50	10	70	69,2	7,7	53,3
Hol, Spain	N	(2)	13/19	7/19	19/19	13/13	0/13	5/13
	%		100	36,3	100	100	0	38,5
Hol + Upper Pleist, Spain	N	(3)	33/44	4/44	43/44	40/42	1/42	14/42
	%		36,6	9,1	97,7	95,2	2,4	33,3
Upper Pleist, Jeunure	N	(1)	1/1	0/1	1/1	5/5	0/4	1/4
Late Middle Pleist, Taubach	N	(4)	0	1	4	0	22	3
	%		0	14	57	0	78	27
L. Mid. Pleist, Biache St Vaast	%	(5)	100	40	95	100	15	15

Table 3. Frequency of premolars in several modern and pleistocene brown bear populations. Source: (1) BALLESIO, 1983; (2) ALTUNA, 1973; (3) TORRES PEREZ-HIDALGO, 1988; (4) KURTEN, 1977; (5) AUGUSTE, 1995.

zise that the MV4 population is older than the MV2 one.

Metrical comparison between modern and fossil European brown bear populations underlines the overall small size of the Mont Ventoux specimens. Skulls are of the same size as modern samples, although slighly larger than female samples (figure 4). The attribution to the Holocene period is confirmed by isolated teeth measurements (tables 4–6). Lower carnassials present metrical characteristics close to modern Pyrenean and Basque populations, which are in every case smaller than Upper Pleistocene individuals (figure 5). DNA studies have been undertaken (Y. TABERLET, Grenoble) in order to precisely locate the Mont Ventoux samples within European populations.

GENERAL OVERVIEW OF BROWN BEAR ASSEMBLAGES

Currently, Mont Ventoux traps are the richest European sites with brown bear remains. Other sites with *Ursus arctos* (fossil or modern forms) are Eemian open-air sites of Biache-Saint-Vaast, Ehringsdorf

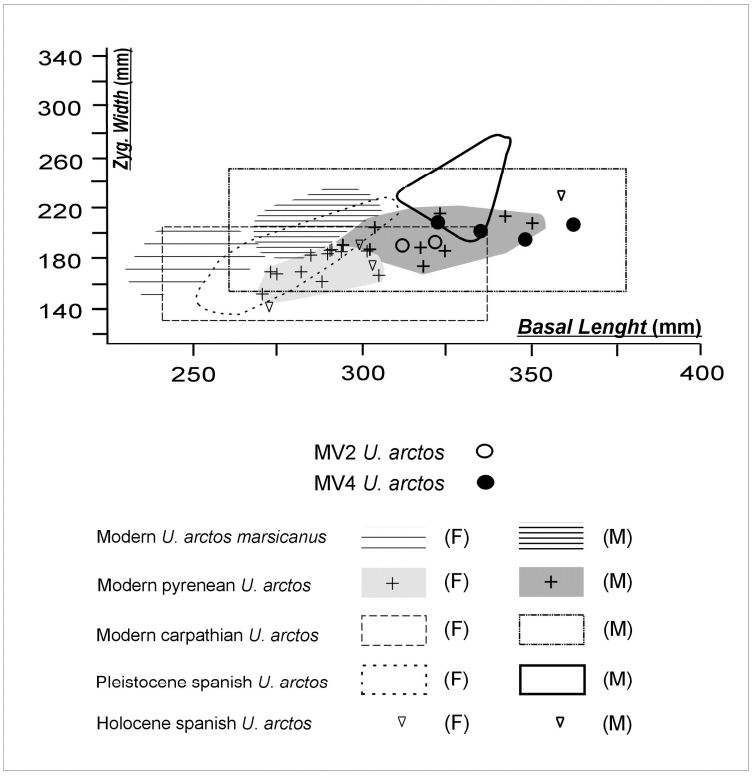

Figure 4. Osteometric data of adult brown bear skulls (mm) from Mont Ventoux natural traps; comparisons with pleistocene and holocene specimens. Source: ALTUNA, 1973; BOURDELLE & DELIZIERE, 1949; CAMARRA, 1989; CAPASSO BARBATO *et al.*, 1993; COUTURIER, 1954; DONAT-AYACHE, 1997; KOHL & SEPSI, 1997; TORRES PEREZ-HIDALGO, 1988.

Gisk.N°	Sex	A	B	C	D	E	F01	F02	G01	G02	H01	H02	I01	I02
MV4.P60		325		170,1	205,5	107,2			12,6		21,3	13,0	36,1	18,1
MV4.204.01		334	335	205,6	205,1	114,8	39	21,7	14,9	13,7	23,4	17,7	adv	adv
MV4.204.02		340	334	196,7	196,8	89,7	27,6	16,0	14,6	14,3	24,9	14,3	35,3	16,3
MV4.204.03		335	330	193,6	200,4	94,6	18,6	14,6	14,4	11,7	25,8	14,6	38,8	16,7
MV2.205.10		318	303	183,6	185,4	97,6	adv		14,6	14,0	adv	adv	38,8	16,6
MV2.205.11		320	307	184,9		101,1	21,4	14,7	14,6	11,6	19,6	14,1	34,6	16,9
MV2.205.12		322	312	175,0	192,0	70,2	13,1	11,4	14,4	10,3	21,4	14,0	30,7	17,9
MV2.205.14														
MV2.205.15	♂	320	310	184,6	194,1	85,7			14,6	9,9	25,4	14,0	35,6	16,9
MV2.205.16	♂								14,1	8,9	20,9	11,0	31,9	16,6
MV2.205.18											21,7	16,6	36,2	18,4
MV2.205.20									15,5	11,7				

♂ : subadult
Refer: skull + mandibles + teeth (exc. below Table)
A : Total Lenght B: Condylo-basal Lenght C : Neuro-cranium, Lenght D : Zygomatic Width
E : Edentilal Width F : C/ G : P4/ H : M1/
I : M2/ 01 : Lenght (=MDD) 02 : Breadth (=YLD) adv : alveolar

Table 4. Metrical data (in mm) for brown bear skulls and upper teeth of Mont Ventoux natural traps. Data from DONAT-AYACHE (1997).

Gisk.N°	Gisk.	AA	BB	CC	DD	EE	FF	GG	HH	II	JJ
MV4.204.01	M	245,6	246,1	207,2	63,9	69,6	158,3	45,1	47,6	63,3	69,6
MV4.204.02	M	239,1	235,6	204,9	47,6	64,2	145,6	46,9	49,6	46,6	47,0
MV4.204.03	M	255,9	259,9	208,0	45,4	72,1		44,7	43,4	45,1	64,6
MV4.204.04	M	253,9									
MV4.204.05	M				55,0	62,3		44,3	49,0	52,0	
MV4.204.06	M	210,1	211,0	180,5	45,9	64,2	37,6	40,4	40,9	46,6	59,4
MV4.204.07	M				46,5	62,2		35,4	35,4	40,1	
MV4.204.09	♂M				26,2			25,1	21,4	25,2	
MV4.204.21	♂M				25,3	65,2	63,2	29,5	22,5	26,3	
MV2.205.04	M				46,1	70,5		46,4	45,4	50,1	55,9
MV2.205.07	M	222,5	215,3	183,3	45,0	65,3	39,7	37,5	35,1	40,2	44,2
MV2.205.08	♂M	188,0	188,0	155,1	24,1	72,9	61,7	32,4	29,6	31,0	
MV2.205.10	M	255,7	254,6	205,5	44,6	69,4	97,7	35,6	34,6	39,6	44,4
MV2.205.11	M	237,7	234,3	194,2			94,6	46,7	39,6	46,9	43,6
MV2.205.13	M					40,6	32,7	35,5	36,1	37,5	38,4
MV2.205.15	♂M	245,9	246,9	203,7	64,9	69,0	65,0	49,9	44,4	46,3	49,4
MV2.205.16	♂M	245,3	245,3	203,7		69,6	64,9	46,1	43,9	46,7	49,6

♂ : subadult
AA : Total Lenght BB: Lenght proc. Ang-Infrad. CC : Lenght condyle-post canine
DD : Lenght P/1-P/4 EE : Lenght P/1-M/1 FF : Height proc. ang-coron.
GG : Height of mand. corpus post. of M/1 (labial) HH : Height of mand. corpus post. of M/2 (lab.)
II : Height of mand. corpus post. of M/2 (lab) JJ : Condyle, Lenght

Table 5. Metrical data (in mm) for brown bear mandibles of Mont Ventoux natural traps. Data from DONAT-AYACHE (1997).

and Taubach, and Upper Pleistocene cave sites of Grimaldi (grotte du Prince), Régourdou, Jaurens and Flavigny (table 7). Most *Ursus arctos* discoveries come from (partial) isolated skeletons for which chronological background cannot be refined without radiometric data. All of skeletal parts have been found (figure 6): unfused bones of young individuals and closed epiphyseal long bones of (sub)adult

Gisement	Dent	a1	a2	b1	b2	c1	c2	d1	d2
MV4 2040 1	M	33,9	7,6	26,3	11,6	24,7	14,0	17,6	10,7
MV4 2040 2	M	33,1	6,6	25,2	ab	21,2	ab	14,9	
MV4 2040 4	P4	14,9	8,3	22,7	10,4	25,0	13,6	13,3	12,3
MV4 2040 5	P4	13,6	6,0	22,3	10,3	23,3	12,3	13,2	11,4
MV4 2040 6	P4	13,1	6,5	21,2	9,9	21,3	12,6	15,1	9,2
MV4 2040 7	P4	11,7	5,7	22,0		22,0	12,4	13,1	13,3
MV4 2040 9	* P4	10,7	5,5	24,1	11,3	26,6	14,2		
MV4 2040 21	* P4	10,7	4,7	22,6	ab	24,9	13,9	13,4	14,7
MV2 2050 4	P4	15,4	8,3	22,3	ab	24,1	ab	13,2	10,9
MV2 2050 7	P4	11,7	6,5	22,4	10,3	23,6	13,3	13,3	13,4
MV2 2050 8	* P4	15,2	8,1	24,5	9,9	24,9	12,6	20,4	14,3
MV2 2050 9	M	33,5	7,5	25,3	11,4	25,5	14,3	16,9	14,9
MV2 2050 11	M	33,5	7,9	25,9		24,4	14,4	16,3	14,9
MV2 2050 13	P4	11,1	6,3	ab	ab	ab	ab	ab	ab
MV2 2050 15	* M	33,3	8,7	26,3	11,0	24,9	13,7	16,3	ab
MV2 2050 16	* M	32,9	7,4	24,3	10,7	ab	ab	16,3	15,4

* : subadult
a : P4/4 b : M1/1 c : M2/
d : M3/ 01 : Long/N 02 : Breadth

Table 6. Metrical data (in mm) for brown bear lower teeth of Mont Ventoux natural traps. Data from DONAT-AYACHE (1997).

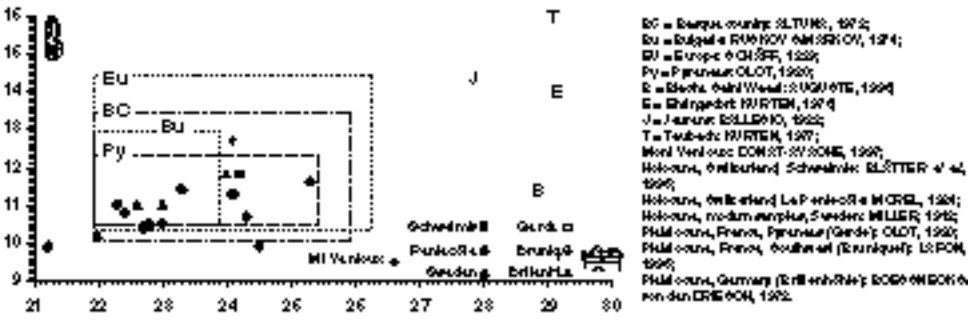

Figure 5. Osteometric data of adult brown bear lower carnassials (mm) from Mont Ventoux natural traps; comparisons with pleistocene and holocene specimens.

skeletons are mixed and great concentrations of bones do not allow a reconstruction (refittings) of all individuals.

Young individuals are especially abundant, most of them belong to new born / first winter individuals (MV4 NISP= 4634; MNI= 87, table 8; MV2 NISP= 2000; MN= 30) whose ages have been estimated from lower tooth eruption/wear stages on known-age samples (DIT-

Age	Country	Site	NISP	MNI	Source
Bronze Age + ? / Roman period	F	Mont Ventoux 4	6342	33	
		Mont Ventoux 2	2000	34	
Eemian	F	Bloch-à-Gi-Vaast	2245	37	AUGUSTE, 1995
Eemian		Taubach	> 1000	43	KURTEN, 1977
Upper Pleistocene, Wurmian age	F	La Fégourdou	± 700	15	BONIFAY, 1989 ; FOSSE, ARTUSAL, pers. data
Holocene	Esp	Gaztelu	skeleton	1	ALTUNA, 1973
Holocene	Esp	Urbasarreta I	skeleton	1	ALTUNA, 1973
Holocene	Esp	Urbasarreta II	skeleton	1	ALTUNA, 1973
Holocene	Esp	Koskobilo	skeleton	1	ALTUNA, 1973
Holocene	Esp	Aizkalgui	skeleton	1	ALTUNA, 1973
Holocene	Esp	Aizkalgui	1	1	ALTUNA, 1973
Holocene	Esp	Mandubi-4	1	1	ALTUNA, 1973
7.33 ± 0,15 ky BP	Esp	Las Grajas II	skeleton	1	ALTUNA, 1973
14.6-14 ky BP	F	Duruthy, 6		1	ALTUNA et al, 1991
11.6 ky BP	F	O. dalle Amalo		1	OLOT, 1995
10.3-9.6 ky BP	F	Duruthy, 3		1	ALTUNA et al, 1991
Pleistocene, Indet	I	Manpino	skeleton	1	KOBY, 1944
Pleistocene, Indet	Gub	Banik	?	5	MALEZ, 1975
Pleistocene, Indet	F	Pleydigny/Cousin	± 200		ARGANT, 1991

Table 7. Frequency (NISP/MNI) of brown bear in Pleistocene/Holocene sites.

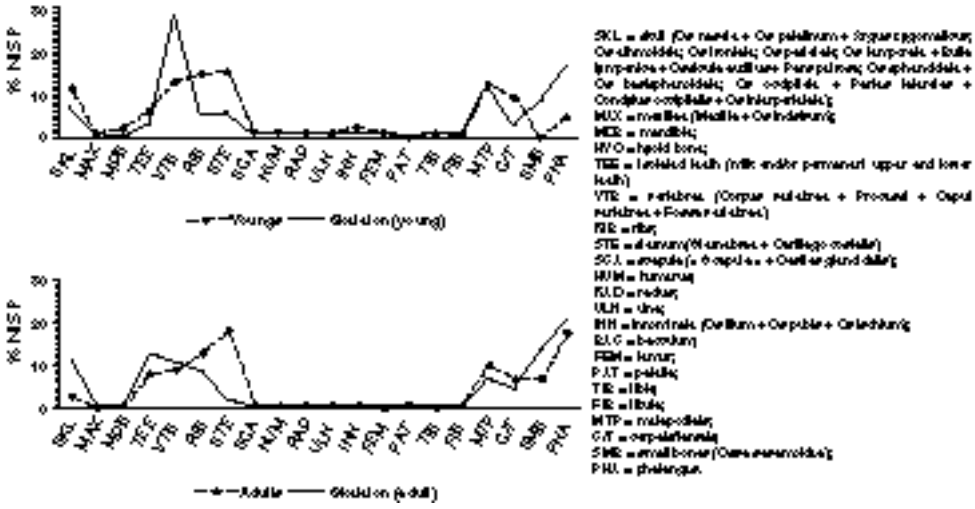

Figure 6. Frequency (%NISP) of skeletal parts of non adult and adult brown bear from MV4 natural trap. NISP youngs = 4634; NISP adults = 900.

TRICH, 1960). Some age classes have been rarely obtained because of the state of mandible preservation (lack of teeth; presence/absence of alveoles; state of eruption slightly different (intermedial) of DITTRICH's one). Unworn milk teeth are rare, whereas 6 weeks – 4 months old (DITTRICH' stages 4-6) followed by 5 months - 6 months old (DITTRICH' stages 9-10) individuals are well represented

(table 8). Because birth of brown bears occurs in January – February (PARDE & CAMARRA, 1992: 10), DITTRICH' stages 4-6 indicate March/May periods and stages 9-10, July. It suggests both mortality during and at the end of hibernation (stage 4, 5 and 6) and during summer (stages 9, 10). The MV4 entrance may be seen as a hibernation place for female bears with their cubs; its characteristics (morphology, size) are similar to pyrenean or abbruzzean rockshelters used as winter refuges (CAMARRA, 1987, 1989; ZUNINO, 1986). Presence of bears during summer might be explained either by their behaviour (frequentation of the highest zones of territory in search of food and coolness) or by first human activities in this area (refuge in front of clearings, pastoralism …).

The 11 adult specimens are identified by 900 bones and teeth. Material belongs to subadult and young adult with unworn permanent teeth. Size of upper and lower canines suggest that females are more abundant than males (figure 7). Long bones extremities often present carnivore activities: discrete pits near epiphyses, grooves along diaphyses and deep furrows into humerus/femur heads which have been sometimes completly cancelled out (figure 8). Some adult brown bears survived to their fall and consume (semi)fresh bones, by gnawing epiphysis.

CONCLUSIONS

Mont Ventoux sites contain one of the richest brown bear samples in Europe. Goals of studies on such original sites have to draw up detailed data sheets both on biological characteristics of bears (presence of so many youngs suppose a recurrent frequentation of these sites for a very long period -several centuries?- by a same population; inter site correlations …) and

DITTRICH'stage (DITTRICH, 1960)		Age	MV4 sample (in %; N=72)
1		1 Week	
2		2 – 3 Weeks	
3		4 Weeks _	
4		6 Weeks	1,4
	(4) or (5)		19,4
5		10 Weeks	36,1
	(5) or (6)		4,2
6		4 months /	13,9
		4 months 1 Week	
	(6) or (7)		1,4
7		4 months _	2,8
		4 months _	
8		5 months	4,2
	(8) or (9)		4,2
9		5 months _	5,6
	(9) or (10)		6,9
10		6 months	
11		6 months _	
12		7 months	
13		10 months	
14		1 year	
15		1 4 months	

Table 8. Age estimation of non adult brown bears from MV4 site.

on methodological researches in bear taphonomy (age estimations, anatomical refittings …).

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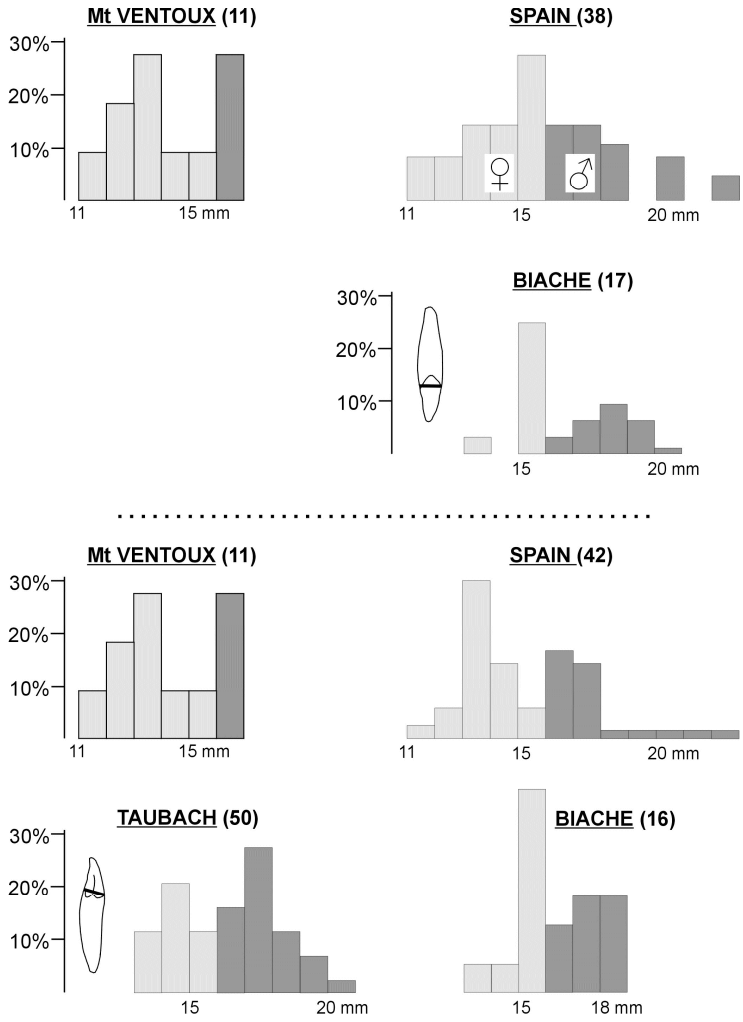

Figure 7. Sexual dimorphism in modern and Pleistocene brown bear populations, based on Transverse Diameters of Upper (above) and Lower (below) canines.

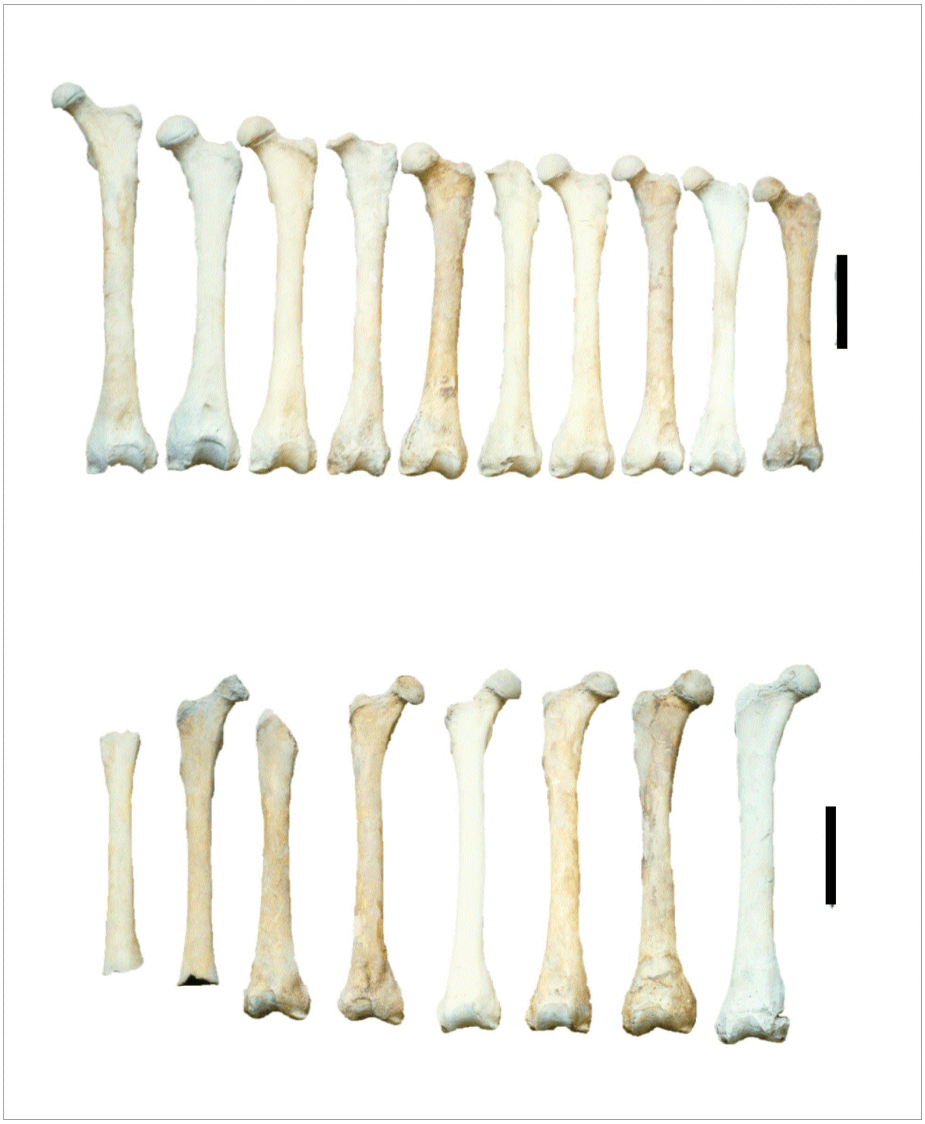

Figure 8. Brown bear gnawed femurs from MV4. Scale = 10 cm.

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