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The Cave bear (*Ursus spelaeus*) scratches in Chauvet cave (Ardèche, France): identification, 3D mapping and paleoethological consideration from wall marking activities

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Abstract

The Chauvet Cave in south-eastern France (Ardèche) is world famous for its exceptionally well-preserved rock art (paintings, engravings), dating exclusively from the early Late Paleolithic (32-36,000 years). This cavity also contains evidence of occupation by cave bears (*Ursus spelaeus*), on the floors (bones, beds, footprints) and walls (scratches, bäremschliffen). Based on both 3D scans and photogrammetric datasets of floors, walls and vaults in several galleries, a morphometric analysis is currently carried out and proposes a new methodological approach for these paleobiological records (size and shape of scratches, individual measurements of scratches, inter-scratches measurements, density of scratches/m², height of ursid marks on the walls, variability, spatialization). First results suggest a high density of scratches in deeper galleries of the cavity (between 80 and 160 meters from the Paleolithic entrance). Scratch sizes reveal intense wall marking activities by cave bear cubs and adult females and in a much less proportion by adult/large males.

Résumé

Les griffades d'ours des cavernes dans la grotte Chauvet (Ardèche) : identification, cartographie 3D des activités marquées sur les parois et considérations paléolithologiques. La grotte Chauvet Pont d'Arc dans le sud-est de la France (Ardèche) est mondialement célèbre en raison de l'exceptionnelle préservation des représentations artistiques (peintures, gravures), datées exclusivement du Paléolithique supérieur ancien (32-36.000 ans). Cette grotte renferme également des indices de fréquentation par les ours des cavernes (*Ursus spelaeus*), sur les sols (ossements, bauges, empreintes) et les parois (griffades, polis de parois). Reposant à la fois sur un scanage 3D des sols, parois et voûtes ainsi que sur des relevés photogrammétriques, une analyse morphométrique des griffades a été engagée pour différentes galeries et propose une nouvelle méthode d'étude pour ces enregistrements paléobiologiques (forme et taille des griffades, mesures de griffades isolées, mesures inter-griffades, densité de griffades/m², hauteur des marques ursines sur les parois, variabilité et répartition spatiale). Les premiers résultats suggèrent une forte densité de griffades dans les galeries les plus profondes de la cavité (entre 80 et 160 mètres de l'entrée paléolithique). La taille des griffades traduit un marquage intense des parois par les ours et les adultes femelles et dans une mesure bien moindre par les ours des cavernes mâles.

1. Introduction

The caves occupied by cave bears (*Ursus spelaeus*) are very common in Europe (Figure 1). While the abundance of bone remains is the main criterion for characterizing a cave bear denning site, many (unexcavated) cavities contain evidence of long-time occupation by the species, based on footprints, beds/nests, scratches and polished walls. All these "traces of life" or bioglyphs (VIEHMANN, 1973, 1987) are particularly important in the extra-Alpine regions, especially in France and Spain. Identified from the beginning in Paleolithic rock art researches (BREUIL, 1908; CARTAILHAC, 1908), these paleobiological records constitute an original support in

studies on the behavior of cave bears but also on the interactions with human/predator occupation of deep caves during the Late Paleolithic, many decorated caves yielding this pattern of painted/scratched walls. The Chauvet Pont d'Arc cave, which contains the oldest directly dated Palaeolithic paintings in Europe (QUILES *et al.*, 2016), is also one of the most important cave bear sites due to the abundance and excellent preservation of ursid bioglyphs in all the accessible galleries. This article reminds the evolution of research and techniques on this topic as well as observations concerning the main bioglyphs (i.e., scratches).

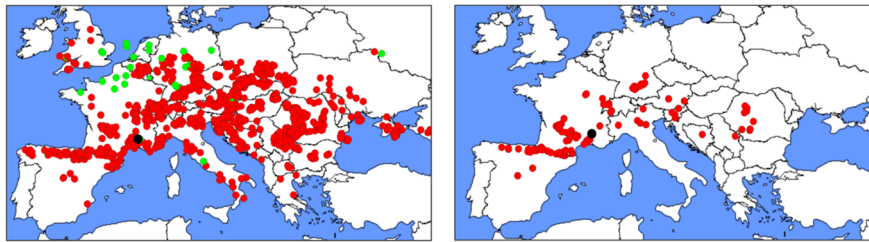


Figure 1: Geographical distribution of European cave bear sites (left) and sites yielding cave bear scratches and/or beds (right). Red circles = caves; green circles = fluvial sites; black circle = Chauvet Pont d'Arc cave.

2. Material and method

The conservation of floors and walls leading the current research in the cavity, all analyses are based on pictures, photogrammetry and high-resolution 3D scanning of areas/galleries yielding these kinds of paleobiological records. Descriptions of the scratches are based on previous works in Palaeolithic rock art (BREUIL, 1908; CARTAILHAC, 1908; VIALOU, 1979; LORBLANCHET, 1981; LADIER *et al.*,

2003a,b) and on a methodological work made by caving research (MOURET, 1988). Based on these data, a protocol for analysis/measurements of scratches is carried out, taking into consideration the body size of extant carnivores, the morphometry of cave bear scratches and also their topographical context.

3. Results

The Chauvet Pont d'Arc cave contains 3703 cave bear bones (including 190 skulls = MNI; FOSSE & PHILIPPE, 2005), more than 300 beds/nests and numerous scratched walls (Figures 2-4). This major site for Paleolithic rock art is also an excellent observatory for the study of cave bear behavior. Modern or Pleistocene carnivores using caves are fossorial animals (mustelids) or species occupying the galleries as dens (canids, felids, hyenids, ursids). Their biological marks on floors result from digging (burrows, nests) and displacement (footprints) and from rubbing along walls (displacement into the darkness) and from wall marking activities (scratches as behavioural or "technical" marks). Available measurements on extant carnivores suggest a correlation between their body length, shoulder height and weight (Table 1) and, consequently, provide indications for specific identification of bioglyphs visible in cavities (i.e., height of wall rubbing, height of wall marking); markings (tree trunks) by extant ursids (brown bear, *Ursus arctos*; american black bear, *Ursus americanus*) standing upright on their rear legs correspond to $x \sim 1.5$ of their body length. In Chauvet Pont d'Arc cave, a very clear dichotomy of wall surface state appears between the floor up to 120-130 cm

height with the upper parts including both Paleolithic paintings and cave bear scratches (Figure 2).

	body length (cm)		weight (kg)		shoulder height (cm)	
	F	M	F	M	F	M
<i>M. marmota</i>	47-60		2-4	3-8		
<i>H. cristata</i>			2-4		20-25	
<i>M. martes</i>	40-45	48-53	0,48-0,85	0,67-1,05	15	
<i>G. gulo</i>	62-67		9-30	8-13	40-45	
<i>M. meles</i>			8-11	8-13	30	
<i>A. lagopus</i>	50-65	55-75	4-6		30	
<i>V. vulpes</i>	58-80		3,5-8	5,5-10	35-40	
<i>C. alpinus</i>			10-13	15-20		
<i>C. lupus</i>	87-117	100-130	18-62	20-80	65-80	
<i>L. lynx</i>	80-130		18-25		60-75	
<i>P. pardus</i>	110-140	130-190	35-50	45-85	45-60	50-70
<i>P. leo</i>	158-192	172-250	120-180	180-240	107	123
<i>C. crocuta</i>			40-85		70-92	
<i>U. arctos</i>	95-150		60-200	100-680	90-110	
<i>U. maritimus</i>	170-250	190-290	150-500	300-800	120-150	
<i>U. spelaeus</i>			180-230 (225)	354-634 (418)		
			142-986 (244)	224-1316 (319)		

Table 1: Main measurements of extant carnivores (and large rodents). Bodymass estimation for cave bear. F = female; M = male.

The lower part of the walls is cleaned (no clay), and « polished » by the cave bear furs whereas in the upper parts, scratches appear, either isolated or on large surfaces mixed or not with engravings/paintings.

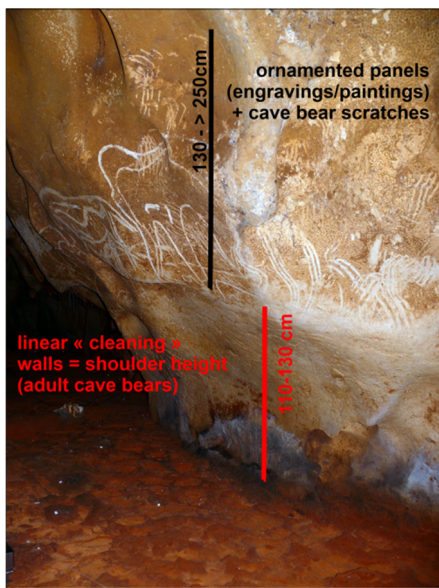


Figure 2: Example of wall modification resulting from human and cave bear activities in the Chauvet Pont d'Arc cave (Cheval gravé, Salle Hillaire). Picture: Ph. Fosse.

Overall, the paintings/engravings or ornamented panels are adjacent to the scratched areas (concentration of human and animal activities on the same walls). The superimposition of human and animal marks is documented in the cave in an exceptional way and frequency and is at the origin of the systematic work on the characterization of cave bear scratches. By considering several variables from the contextual and ichnometric data (Table 2), several observations were made:

1. topographical context	
1.1	distance from the entrance
1.2.1	scratches n°(1-x)
1.2.2	scratched zone (Length x width)
1.3	height from the floor (min/max)
1.4	presence of polished walls (Bärenschliffen)
1.5	archaeological (rock art) context and position (under/over paintings)
2. scratches	
2.1	number of digits (1-5)
2.2	morphology of digits (parallel, oblique, horizontal ...)
2.3	upper extremity of digit : with/without circular depression (claw)
2.4	length max
2.5	width max
2.6	width inter-scratches
2.7	width digit (1-5)
2.8	morphology and section of digit (deep, flat, sharpen)

Table 2: Variables retained in the study of cave bear scratches in Chauvet Pont d'Arc cave.

1) although a few scratches were found near the paleolithic entrance area (~30 m) lit by daylight, the first isolated and small scratches (< 10 cm wide) appear beyond 60 meters (galerie du Cactus, end of the Salle des Bauges); then, scratches areas become much more common and are very abundant up to the deepest galleries (galerie des Croisillons, Le Belvédère, La Sacristie), more than 150/200 meters from the Paleolithic entrance;

2) The scratches generally consist of 4 or frequently 5 sub-parallel digits (distinction with scratches led by digitigrad carnivores), oblique and vertical on flat walls, sinuous on the

reliefs, in response to the force produced by the front legs scratching the limestone (Figure 3).

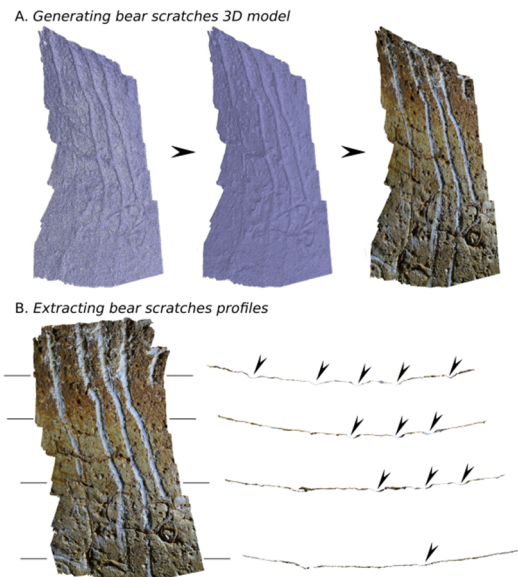


Figure 3: Example of photogrammetry and cross-section of cave bear wall marking scratches from Chauvet Pont d'Arc cave. Pictures : Ph. Fosse & J.B. Fourvel.

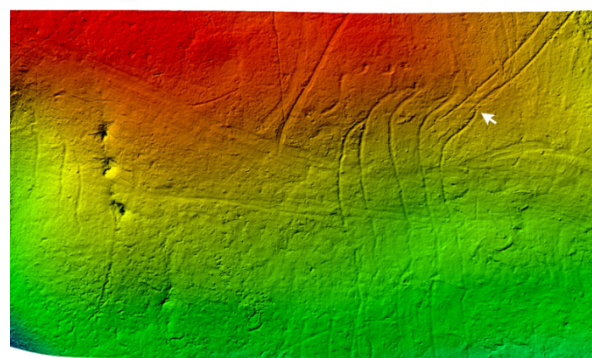


Figure 4: Example of a photogrammetric analysis of cave bear scratches covering a cave lion dorsal painted line from Chauvet Pont d'Arc cave (Salle du Fond). Pictures & scans : F. Baleux, C. Fritz, A. Laurent, T. Sagory, G. Tosello.

These traces, more dynamic (zigzagging), produce wall marking modifications that are comparatively wider than scratches made on vertical walls. The measurements recorded in several galleries (Salle Hillaire, Galerie des Croisillons, Le Belvédère) show two main scratch size

classes: one grouping scratches of small size (width = 7-10 cm for 5 digits) positioned between 140 and 170 cm from the floor: the other much wider scratches (12-15 cm width) found at these same heights (1.70 m) and up to 2.50 meters from the floor. These two categories are sometimes associated on the same flat walls or scratched panels, but often dissociated (gallery entrances, deep and narrow walls in the niches, low vaults for the former, large regular surfaces on high flat walls for the latter) correspond on the one hand to cave bear cubs and on the other hand to adult females. This sexing is based on the general growing pattern noticed on modern brown bears (BLANCHARD, 1987); very

4. Conclusions/perspectives

Cave bear scratches are still poorly studied. However, many decorated caves contain paintings/engravings and these bioglyphs (Aldène, Altamira, Bara Bahau, Baume Latrone, Chauvet, Coliboaia, Cognac, Cussac, Ekain, Escabasses, Font de Gaume, Gargas, Isturitz, Letzetxiki, Le Portel, Marsoulas, Massat, Pech Merle, Rouffignac, Les Trois Frères, Tuc d'Audoubert...). Studying cave bear scratches is important from a chronological point of view (succession of ursid occupations, alternation Humans/cave bear wall

rare isolated scratches (Salle Hillaire, Salle du Crâne, Salle du Fond) have been identified at a height of nearly/over 4 metres on the highest walls and attest to the presence of males;

3) The 3D scans suggest that scratches have a shallow U-section (see Figure 3);

4) the photogrammetric analysis of scratches appears to be a useful tool to precise the chronology of wall marking traces, both by Humans and cave bear and reveal unique examples of mixed decorated panels resulting from wall sub-diachronic modification by Aurignacians and cave bear (see Figure 4).

marking), paleobiological (ethological significance of such and specific intense wall marking) and taphonomic (identification/evolution of biotic and abiotic traces on walls). Digitized cave bear scratches from Chauvet Pont d'Arc cave will allow to propose an ichno-morphometric corpus on these bioglyphs (variability, size and shape, topography) and criteria for distinguishing those ursid wall marking traces from human-origin ones and from other extinct and extant carnivore species as well.

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