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SAME BUT DIFFERENT: 20,000 YEARS OF BONE RETOUCHERS FROM NORTHERN ITALY. A DIACHRONOLOGIC APPROACH FROM NEANDERTHALS TO ANATOMICALLY MODERN HUMANS

Abstract

Bone retouchers are common in Middle and Upper Palaeolithic contexts. In northern Italy, these tools are abundant in final Mousterian sites. In order to pinpoint the possible cultural similarities or differences in the use of these artefacts, the present study analyses the bone retouchers of two nearby sites: Fumane and de Nadale caves. Fumane cave is a large cavity where various techno-complexes have been identified. For the purposes of this research, we analysed more than 300 pieces from the Discoid, Levallois, Uluzzian and Proto-Aurignacian layers. De Nadale cave is a single occupation site attributed to the Quina Mousterian. This site, although still under excavation, includes a high number of bone retouchers – about 200 elements have so far been identified. These elements were subjected to a multidisciplinary study, dealing with their archaeozoological, taphonomic, technological and functional characteristics. The faunal remains on which the retouch stigmata occur are similar, especially throughout the whole of the Fumane sequence, although the general faunal spectrum changes over time. Similarities are also found in the anatomical portions used as retouchers in the different techno-complexes under review. From a functional standpoint, the differences are more obvious. The intensity of use varies diachronically, as the number of identified stigmata changes from one techno-complex to the next. This contribution offers a wide overview of the cultural differences and similarities of this little elaborated tool from a chronological standpoint.

Keywords

Retouchers; Middle and Upper Palaeolithic; Northern Italy; Bone technology

Introduction

Bone retouchers have been sporadically identified in various archaeological assemblages, from the Lower Palaeolithic onwards (Blasco et al., 2013; Moigne et al., 2016; Serangeli et al., 2015; van Kolfschoten et al., 2015). They are more frequently recognised in archaeological sites related to the Middle Palaeolithic (Auguste, 2002; Mozota, 2007, 2009; Daujeard and Moncel, 2010; Jéquier et al., 2012, 2013; Mallye et al., 2012; Peresani et al., 2012; Daujeard et al., 2014) and the Upper Palaeolithic (Taute, 1965; Castel et al., 1998, 2003; Castel and Madelaine, 2006; Tartar, 2012a). Their eventual disap-

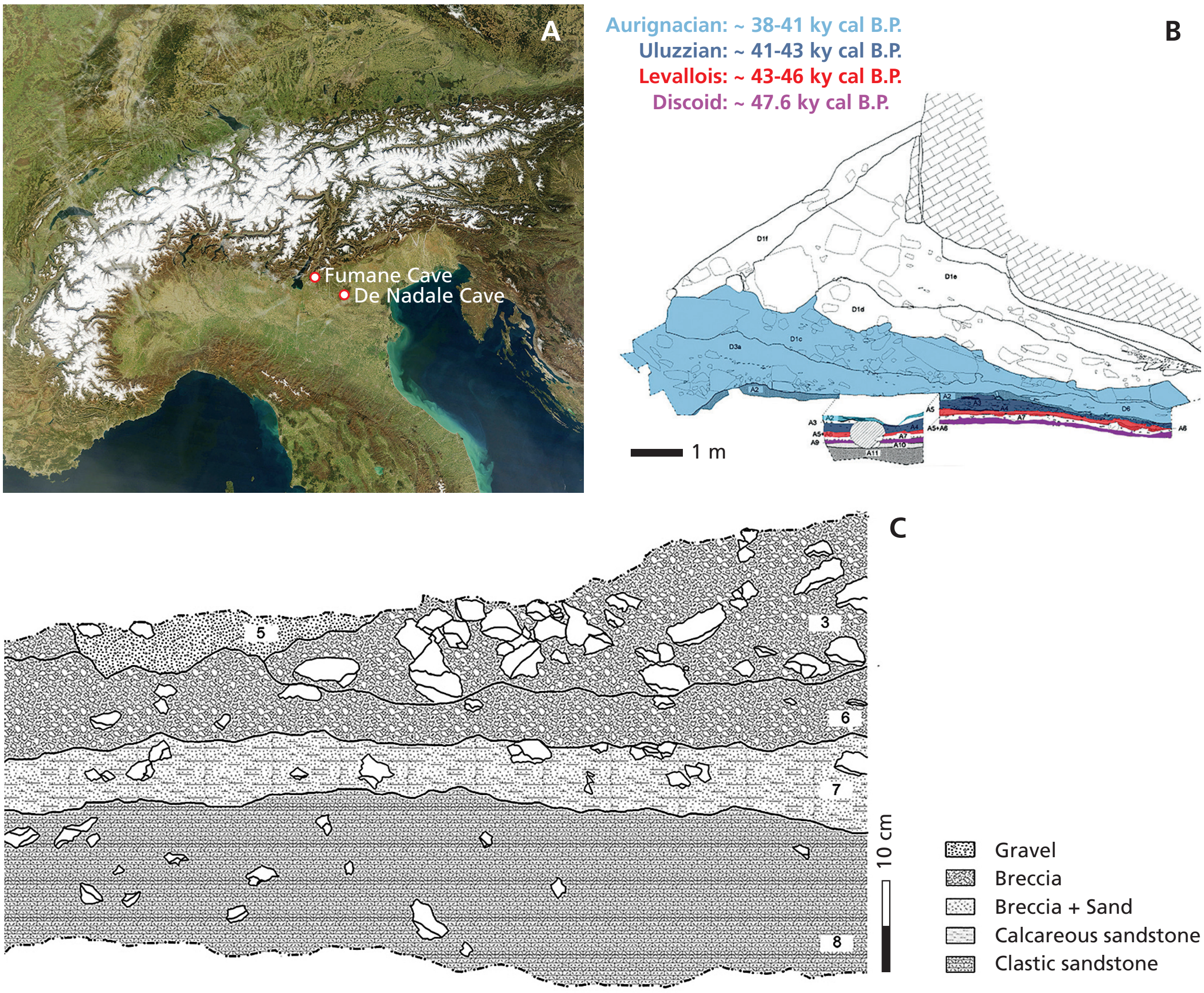


Figure 1 Geographical and stratigraphical context: a) position of Fumane and de Nadale caves in northeast Italy; b) stratigraphical context of Fumane cave; c) stratigraphical context of de Nadale cave.

pearance seems to coincide with the advent of the metal ages and the disuse of stone as a raw material to produce tools. From a geographical standpoint, and throughout this very long time span, retoucher assemblages are found in various contexts, from the Middle East to Russia (Filipov and Lioubine, 1993; Blasco et al., 2013), although Europe yields most of these finds (e.g., Taute, 1965; Patou-Mathis, 2002; Mallye et al., 2012; Daujeard et al., 2014), which is probably the result of bias related to research intensity.

These tools are mainly used during the final stages of the lithic *chaînes opératoires*, although some evidence suggests that during the beginning of the Upper Palaeolithic bone retouchers might have been used to detach bladelets from cores (Tartar, 2012b). Retouchers can be used through percussion or pressure (e.g., Bordes, 1961), although the former is more widely employed. Even though the different techniques can be difficult to extrapolate, Mozota (2013) demonstrated that "trihedral impressions", which we here refer to as punctiform impressions, were more often present when the bone shafts were used in pressure activities.

During the Lower and Middle Palaeolithic, bone is the osseous raw material almost exclusively used to retouch artefacts. From the Aurignacian *sensu lato* onwards, ivory and antler were used for the same purpose. Moreover, their symbolic value could vary with raw material. Castel et al. (2003) suggest ivory elements and ursid canines, in particular, could convey more significance than bone retouchers, as bone was more readily available among the food waste.

Although the available data on bone retouchers has exponentially increased during the last decade, quantitative and qualitative analyses from recently excavated sites and in the context of varied techno-complexes are still lacking. The current state of research is focused mainly on one techno-complex and does not evaluate bone retouchers in the context of large collections from different techno-complexes.

With this current research, we present the results of the study of several hundred bone retouchers from various techno-complexes at two archaeological sites in northern Italy: Fumane cave (Discoid, Levallois, Uluzzian and Aurignacian) and de Nadale cave (Quina) (Figure 1a). The main aim is to determine if discrepancies between the different techno-complexes can be identified from an archaeozoological or a technological standpoint. Moreover, the differences observed in the retouched lithic tools promote an interest in further investigating whether different types of retouch observed on the blanks induced different stigmata on the bone surfaces, possibly implying different uses for and management of these little elaborated tools.

Fumane cave

Fumane cave is located at the foot of the Lessini Mountains (see Figure 1a). The site represents one of the most important stratigraphic sequences of Mediterranean Europe, owing to its rich archaeological record and optimal preservation conditions. The sequence covers more than 80,000 years of hominin prehistory, from the Mousterian to the Last Glacial Maximum (Martini et al., 2001; Broglio et al., 2003; Fiore et al., 2004; Peresani et al., 2008; Higham et al., 2009). For the purposes of this research, we studied the bone retouchers from the Discoid (A9), Levallois (A5+A6 and A6), Uluzzian (A3-A4) and Proto-Aurignacian (A1-A2) levels (Figure 1b; Peresani, 1998; Broglio et al., 2005; Peresani et al., 2013; Tagliacozzo et al., 2013; Romandini et al., 2014; Peresani et al., 2016).

Through the sequence, a shift can be observed in the spectrum of animal species represented (Cassoli and Tagliacozzo, 1994; Fiore et al., 2004; Tagliacozzo et al., 2013; Romandini et al., 2014). During the late and final Mousterian, the main taxa represented are red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*), with a sporadic presence of giant deer (*Megaloceros giganteus*) and large bovids (*Bos/Bison* spp.). Starting from the Uluzzian, cervids decrease in favour of medium-sized bovids, mainly represented by ibex (*Capra ibex*). The same trend can be observed for chamois (*Rupicapra rupicapra*), which, although present during the Mousterian, clearly increases in the Aurignacian with the onset of a colder phase in the region leading up to the harsh conditions associated with Heinrich Event 4, as suggested by the oscillation recorded within the small mammal assemblages (López-García et al., 2015).

Although some rare carnivore gnawing marks are observed on the bone surfaces, anthropic activities are responsible for the faunal accumulation. Frequent impact notches, percussion cones as well as many striae attributed to the various phases of the butchery process have been identified in all layers considered. Moreover, burnt and calcinated bone fragments have also been recorded. The prominent anatomical elements represented are the hind and front limbs, especially diaphyses, although axial remains are also present (Cassoli and Tagliacozzo, 1994; Romandini et al., 2014).

The Discoid flint industry in layer A9 is typically represented by thick flakes, pseudo-Levallois points, backed flakes with a thin opposite edge, polygonal and triangular flakes, scrapers, points, and denticulates (Peresani, 2012). The lithic evidence of the A5-A6 stratigraphic complex shows close similarities with A11, A10V, and A10 based on the extensive use of a blade-focused, unipolar Levallois technology (Peresani, 2012). Levallois blades, blade-flakes and other by-products were shaped into simple or convergent scrapers and points. The Uluzzian in layer A3-A4 is a flake-dominated industry featuring Levallois technology in the initial phase (layer A4), but is replaced in A3 by more varied flaking procedures and light increase in bladelets and flake-blades. Sidescrapers, points, splintered pieces, backed knives and other items compose the tool-kit (Peresani et al., 2016). The Proto-Aurignacian lithic implements are blades, bladelets and microbladelets shaped into common tools like end-scrapers, burins and retouched blades, as well as points and Dufour bladelets using marginal abrupt retouch (Broglio et al., 2005).

De Nadale cave

The de Nadale cave is a small cavity located in the Berici Hills, in the province of Vicenza (see Figure 1a), whose excavation is still ongoing. Situated at 50 m ASL, the entrance faces south at the base of a small cliff. The first excavation was conducted in 2013 in order to remove a superficial disturbed layer (1Rim) off the excavation area. Since then, successive excavation campaigns have unearthed a single archaeological layer (Unit 7) containing a large amount of bone fragments and lithic implements (Figure 1c). The archaeological material is either very scant or altogether absent in the other layers, except Unit 6, where some archaeological remains were discovered in a channel dug by a fossorial animal. One date obtained on a *Megaloceros* molar attributes the formation of Unit 7 to 70 ± 1 ka minimum age, placing the occupation of the cave to at least the onset of MIS 4 (Jéquier et al., 2015).

Out of the 319 identified faunal elements in Units 6 and 7, the most frequent species is giant deer (*Megaloceros giganteus*), followed by red deer (*Cervus elaphus*) and large bovids (*Bos/Bison, Bison priscus* and *Bos* cf. *primigenius*). To a lesser extent, roe deer (*Capreolus capreolus*), chamois (*Rupicapra rupicapra*) and ibex (*Capra ibex*) have also been identified. Carnivores, in particular ursids, are sporadically present. The faunal association indicates a relatively open environment, characteristic of a cold-temperate climate with boreal forests and steppes.

The preservation of the faunal remains is excellent, except for the presence of natural alterations due to root dissolution, manganese oxide staining, concretions and rare corrosion notches. Superficial modifications attributed to rodents, carnivores and exfoliation are extremely rare. On the contrary, the proportion of burnt and calcinated fragments, as well as the frequency of anthropic modifications identified on the osseous surfaces, is high.

The lithic industry is technologically and typologically Quina, with cores, cortical and ordinary flakes, and several scrapers of different types made of non-local flint due to its absence in proximity of the site (Jéquier et al., 2015).

Materials and methods

Bone retouchers from Fumane and de Nadale caves were identified and registered during excavations or, in case of small bone fragments, were retrieved during sieving. The pertinent pieces were usually identified without the aid of a lens. However, in some cases, a Leica S6 D Greenough electronic microscope (magnification 6.3x-40x) was used to confirm and photograph the stigmata. In both sites, the excellent preservation conditions allowed for the conservation of the osseous surfaces. A few post-depositional modifications have been ascribed to concretions or manganese oxide staining, and rarely to root dissolution. Very few bone retouchers are burnt or calcinated, most of which are very small fragments.

Each retoucher has been determined taxonomically and anatomically with the reference collections present at the Section of Prehistoric and Anthropologic Sciences of the University of Ferrara and the National Museum of Prehistory and Ethnography "L. Pigorini" (Rome) by M. Romandini and A. Livraghi.

Since the pieces observed in other contemporaneous contexts have smaller dimensions than those under study here (Cassoli and Tagliacozzo, 1994; Tagliacozzo et al., 2013; Romandini et al., 2014; Livraghi, 2015), the authors include red deer (*Cervus elaphus*) in the large-sized ungulate category, along with giant deer (*Megaloceros giganteus*), bovid (*Bos/Bison*) and elk (*Alces alces*). Ibex (*Capra ibex*) was considered as a medium-sized animal, along with roe deer (*Capreolus capreolus*) and chamois

(*Rupicapra rupicapra*). When taxonomic attribution was not possible, the bone shaft was categorised by its thickness: large, medium-large, medium, medium-small and small sized.

At Fumane cave, a total of 363 retouchers were recovered from the four techno-complexes (**Table 1**). The Uluzzian retouchers are fewer in comparison with the other groups, probably due to the more sporadic visits to the cave during that period. The proportion of complete and fragmentary elements is similar throughout the sequence.

The de Nadale cave retoucher inventory currently contains 204 elements (see **Table 1**). This number is likely to increase as the excavations continue. Contrary to the Fumane cave, the proportion of fragmentary elements is much higher at de Nadale cave. A possible reason could be that the elements discovered until now are situated near the entrance of the cave and were subject to greater post-depositional perturbations. Since the cave is a single occupation site, we grouped the pieces from the reworked unit with those found *in situ*.

The maximum length, width and thickness (mm) and the weight (g) of the shafts were measured. The latter is only mentioned cursorily since post-depositional processes lead to weight loss; thus, the current weight does not correspond to the original weight of the retoucher.

We then proceeded to the analysis of the technological stigmata on the bone surface, counting each trace according to its category, describing the position of the area of occurrence, its orientation with respect to the longitudinal axis of the fragment, density of stigmata and the number of functional areas, including their surface areas in mm². For all data, we first performed descriptive statistics, including arithmetic mean, median and standard deviation. Next, we conducted a set of univariate and bivariate statistical analyses on the measurements, in particular the lengths-to-width ratios, using Microsoft Excel 2013 and Past 3.10 software. Since the data available for the Uluzzian layers only consisted of ten entries, we did not take them into account for the statistical analysis. We performed a Shapiro-Wilk normality test to ascertain the normal distribution of the data. The results demonstrate that our available data on the length-to-width ratios were not normally distributed. As a result, we performed a Kendall's tau correlation test on the lengths vs. widths and lengths vs. thicknesses of each complete retoucher, separated by techno-complex.

We also studied the type of fractures present on the bone shafts in order to determine whether the elements were obtained from fresh or dry bones (Villa and Mahieu, 1991; Outram, 2001; Wheatley, 2008). This analysis was useful to understand if the elements were to be considered as complete or fragmentary, and to determine, when possible, if the fractures were post-depositional or linked to deliberate retouch. Fragmentary elements were not included in the metric analyses. We identified a fragmentary element based on the presence of fresh fracture margins and/or where the fracture crosses one or more of the use areas.

The stigmata have been subdivided into four categories (**Figure 2**), partially following Mozota's classification (2007, 2009):

1) Punctiform impressions: sometimes referred to as "trihedral", these impressions are the most frequent stigmata in all techno-complexes;

Table 1 Inventory of complete and fragmented bone retouchers at Fumane and de Nadale caves.

	Fumane								de Nadale	
	Aurignacian		Uluzzian		Levallois		Discoid		Quina	
	NR	%	NR	%	NR	%	NR	%	NR	%
Complete	51	53.7	10	47.6	84	50.3	50	62.5	75	36.8
Fragment	44	46.3	11	52.4	83	49.7	30	37.5	129	63.2
Total	95	100	21	100	167	100	80	100	204	100

(NR = Number of Remains)

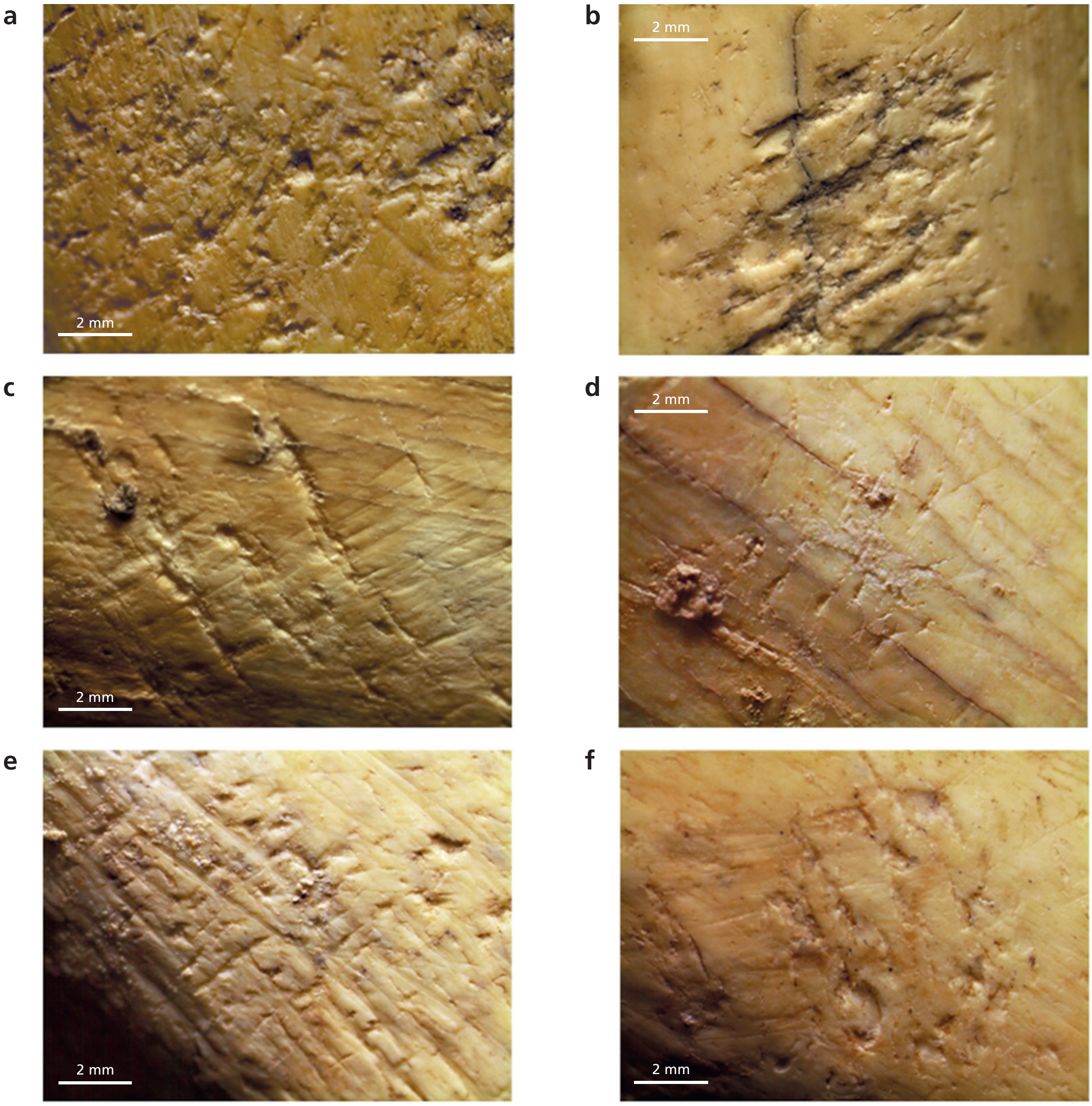


Figure 2 Types of stigmata: a) intersection between two use areas with punctiform and linear impressions vs. punctiform impressions; b) linear impressions and notch; c) linear impressions with scraping traces under the retouch-induced stigmata; d) linear impressions; e) linear and punctiform impressions; f) punctiform impressions and scraping.

2) Linear impressions: large and wide impressions, long and deep;
3) Retouch-induced striae: usually short, parallel, and shallower than linear impressions;
4) Notches: deep depressions due to repeated percussions on the bone surface. Features vary according to the freshness of the bone, force implied, the number of previous percussions, and the type of principal stigmata.

Results

Raw materials

Throughout the entire stratigraphic sequence at Fumane cave the edges of the osseous shafts used as retouchers show that their fracturing mostly occurred on fresh bones. This is demonstrated by the frequent occurrence of spiral fractures and smooth fracture margins (Villa and Mahieu, 1991; Outram, 2001; Wheatley, 2008), as well as by the recurrent presence of impact notches and negatives along the diaphyses. All the abovementioned fracture features are diagnostic elements for the recovery of bone marrow or other butchery processes.

For the Aurignacian at Fumane cave, out of the 51 complete elements, 22 bear traces of butchery, while two pieces have been successively used like a wedge, as some impact negatives attest (Tartar, 2012b). In the Uluzzian layers, out of the ten complete elements, only three bear clear signs of anthropic fracturing, while the retouchers assigned to Levallois context have fracture marks on 31 of the 84 complete elements. Finally, 34 of 50 complete pieces from Discoid context bear diagnostic fresh fractures. It should be noted that the incidence of butchery marks could be influenced by the degree to which some bones were used as retouchers, which could have led to overprinting of previous traces on the bone surfaces due to extensive use.

The faunal spectrum is fairly similar throughout the whole sequence: bones from *Cervus elaphus* are always, and by far, selected first, followed by *Megaloceros* (**Table 2**). Interestingly, the number of *Capra ibex* blanks used as retouchers in the Aurignacian layers is noticeably higher than in the Levallois techno-complex. In the Uluzzian and Discoid assemblages, no *Capra ibex* remains have been identified. The use of carnivore bones is rare, but is attested in the Levallois and Uluzzian layers.

Tibiae and femora are the most frequently selected anatomical portions (**Table 3**). Except for the Discoid layers, the proportions between these two elements are fairly similar. Aside from these elements, humeri and ulnae have often been selected. Retouchers on metapodials (both metacarpals and metatarsals) are also observed. Finally, one bear phalanx and a few mandible fragments were discovered in the Levallois (Jéquier et al., 2012, 2013) and Discoid layers. The absence of epiphyses, sometimes mentioned in other archaeological con-

Table 2 Faunal spectrum of the bone retouchers from Fumane and de Nadale caves.

	Fumane								de Nadale	
	Aurignacian		Uluzzian		Levallois		Discoid		Quina	
	NR	%	NR	%	NR	%	NR	%	NR	%
Ursus arctos	-	-	1	6.7	1	0.9	-	-	-	-
Ursus sp.	-	-	-	-	1	0.9	-	-	-	-
Carnivora	-	-	-	-	-	-	-	-	1	0.9
Cervus elaphus	43	55.1	10	66.7	73	68.2	33	62.3	26	24.3
Alces alces	-	-	-	-	-	-	1	1.9	1	0.9
Megaloceros giganteus	4	5.1	-	-	7	6.5	6	11.3	36	33.6
Capreolus capreolus	1	1.3	-	-	2	1.9	1	1.9	-	-
Cervidae, large	5	6.4	2	13.3	17	15.9	7	13.2	16	15.0
Cervidae, medium-large	-	-	1	6.7	1	0.9	-	-	-	-
Cervidae, medium	-	-	1	6.7	-	-	-	-	-	-
Bison priscus	-	-	-	-	-	-	2	3.8	5	4.7
Bos / Bison	7	9	-	-	1	0.9	-	-	21	19.6
Bovidae	1	1.3	-	-	-	-	-	-	-	-
Capra ibex	9	11.5	-	-	2	1.9	-	-	1	0.9
Rupicapra rupicapra	4	5.1	-	-	2	1.9	2	3.8	-	-
Caprinae	4	5.1	-	-	-	-	1	1.9	-	-
Total	78		15		107		53		107	

(NR = Number of Remains)

Table 3 Anatomical portions identified at Fumane and de Nadale caves.

	Fumane								de Nadale	
	Aurignacian		Uluzzian		Levallois		Discoid		Quina	
	NR	%	NR	%	NR	%	NR	%	NR	%
Antler	-	-	-	-	2	1.2	-	-	-	-
Horn core	-	-	-	-	-	-	-	-	1	0.5
Mandible	1	1.1	-	-	2	1.2	2	2.5	2	1.0
Scapula	1	1.1	-	-	-	-	-	-	1	0.5
Rib	3	3.2	1	4.8	3	1.8	-	-	3	1.5
Humerus	8	8.4	1	4.8	10	6.0	6	7.5	12	5.9
Ulna	8	8.4	1	4.8	12	7.2	7	8.8	16	7.8
Metacarpal	9	9.5	2	9.5	13	7.8	5	6.3	11	5.4
Phalanx	-	-	-	-	1	0.6	-	-	-	-
Pelvis	-	-	-	-	-	-	-	-	2	1.0
Femur	20	21.1	6	28.6	30	18.0	7	8.8	17	8.3
Tibia	16	16.8	3	14.3	39	23.4	17	21.3	37	18.1
Metatarsal	7	7.4	2	9.5	7	4.2	8	10.0	10	4.9
Metapodial	2	2.1	1	4.8	1	0.6	-	-	2	1.0
Indeterminate	20	21.1	4	19.0	47	28.1	28	35.0	90	44.1
Total	95		21		167		80		204	

(NR=Number of Remains)

texts – Mousterian (Auguste, 2002; Valensi, 2002; Abrams et al., 2014) or more ancient (Serangeli et al., 2015; van Kolfschoten et al., 2015) – can to a certain point be justified by the intense, intentional fragmentation of the faunal remains throughout the whole stratigraphic sequence. Moreover, these anatomical portions might have been used as fuel, as the burnt and calcinated part of the assemblage is rich in epiphyseal fragments (Romandini, 2012). Finally, at Fumane cave, these parts of bones were not selected for use as retouchers, as they do not fit the characteristics that the diaphysis offered, although, as previously stated, some sites do contain bone retouchers on epiphyses (Auguste, 2002; Abrams et al., 2014).

The number of fragmentary bone retouchers at de Nadale cave is much greater than at Fumane. Out of the 204 retouchers, 75 were considered complete; 60 of these bear traces of green bone fracture.

The faunal spectrum shows that the retouchers were mainly obtained from *Megaloceros giganteus* (33.6%) and *Cervus elaphus* (24.3%) bones (see **Table 2**). Bovids are also represented, in particular *Bison priscus* (4.7%). Medium-sized taxa are represented by only one fragment of ibex. A significant proportion (34.6%) of bone fragments could only be determined as ungulates. It was, however, possible to determine that they were mostly from large-sized animals. The taxonomic distribution of bones used as retouchers is proportional to that of the overall archaeozoological assemblage.

Diaphyses have been mainly selected. No epiphysis was identified as being used as a retoucher. The most frequent anatomical portion is the tibia (18.1%) (see **Table 3**). Femora (8.3%), ulnae (7.8%), humeri (5.9%), metacarpals (5.4%) and metatarsals (4.9%) have also been used, although to a lesser extent. Some other bone fragments have also been rarely used as retouchers: a scapula fragment, a possible horn core base and two pelvic fragments. Moreover, one of two mandible fragments was utilised with two teeth still embedded. As for the faunal spectrum, the number of undetermined elements is high (44.1%).

Table 4 Summary of descriptive statistics on retouchers from Fumane and de Nadale caves.

	Fumane			de Nadale
	Aurignacian	Levallois	Discoid	Quina
Length (mm)				
Mean	85.2	88.3	75.9	80.4
Stand. dev	19.6	21.8	19.6	19.3
Median	85	85.5	73.5	77
Width (mm)				
Mean	26.4	27.4	27.0	30.9
Stand. dev	8.8	6.0	6.5	7.5
Median	25	27	27	29
Thickness (mm)				
Mean	6.7	6.5	7.7	9.0
Stand. dev	2.3	2.0	2.4	2.8
Median	6	6	7	8

Table 5 Kendall's tau correlations between retoucher measurements at Fumane and de Nadale caves.

	Fumane			de Nadale
	Aurignacian	Levallois	Discoid	Quina
Length / Width	0.24882	0.19946	0.13583	0.24980
p	0.00997	0.00723	0.16396	0.00152
Length / Thickness	-0.02146	-0.04493	0.07456	0.12360
p	0.82410	0.54517	0.44486	0.11667

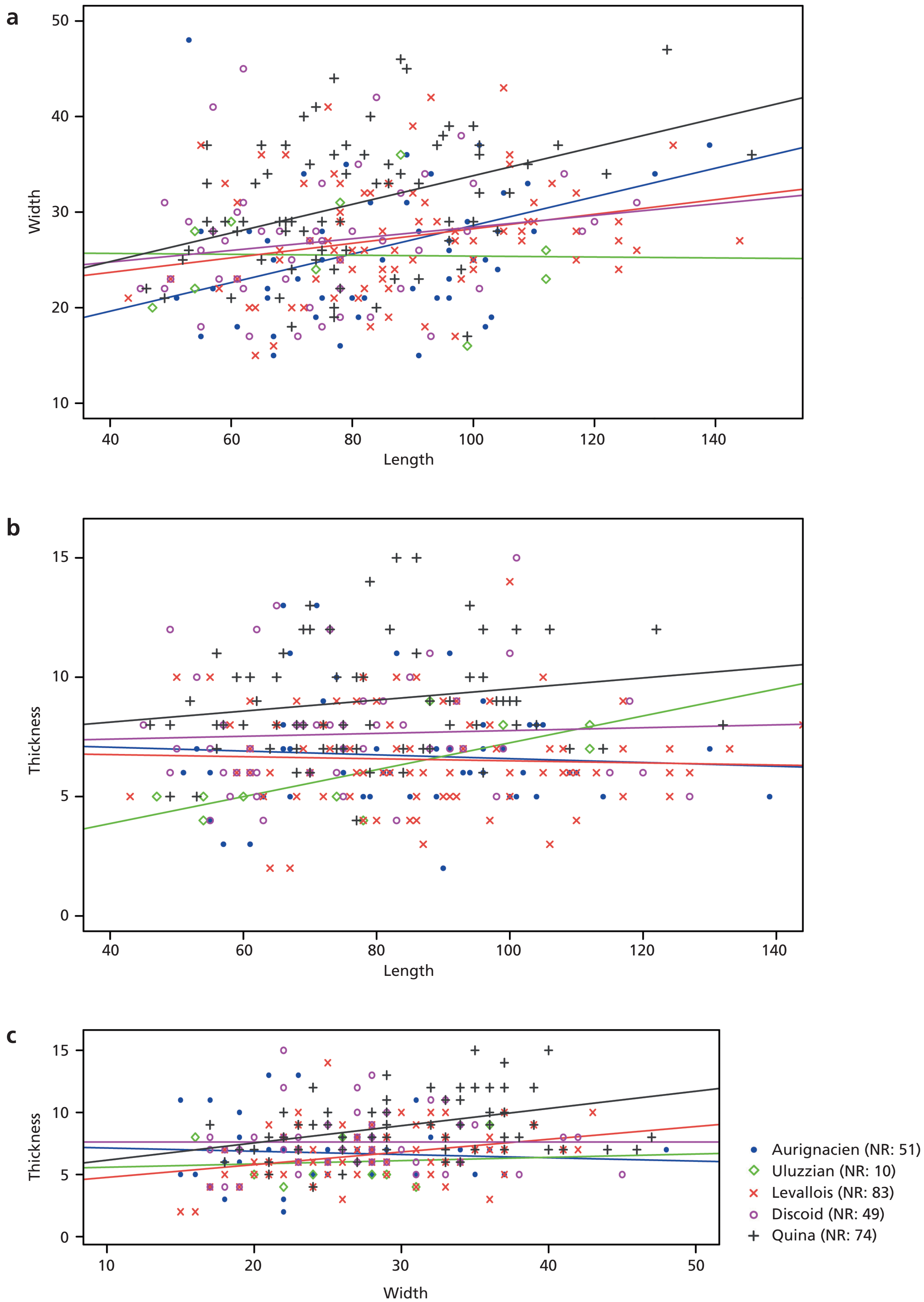
Metric data

The measurements of the complete retouchers vary appreciably throughout the whole sequence and within the techno-complexes at Fumane cave. However, the Levallois and Discoid retouchers show a remarkably similar correlation between their lengths and widths (**Figure 3a, Table 4**), meaning that the sizes are fairly similar between the two techno-complexes. The Aurignacian retouchers, however, are often longer than wide. Interestingly, the length-to-thickness (**Figure 3b, Table 4**) and width-to-thickness (**Figure 3c, Table 4**) ratios are fairly similar and show that the thickness of the bone retouchers does not dramatically vary according to their length or width. The importance of long, smooth retouchers was mentioned by Bourguignon (2001) for the organic retouchers used during the Quina retouch to enhance the knapper's precision.

Indeed, except for the Levallois techno-complex, where a correlation between the length-to-width ratio could not be made (**Table 5**), all techno-complexes show a very strong correlation between length and width of the shaft. The length-to-thickness ratio, cannot be correlated as such.

The general morphology of the bone retouchers is usually rectangular, elongated and flat. As far as weight is concerned, the Levallois elements are the heaviest, while the Aurignacian, Uluzzian and Discoid greatly overlap in weight (see **Figure 3d**). In all instances, however, most of the retouchers weigh between 10 and 20 grams.

At de Nadale cave, the retouchers are usually larger than those from Fumane cave; the shafts are longer, wider and thicker (see **Figure 3a-3c; Table 4**) than any of the techno-complexes present at Fumane. Moreover, the thickness of the elements is indicative of the fact that the fragments were derived from large-sized taxa, as they all exceed the mean thickness of the retouchers from Fumane. In contrast to the increase in size, the general morphology of the retouchers remains the same: they are typically rectangular in shape, longer than wide, possibly to allow for a good handle of the shaft. The length


a
Width
Length
b
Thickness
Length
c
Thickness
Width
Aurignacien (NR: 51)
Uluzzian (NR: 10)
Levallois (NR: 83)
Discoid (NR: 49)
Quina (NR: 74)

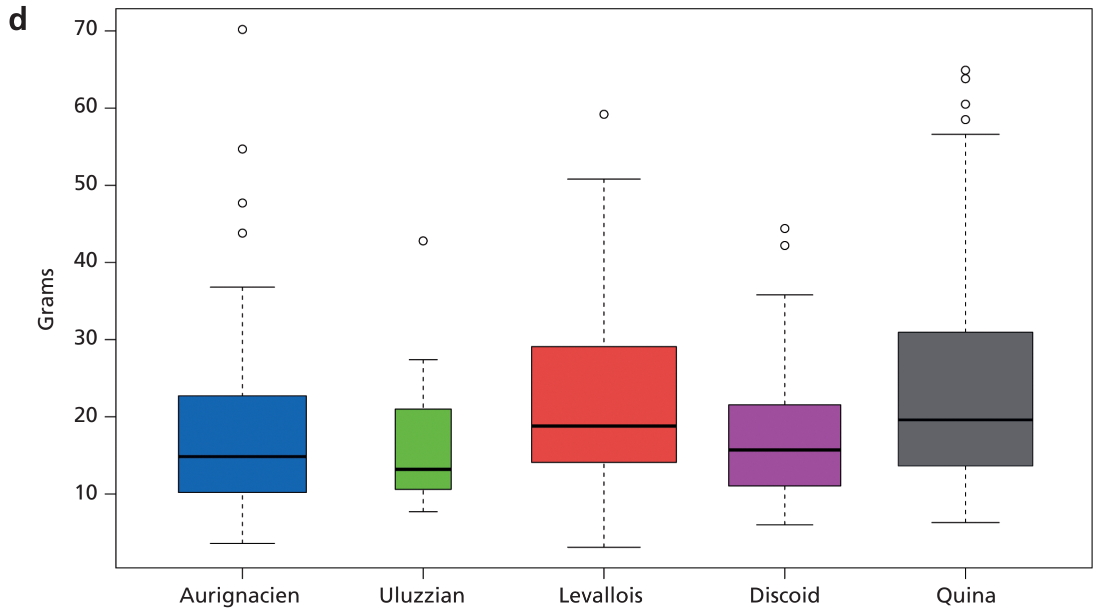


Figure 3 Metric data: a) length vs. width ratios; b) length vs. thickness ratios; c) width vs. thickness ratios; d) weight.

of the Quina bone retouchers is correlated to the width but not to thickness (see **Table 5**). In terms of weight, most of the retouchers weigh between 10 and 20 grams, although their range is large (see **Figure 3d**). The median weight (17 g) is similar to the Levallois retouchers from Fumane cave.

Functional areas and stigmata

Retouch-induced stigmata are usually grouped into small use areas. In all of the stratigraphic units at Fumane cave, the shafts have been used only once in more than 70% of the cases, with 72% for the Levallois, 76% for the Aurignacian and 86% in the Discoid layers. Some elements have up to three use areas. The Levallois layers contain more two-use area retouchers than the rest of the stratigraphic units, while the Aurignacian pieces have more of the three-use area retouchers. When two use areas are present, they are usually located on the two extremities of the bone shaft/fragment. In cases with three use areas, two often overlap, and can be separated by the different orientations of the stigmata or a distinction in the degree of use. It is interesting to note that in all cases, the second and/or third use area is always less intensively utilised than the first, i.e., there is always a "principal" use area and one or more "secondary" use areas (**Figure 4**).

All four stigmata categories are present on the Fumane cave retouchers: linear impressions, punctiform impressions, retouch-induced striae and notches. Punctiform impressions are predominant in all the techno-complexes, followed by linear impressions. Retouch-induced striae and notches (indicating intensively used areas) are rarely observed. In some cases, the stigmata seem to indicate that retouch activities were undertaken when the bones were semi-dry, as the observed stigmata are similar to those reported by Mallye et al. (2012).

The medium and medium-large-sized taxa show fewer stigmata than their large-sized counterparts in all techno-complexes, except for the Uluzzian, where no complete medium-sized elements were found. This has been observed for all four types of stigmata combined, as well as for each type individually.

The use areas of the Aurignacian and Discoid retouchers are reduced in comparison to those of the Levallois and Uluzzian (**Figure 5**). In particular, the use areas of the Discoid retouchers are smaller and are more homogenous. Their median use area

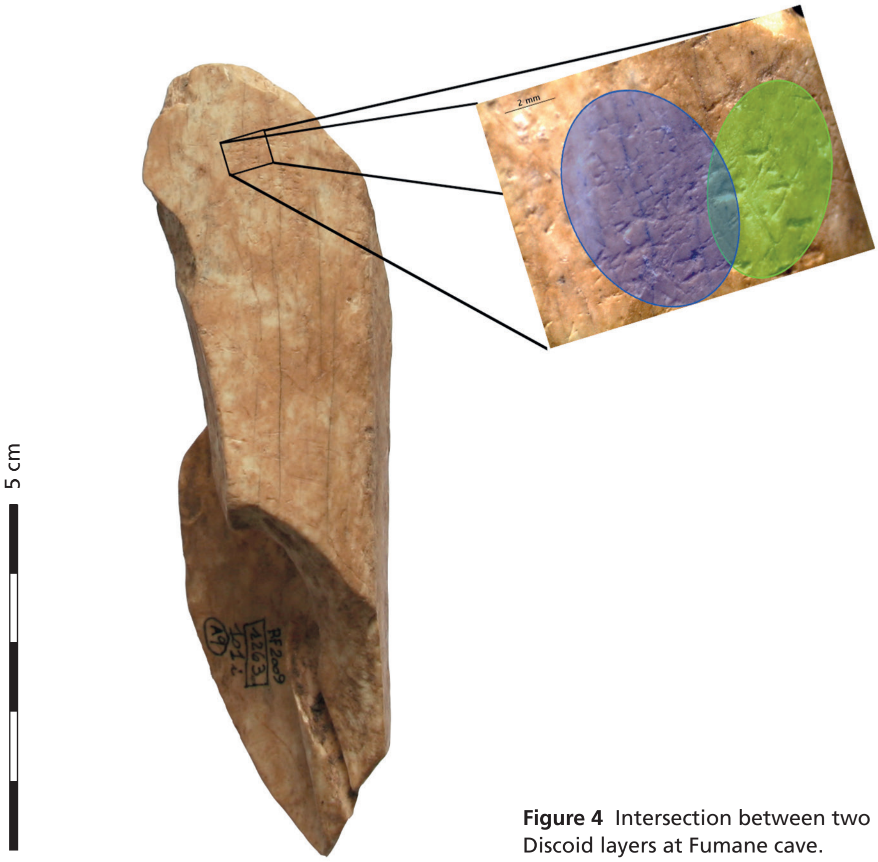


Figure 4 Intersection between two use areas on a retoucher from the Discoid layers at Fumane cave.

dimensions are also significantly lower than those of the retouchers from the other techno-complexes.

In rare instances, subtle surface scraping was observed underneath the stigmata. These striae are always oriented parallel to the long axis of the bone and cover an area slightly larger than that of the retouch-induced stigmata, but never cover the entire shaft fragment.

As is the case for Fumane, most de Nadale cave retouchers have one use area (54 elements in total, 72.0%), although elements with two (17; 22.7%) are relatively frequent. Retouchers with three use areas are rare (3; 4.0%). Finally, one element showed four use areas, accounting for 1.3% of the total.

The bone retouchers also bear all four types of stigmata in similar proportions to those from Fumane cave, although the punctiform impressions represent almost 70% of the total traces, followed by linear impressions, retouch-induced striae and, finally, notches. As with the different techno-complexes at Fumane cave, the morphologies of the stigmata seem to indicate a semi-dry state of the bones when they were used – the margins of some of the stigmata show the diagnostic micro-removals of the osseous surface.

Preliminary scraping has been observed on 21 pieces (28.0% of the total). As with Fumane cave, scraping does not cover the whole surface of the bone shaft, but systematically encompasses the use area.

The use areas occupy a surface between 8 and 840 mm², with a mean of 143 mm² (see **Figure 5**). In the vast majority of cases, the use areas are located in the central, apical part of the shaft; in some other instances, the stigmata are situated along the fractured margin of the shaft (**Figure 6**).

Discussion and conclusion

In a broad sense, the bone shafts that were selected for retouch activities present similar characteristics throughout all of the techno-complexes under re-

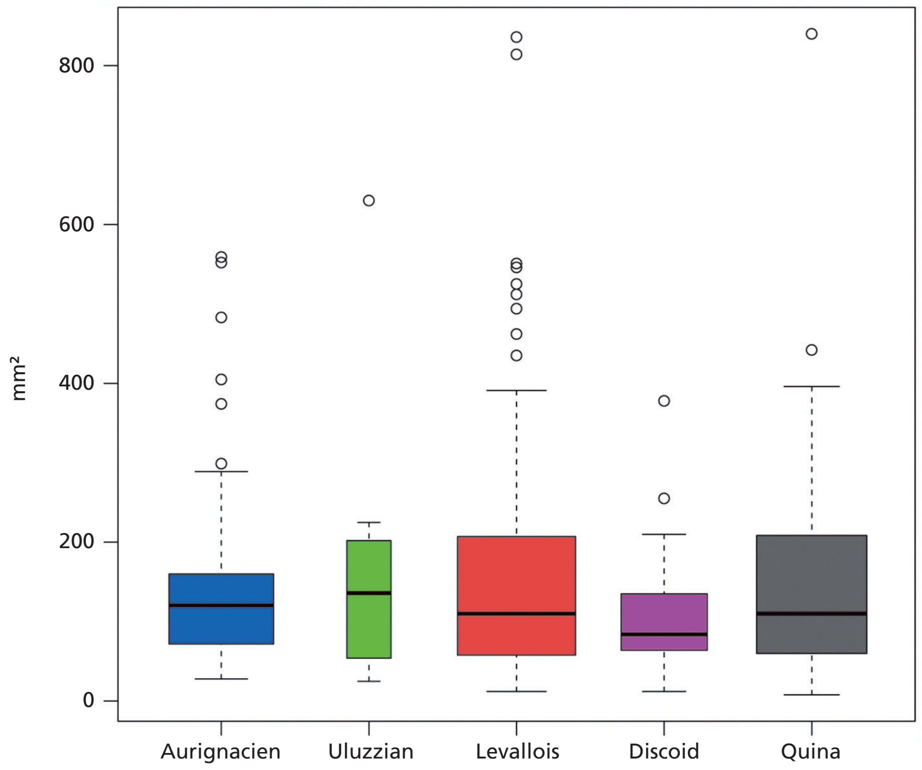


Figure 5 Surface areas (mm²) affected by stigmata on the retouchers of Fumane and de Nadale caves.

view. Their morphology is comparable: long, with relatively straight margins and flat surfaces. In all of the techno-complexes, bone fragments from the limbs have been preferentially selected. This is comparable to the general archaeozoological context, where a clear abundance of limbs has been noted. Although the dimensions of the bone retouchers are not particularly standardised, there is a positive correlation between the length and width in the retoucher sample. In other words, the longer they are, the wider they become. Moreover, one of the determining criteria seems to be mass, as most of the pieces weigh between 10 and 20 grams, irrespective of the techno-complexes. Mozota (2009), in his experimentation to understand the gestures and the processes necessary for the recovery of suitable bone shafts, concluded that the knappers were looking to obtain, in an intentional manner, retouch-adequate handles, with a preference for rather thick elements.

At Fumane and de Nadale caves, systematic fragmentation of long bones was aimed at the recovery of bone marrow. A generalised fragmentation scheme is evident at both caves and through all the techno-complexes: the epiphyses were detached through direct percussion, followed by the breaking of the diaphysis, also through direct percussion, at specific points of weakness. These observations on the selection of homogeneous pieces with similar characteristics must be considered in conjunction with the use of oddly-shaped skeletal elements (scapula, mandible, rib) and bones derived from medium-sized taxa. The choice of these less sturdy raw materials could be assigned to a different use, possibly for less intense *façonnage*. This could possibly be verified by the fact that large-sized bone shafts always bear more stigmata than smaller bone shafts.

Quina retouchers have bigger dimensions than all of the other techno-complexes. This can probably be attributed to the taxa selected at de Nadale cave (i.e., mainly giant deer, bison and red deer), which are larger in size than those from Fumane (mainly red deer). Moreover, the technological requirements

Figure 6 Retouch-induced stigmata on the margins of a bone shaft from the Levallois layers of Fumane cave.

for the removal of large and thick flakes (Bourguignon 2001; Mozota 2013) in shaping Quina scrapers, implies the need for more robust blanks in order to avoid fragmentation of the bone shaft. As far as the Quina lithic industry is concerned, the rarity of medium-sized taxa, as well as the greater thickness of the shafts at de Nadale cave, confirms the suggestions of Mozota (2009). In fact, it is interesting to note the similarities between de Nadale cave and Axlor, Spain (Mozota, 2009), as both assemblages are attributed to the Quina techno-complex, although geographically separated.

While the general faunal spectrum indicates a prevalence of ibex in the Aurignacian layers at Fumane cave, the main species used for the retouchers continues to be red deer, although ibex proportions are higher than in the other techno-complexes. This may indicate that instead of a random selection of diaphyses readily available on site, there was a marked preference for a given thickness. In particular, the thickness of the shaft seems to play an important role in choosing a bone with a suitable handle.

Compared to the other techno-complexes at Fumane cave or that of de Nadale cave, the Discoid elements stand out for their smaller use areas, lighter stigmata and overall lower number of traces. This is ascribed to the low rate of retouch of the lithic elements found in these Discoid layers (Peresani, 2012).

All four types of stigmata are present in all the techno-complexes, but in varying proportions, possibly as a result of the different uses for the retouchers. In any case, they follow the same pattern: punctiform impressions are predominant, followed by linear impressions, retouch-induced striae and notches. Punctiform impressions represent 69.9% of the total stigmata on the Quina retouchers, while the proportion of linear impressions in the Discoid technocomplex reaches 28.8%. However, these differences are not sufficient to accurately demonstrate that the gestures used in the retouch of one type of lithic industry lead to the formation of a specific pattern of stigmata unique to a particular techno-complex. In other words, the bone retouchers are not chronologically diagnostic at the current state of research and might never become a relevant marker for a chronological period.

The fact that the retouchers often bear only one use area is probably due to the abundance of available raw material on-site. This has been observed in various other archaeological sites (Mozota, 2009; Mallye et al., 2012; Tartar, 2012a; Jéquier et al., 2012; 2013; Daujeard et al., 2014). The intensity of use can vary extensively, which is confirmed in other works on the Quina techno-complex. Indeed, Verna and d'Errico (2011) and Mozota (2007, 2009) indicate an intense use of the surfaces of the bone fragments. Similarly, the Quina retouchers at de Nadale cave seem to have been repeatedly and intensively used. In their extensive experiments on retoucher stigmata, Mallye et al. (2012) demonstrated the correlation between the degree of use and the amount of stigmata and notches.

At de Nadale cave, where the stigmata are heavily impressed on the bone surface, the force necessary to create them was greater than in the other techno-complexes under review. Moreover, the invasive and abrupt retouch in the Quina industry calls for a more prominent use of force than what is required for the other techno-complexes. Since some of the lithic implements bear the diagnostic characteristics of a blow given through direct percussion with a soft, likely organic material, it is possible that some of the diaphyses may have been used as percussors and not only as retouchers (Jéquier et al., 2015). Further investigation is required in order to verify this hypothesis.

In the Aurignacian layers at Fumane cave, the re-use of tools as retouchers has been observed. This pattern is also seen in other Aurignacian contexts (e.g., Tartar, 2012a). In the case of awls, their use as retouchers is secondary to the primary function of the tool. However, two diaphyses have been used as retouchers and later as a wedge, similarly to that demonstrated by Tartar (2012b).

Finally, in all of the techno-complexes under review, the retouch-induced stigmata reflect repeated contact with flint and are consistent with the findings of Mallye et al. (2012). The punctiform impressions seem to correspond to a type of stigmata more frequently associated with flint than with other lithic raw materials. This result is not surprising since the main lithic raw material is flint at both Fumane (Peresani, 2012; Peresani et al., 2016) and de Nadale caves (Jéquier et al., 2015).

The preliminary scraping of the use areas has been identified at various archaeological sites, most notably in Spain (Mozota, 2009) and France (Mallye et al., 2012; Tartar, 2012a; Verna et al., 2012; Daujeard et al., 2014). These authors attribute this type of trace to the preparation of a clean surface, without organic residues such as sinew, meat or periosteum, in order to create a better contact surface with the lithic edge. However, we postulate that it could be the result of preparing of the margins of the lithic blank before retouch can start. Indeed, these scraping traces are quite localised and always occur underneath the retouch-induced stigmata. Moreover, experimental data (in preparation) indicates that the bone shaft can still be suitable as a retoucher even with the periosteum still present.

Organic retouchers are important for understanding the dynamics of the lithic *chaînes opératoires*. Moreover, the processes and gestures that lead to the fragmentation of the bones are central to comprehending the mechanisms of blank selection. Although little elaborated and generally without a determined form, these tools present similar characteristics throughout the different techno-complexes, chronologies and geographical areas covered by *Homo neanderthalensis* and *Homo sapiens*. They are all longer than wide, usually robust, easily held in the hand and have smooth surfaces. These features allow for a precise percussion against the lithic margin to be retouched.

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