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PALAEOLITHIC BONE RETOUCHERS FROM BELGIUM: A PRELIMINARY OVERVIEW OF THE RECENT RESEARCH THROUGH HISTORIC AND RECENTLY EXCAVATED BONE COLLECTIONS

Abstract

Since the first half of the 19th century, Belgium has provided a multitude of sites dating back to the Palaeolithic. These discoveries have contributed to the definition of the Palaeolithic and to the understanding of prehistoric people. This long tradition of research has resulted in the collection of thousands of bones that are increasingly the subject of extensive analysis, including the study of bone retouchers. At present, this research has identified 535 retouchers in various Belgian repositories. The tools come from different sites with highly variable and incomplete contextual information depending on their excavation history (e.g., Trou du Diable and the Caves of Goyet). In contrast, unit 5 of Scladina Cave constitutes a well-defined assemblage. Bones with fresh fracture patterns provide interesting technological data, such as a refitted cave bear femoral shaft that includes four retouchers. The use of cave bear bones for producing tools at Scladina Cave as well as retouchers made from Neanderthal remains from the 3rd Cave of Goyet gives rise to questions about the possible symbolic meanings attributed to particular species.

Keywords

Belgium; Middle Palaeolithic; Retouchers; Neanderthals; Cave bear; Refitting

Introduction

Belgian Palaeolithic research has its roots deep in the first half of the 19th century with the work of Philippe-Charles Schmerling, who found the first Neanderthal remains in Engis Cave in the early 1830s. This discovery was followed by the fieldwork of Édouard Dupont, who excavated dozens of caves between the 1860s and 1870s, and the investigations of Spy Cave between 1885 and 1886 by Marcel de Puydt and Max Lohest (Toussaint and Pirson, 2006; Toussaint et al., 2011). The attractiveness of cave sites was such that most were explored during the 19th century.

Since the beginning of research into Belgian prehistory, archaeologists have focused their attention on the lithic artefacts. They used typological and technological analyses to balance the lack of contextual information, sorting the material based on their cultural attributions (Ulrix-Closset, 1975). While chrono-cultural attributions of lithic artefacts is facilitated by this techno-typological approach,

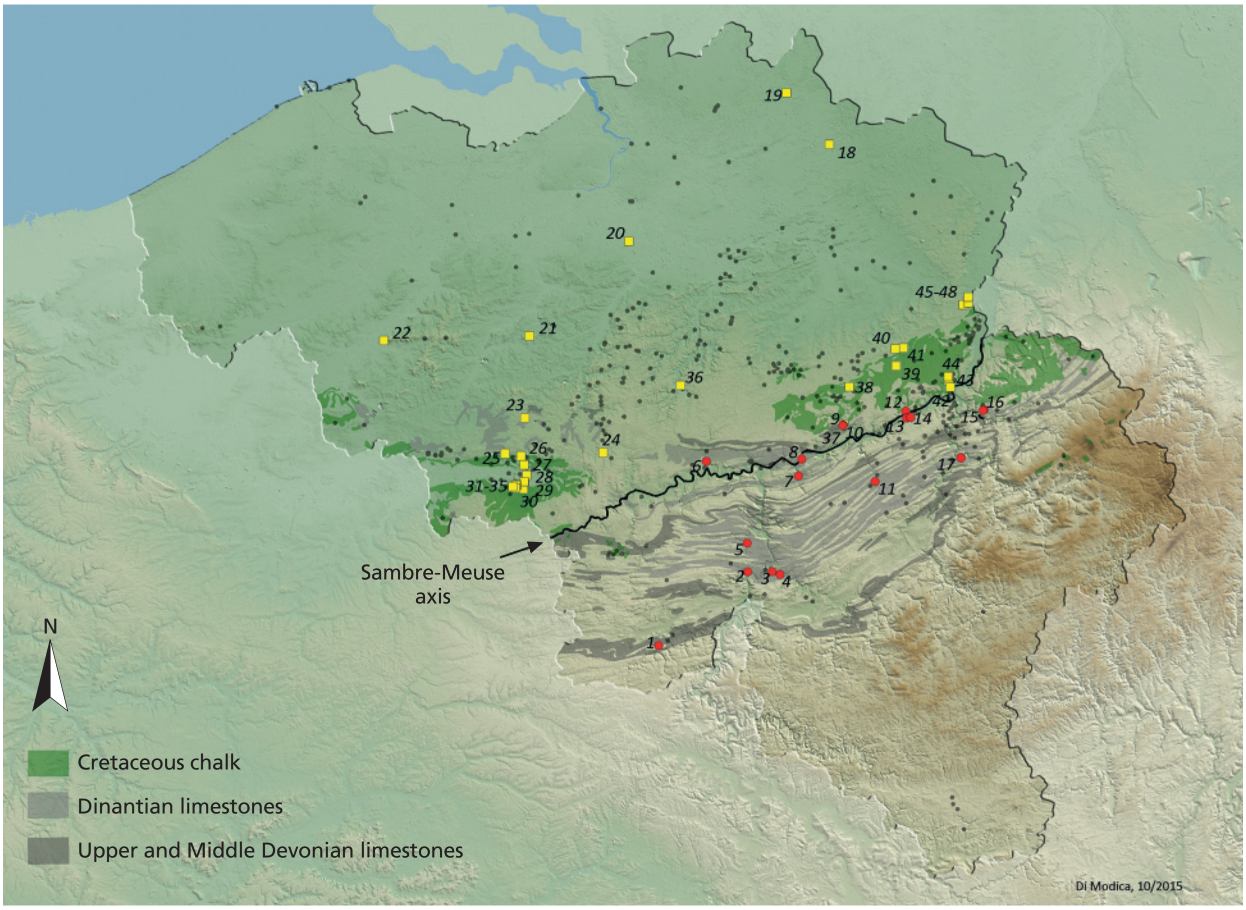

Figure 1 Distribution map of the Lower and Middle Palaeolithic locations in Belgium. Red circles are major cave sites; yellow squares are major open-air sites. Cretaceous chalk outcrops and Palaeozoic limestones outcrops redrawn after de Béthune (1954) (from Di Modica et al., 2016).

the absence of reliable contextual information makes the study of faunal remains much more difficult because no substantial distinction in the processing of animal carcasses can be established for the entire Palaeolithic timeframe.

It is for this reason that bone material from historic excavations has often been neglected. To date, there is no zooarchaeological synthesis across Belgian Palaeolithic sites, nor has there been a study of the bone retouchers. However, the existence of these tools has been known for over a century, since the beginning of Belgian Palaeolithic archaeology. In the late 19th century, Dupont (1871) described some bone fragments from Trou Magrite as intentionally broken with artificial blow marks and grooves. Even if they were not specifically called "retouchers", these characteristics fit with the modern descriptions of these types of tools (e.g., Patou-Mathis and Schwab, 2002; Mallye et al., 2012; Daujeard et al., 2014). The name "bone retoucher" does not appear until later; the first mention, so far established, comes from the catalogue of the International Exhibition of Paris edited by the Société d'Anthropologie de Paris (1889).

Unfortunately, early excavations were not conducted with the methods we aspire to now. Stratigraphic records, if they exist, are only schematic and often appear to be inaccurate, especially when considering the stratigraphic complexity documented recently in other cave sites, for example the Scladina Cave and Walou Cave sequences (Pirson, 2007; Pirson et al., 2008; Pirson et al., 2011; Pirson et al., 2012). For historic collections, original interpretations regarding the division of the deposits into different layers and their cultural attribution must be considered with caution. For example, a refitting was made on bones from the terrace of the 3rd Cave of Goyet, which included fragments coming from three different ossiferous levels observed during the excavation (Rougier et al., 2016). Another example comes from Spy Cave, where the 2nd and the 3rd ossiferous levels with "mammoth age-like faunas" are associated with Neolithic ceramic fragments (Fraipont, 1887).

On the basis of current knowledge, Belgium is scattered with at least 443 Middle Palaeolithic sites that are unequally distributed throughout the whole territory (**Figure 1**) and cover a long timeframe, from the early Middle Palaeolithic to the Middle/Upper Palaeolithic transition (**Figure 2**). The sites are of variable importance due to the quantity of the recovered artefacts and the quality of the asso-

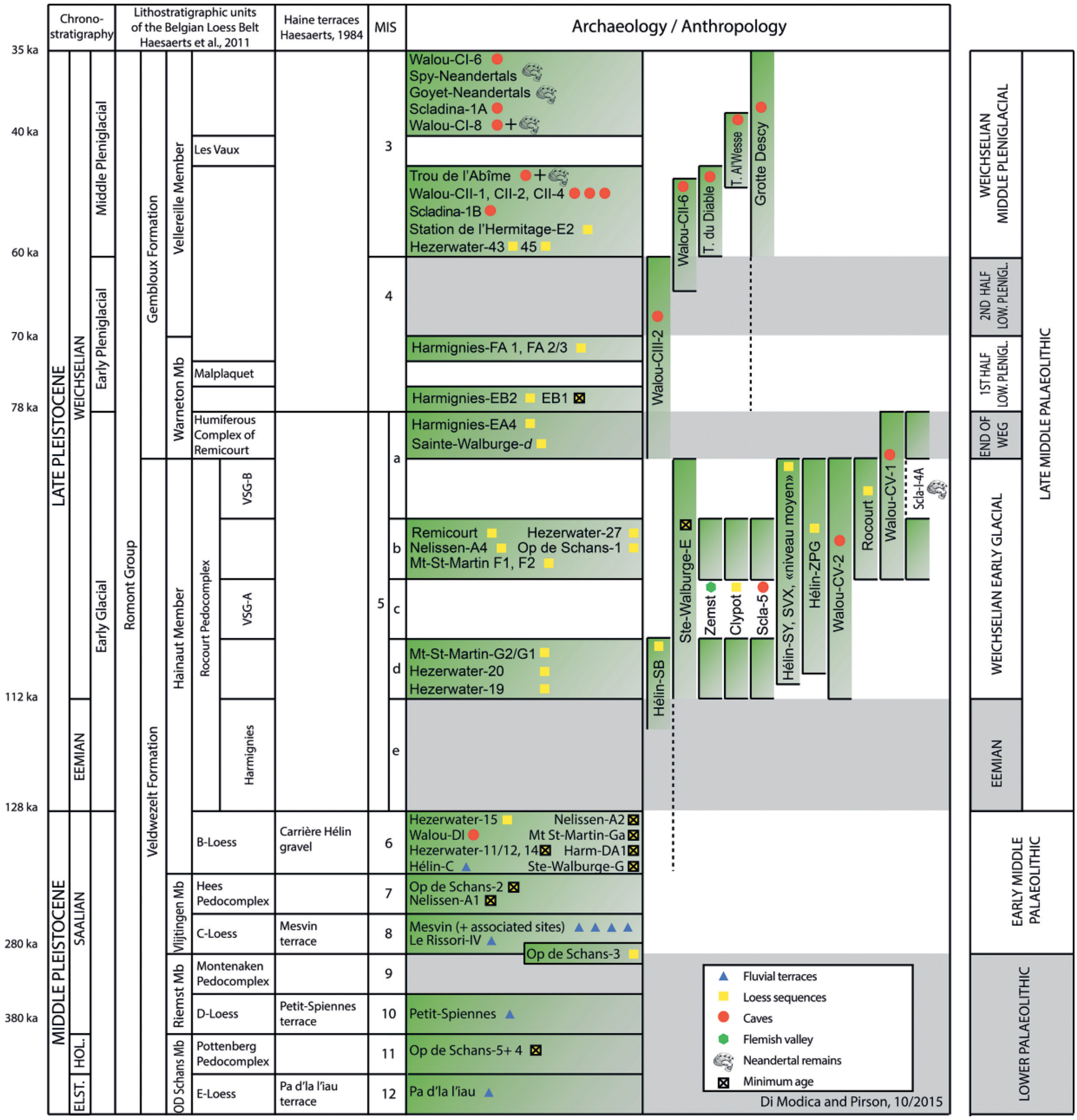

Figure 2 Chronostratigraphic distribution of the Middle Palaeolithic sites from Belgium (from Di Modica et al. 2016).

ciated contextual information (Di Modica et al., 2016). Almost 90% of the known sites are open air, but the vast majority of bone tools are found in cave deposits. The lack of bone tools discovered in Belgian open air sites is most likely related to the preservation conditions, as bones unearthed in such depositional environments are often very poorly preserved (Bosquet et al., 2009). Nevertheless, bone retouchers have been recovered in open air settings dating back at least to the early Middle Pleistocene in sites such as Boxgrove (UK; Roberts and Parfitt, 1999), Cagny-l'Epinette (France; Moigne et al., 2016) or Schöningen (Germany; van Kolfschoten et al., 2015).

Most of the studied faunal remains from the Belgian Palaeolithic were unearthed from cave deposits, which results in a better preservation of the faunal remains. To date, 46 caves have yielded Middle Palaeolithic artefacts, of which eight have delivered Neanderthal remains (Toussaint et al., 2011). All cave sites are located in the Devono-Carboniferous limestone of the Meuse Basin in southern Belgium.

The aim of the current project was to study the faunal remains collections from southern Belgium, first to identify and re-examine the bone retouchers described in the 19th century within the current methodological framework. Furthermore, species preference and the *chaîne opératoire* of retoucher production were investigated in order to shed light on patterns of Neanderthal behaviour.

Materials and methods

Twenty historical and recently excavated faunal collections were inspected in the course of this analysis

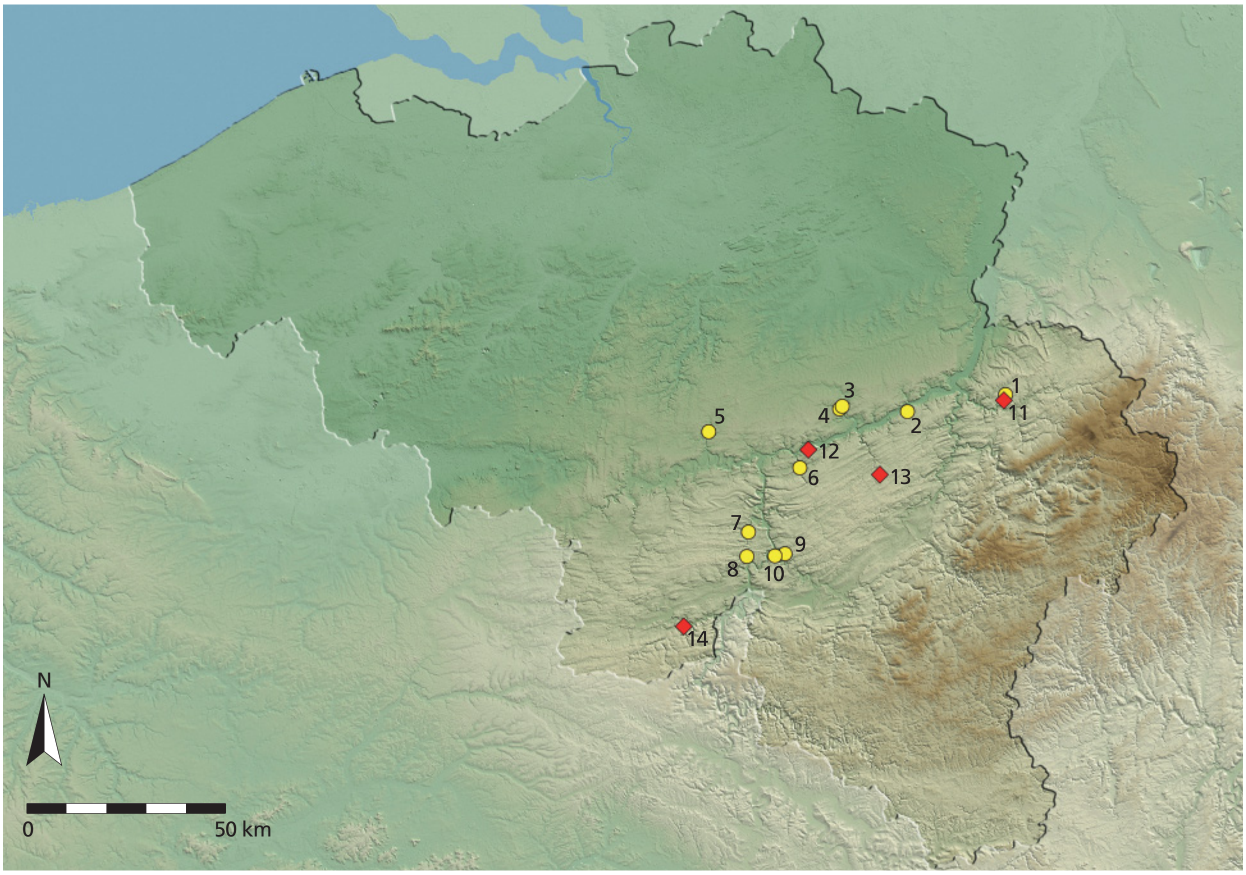

Figure 3 Location of the sites that have yielded bone retouchers. Historic collections are shown as yellow circles: 1. Bay Bonnet Cave (Fond-de-Forêt); 2. Palaeolithic site of Engihoul; 3. Hermitage Cave; 4. Docteur Cave; 5. Spy Cave (Bêtche Al Rotche); 6. Goyet Caves ; 7. Trou du Sureau ; 8. Trou du Diable ; 9. Trou du Renard ; 10. Trou Magrite. Modern collections are shown as red diamonds: 11. Walou Cave; 12. Scladina Cave; 13. Trou Al'Wesse; 14. Trou de l'Abîme.

Table 1 Chronological data available for Belgian sites with bone retouchers.

Site	Units	MIS	Sample-ID[1]	Uncal date	+ σ	- σ	References
Spy Cave (Betche-aux-Rotches)	1st-3rd Ossiferous Levels	3	**GrA-32617**	30170	160	150	Semal et al., 2013
Trou Magrite	1st-4th Ossiferous Levels	3	**Beta-419008**	39080	280	280	Smolderen, 2016
			Beta-419007	39690	320	320	
Trou du Renard	E	3	**OxA-26773**	40800	1300	1300	Dinnis and Flas, 2016
	B?		**OxA-26311**	>48400			
Scladina Cave	T-RO	3	GrA-48408	34000	2050	2760	Bonjean et al, 2013
			GrA-47939	38470	350	310	
			OxA-23790	40800	1300	1300	
Goyet, 3rd Cave	1st-3rd Ossiferous Levels	3	GrA-54024	36590	300	270	Rougier et al., 2016
			GrA-60018	37250	320	280	
			GrA-54257	37860	350	310	
			GrA-60019	38260	350	310	
			GrA-46170	38440	340	300	
			GrA-46178	39140	390	340	
			GrA-54022	39870	400	350	
			GrA-46176	40690	480	400	
			GrA-46173	41200	500	410	
Trou Al'Wesse	16-17	3	OxA-7497	41100	2300	2300	Otte et al., 1998
Trou de l'Abîme	II	3	GrA-40444	44500	1100	800	Toussaint et al., 2010
Trou du Diable	1st-3rd Ossiferous Levels	3	-	-	-	-	Di Modica et al., 2016
Engihoul, Palaeolithic site	Typical Mousterian	3	-	-	-	-	Di Modica et al., 2016
Walou Cave	CV-2	5d-5a	-	90300	4600	4600	Debenham, 2011
Scladina Cave	5	5d or 5b	-	-	-	-	Di Modica et al., 2016
Goyet, Salle du Mouton	Mousterian	-	-	-	-	-	
Trou du Sureau	3st-4th Ossiferous Levels	-	-	-	-	-	
Docteur Cave	-	-	-	-	-	-	
Hermitage Cave	-	-	-	-	-	-	
Bay Bonnet Cave	(2nd Level)	-	-	-	-	-	

[1] bold identification numbers denote samples taken directly from bone retouchers

(**Table 1; Figure 3**). From thousands of bone fragments originating from extensive prehistoric excavations conducted during the 19th century, bone tools were extracted and examined for their use as retouchers.

In order to overcome uncertainties related to the methodology of historical excavations, specifically the lack of chronostratigraphic context, several radiocarbon dates have been carried out directly on bone retouchers from Spy Cave (Semal et al., 2013), Trou Magrite (Smolderen, 2016) and Trou du Renard (Dinis and Flas, 2016) (see **Table 1)**. As part of our NERC research project, an extensive sampling programme has been undertaken to date bone retouchers, but the results are not yet available.

For the recently excavated collections, stratigraphic observations were more accurate and gave precise information regarding chrono-cultural attributions. With the exception of sedimentary units DII and DI of Walou Cave, dated to at least MIS 6 (see **Figure 2**; Draily, 2011; Di Modica et al., 2016), and the lithic industry recovered in the deposits of la Belle Roche, dating from at least 500 ka (Cordy, 2011), none of the sedimentary cave deposits in southern Belgium have yielded conclusive evidence of a hominin occupation before MIS 5d. Considering this, it is likely that most of the faunal material studied can be attributed to deposits ranging between MIS 5d and MIS 3.

The identification of bone retouchers was first based on macroscopic observations followed by comparisons with experimental material and an extensive literature on Middle and Upper Palaeolithic tools (Patou-Mathis and Schwab, 2002; Mallye et al., 2012; Abrams et al., 2014b; Daujeard et al., 2014). All bone fragment surfaces were analysed under a Leica S6D stereomicroscope with magnification ranging between 6.3x and 40x. This allowed for preliminary identifications of anthropogenic modifications, such as grooves and pits associated with a knapping activities. Finer details, such as the shape of the use marks and the presence of lithic chips embedded within the bone matrix, were analysed using a LEO1455VP Scanning Electron Microscope (SEM). Images were captured at high lateral resolution (3 nm) with a magnification ranging from 40x to 600x.

Energy-dispersive X-ray (EDX) spectroscopy was used to identify the nature of the lithic fragments embedded in the scores. This technique can distinguish siliceous material from concretions, adhering sediment and bone splinters on the basis of their chemical compositions and fracture characteristics (Bello et al., 2013). The EDX microanalysis determined the elemental composition of surface inclusions using an Oxford Instrument X-Max 80 Silicon Drift Detector and INCA software.

Figure 4 Significant loss of bone material on the use surface causes by an intense use of a retoucher from Scladina Cave (Sc84-E16-48). Picture A. Mathys; © RBINS.

Site	N retouchers	%
MODERN COLLECTIONS		
Scladina Cave, Unit 5	27	5.0
Scladina Cave, Unit T	1	0.2
Trou Al'Wesse, Layers 16/17	11	2.1
Trou de l'Abîme, Unit II	3	0.6
Walou Cave, Layer CV-2	1	0.2
HISTORIC COLLECTIONS		
Bay Bonnet Cave	13	2.4
Betche-aux-Rotches (Spy Cave)	5	0.9
Docteur Cave	1	0.2
Engihoul, Palaeolithic Site	48	8.9
Goyet, 3rd Cave	30	5.6
Goyet, Salle du Mouton	59	11.0
Hermitage Cave	1	0.2
Trou du Diable	295	55.1
Trou du Renard	3	0.6
Trou du Sureau	3	0.6
Trou du Magrite	34	6.4
TOTAL	535	100

Table 2 Total bone retouchers for each site. An additional 400 bone tools from the Trou Magrite historical collection have been identified by E.-L. Jimenez and A. Smolderen but are not yet analysed in detail.

Figure 5 (A) Retoucher made from a horse tooth (Trou du Diable © RBINS). (B) from a limb shaft fragment (Scladina Cave, unit 5).

The retoucher use areas provide information related to the intensity of use based on the concentration of marks: isolated, dispersed, concentrated or concentrated and superposed (Mallye et al., 2012). In some cases, prolonged use of the tools has generated deep alterations and a significant loss of bone material from the cortical surface (**Figure 4**). The retoucher use area locations on the bone fragment were described using the categories and nomenclature proposed by Mallye et al. (2012): apical, centered, covering or lateral.

Other anthropogenic modifications were documented, including cut marks, scraping marks and bone breakage patterns. Characterization of cut marks was based on several features, such as v-shape, internal microstriations, shoulder effects and hertzian cones (Shipman and Rose, 1983; Andrews and Cook, 1985; Behrensmeyer et al., 1986; Greenfield, 1999; Bello and Soligo, 2008; Bello, 2011; Bello et al., 2011). Patterns of bone fracture were characterized using several frameworks to identify the agents responsible for breakage (Binford, 1981; Blumenschine and Selvaggio, 1988; Chase, 1990; Villa and Mahieu, 1991; Lyman, 1994). Bone freshness was assessed based on fracture shape (Lyman, 1994).

Results and discussion

Detailed analysis of the collections led to the discovery of 535 retouchers originating from 14 cave sites (**Table 2**). Preservation quality varied between sites, but overall preservation was excellent. Regardless of the preservation conditions, the number of retouchers is highly variable from one cave site to another, ranging from one to nearly 300 pieces.

So far, the faunal collection of Trou Magrite has not been subjected to detailed study by the author, but about 400 additional tools been recovered from the material collected by Dupont (E.-L. Jimenez, personal communication). If further analysis can confirm these identifications, it would increase the corpus of bone retouchers in Belgian collections to almost 900.

Figure 6 The proximal end of this retoucher was intentionally reshaped (Scladina Cave, Unit 5).

Figure 7 The distal end of this small retoucher features a bend-breaking pattern, suggesting breakage during use (Scladina Cave, Unit 5).

Blanks

Horse upper molars or premolars are documented as retoucher blanks in a few sites, such as Trou Magrite, Trou du Diable and Trou de l'Abîme (**Figure 5A**). The use marks are concentrated on the proximate surfaces, where one tooth contacts a neighbouring tooth. The only site that has yielded these peculiar blanks within a reliable chrono-cultural attribution is Trou de l'Abîme (see **Table 2**; Toussaint et al., 2010; Abrams and Cattelain, 2014). At present, in Belgian sites there is no further evidence of retouchers made from other herbivore or carnivore teeth, such as those from La Ferrassie, France (Castel et al., 2003), or in the Swabian Jura (Conard and Bolus, 2006).

Most often limb bone shaft fragments were used as tool blanks, selected for their thickness, length, mass, shape and raw material (bone versus tooth). The length ranges from 3.5 cm to 15 cm; 70% fall between 8 cm and 12 cm, with a mean of 9.5 cm for the whole sample. The thickness measured at the use area fluctuates between 0.4 cm and 2.4 cm (mean = 1.05 cm).

All retouchers bear fractures and evidence of percussion notches and flaking. Helical and spiral fractures are abundant. These patterns reinforce assumptions about the systematic use of fresh bone fragments. It also appears that bones were fractured prior to their use as retouchers (see refitting section below). Nevertheless, surface damage on dry bones has also been observed, but likely relates to the use of picks during excavation or damage from storage and handling.

In some cases (e.g., Scladina Cave and Trou du Diable), blanks show evidence for having been reshaped (**Figure 6**). The presence of very small retouchers, where the distal part was broken by bending, suggests that some tools may have been broken during use (**Figure 7**).

Unlike older sites, such as Schöningen where a complete bison radius and complete horse metacarpals were used as tools (van Kolfschoten et al., 2015), there was no evidence for the use of complete bones at the Belgian sites. This difference is probably related to the technological process. Com-

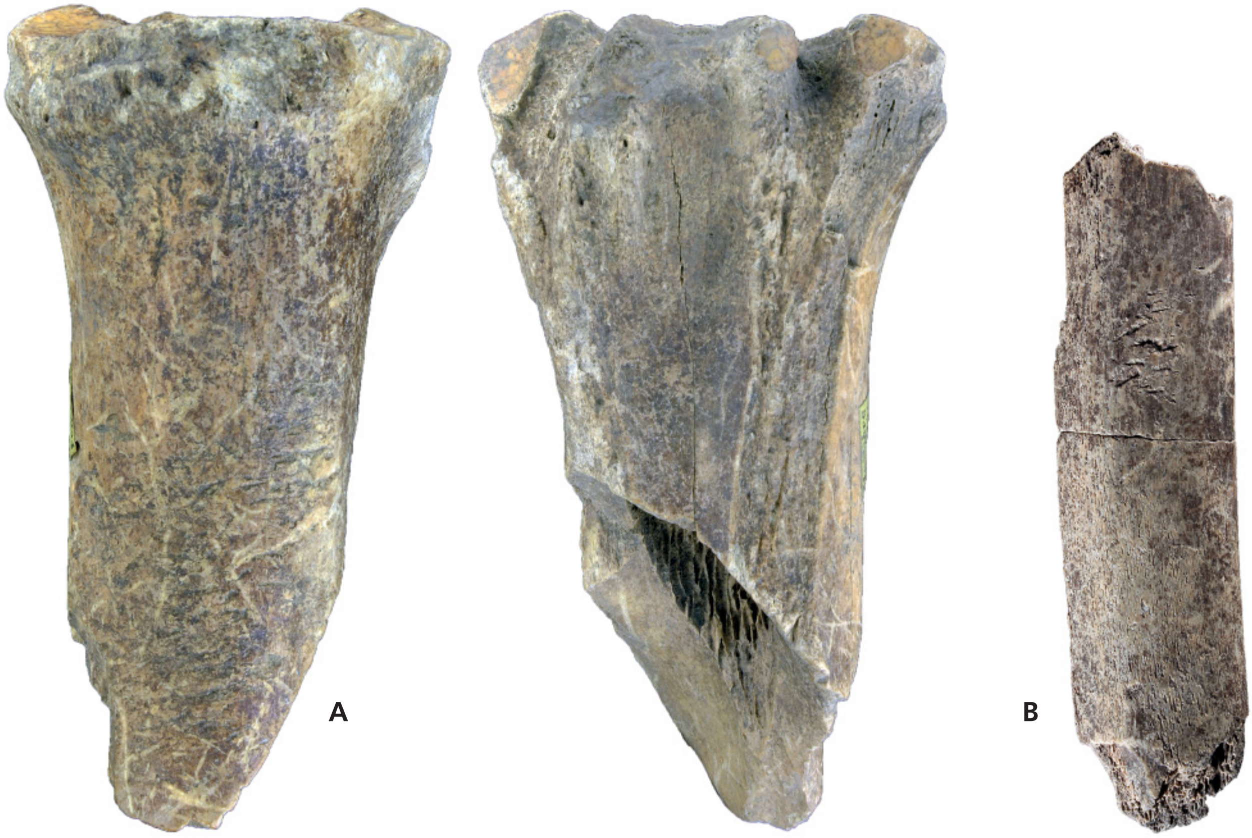

Figure 8 (A) Retoucher made from a complete proximal section of a horse metatarsal (Trou du Diable © RBINS). (B) From a rib fragment (Scladina Cave, unit 5).

3 cm

plete bones seem to provide increased accuracy as anvils or soft hammers, while shaft fragments seem to be more efficient for shaping lithic edges. Moreover, limb bone fragments with the entire original circumference preserved were rarely used (Figure 8A). The use of flat bones, such as ribs, was even more rare (Figure 8B).

Use Marks

The various use marks are the result of contact between bone (or other osseous material) and the hard edges of a stone tool. Scores (elongated grooves) and pits (small depressions) are the most common damage and are often concentrated in the same area. The pits are evidence of punctiform penetration into the bone matrix. The scores feature two opposing sides: one side is characterised by micro-cracks and a crushing pattern generated by the penetration of the stony edge into the cortical bone; the opposite side presents internally perpendicular micro-striations resulting from the sliding of the lithic edge on the bone surface (Figure 9A). Together, both sides of the score form a mouth-like shape.

Scores are oriented transversely relative to the long axis of the bone blank, but sometimes perpendicular. Longitudinal scores have been documented to appear during the Aurignacian with the development of tools made from laminar blanks (Schwab, 2002; Tartar, 2012). The orientation of the scores may be an indication of lithic technology; the dominance of transverse scores indicates that many of the retouchers described here were used on flakes rather than on blades. This is an interesting possibility, but may not be conclusive because the transverse orientation of scores persists throughout the Upper Palaeolithic.

The accumulation of use marks on a surface creates a so-called "use area". Most often, this area is located near the edge of the bone fragment (see

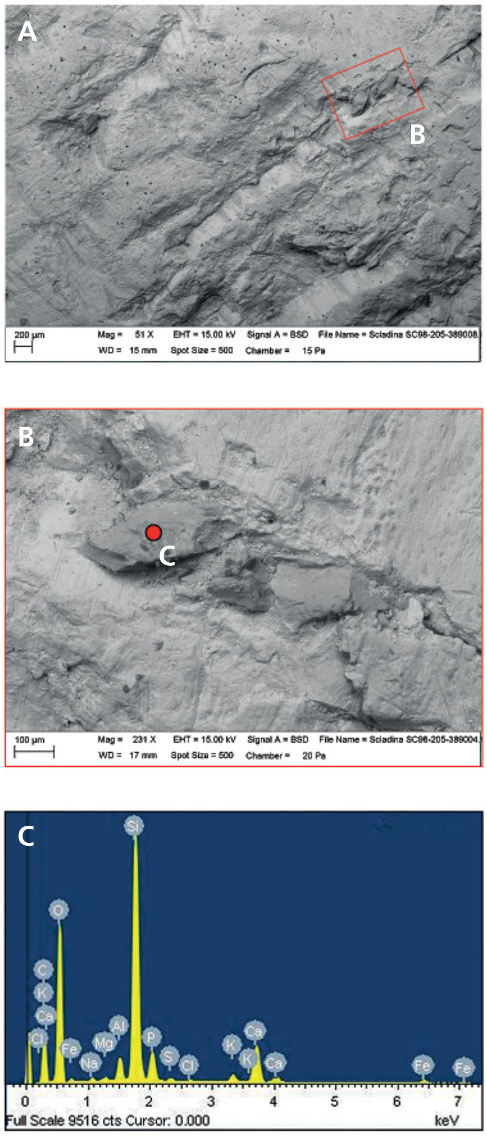

Figure 9 SEM observation of a retoucher highlighting the shape of the use marks (A) with small lithic chips are still embedded (B). The siliceous composition of these lithic fragments is confirmed by the spectroscopy (C) (Scladina Cave, unit 5).

Figure 5). According to Mallye et al. (2012), bone retoucher use areas are generally centred or laterally oriented and occur on convex or plano-convex surfaces. On horse teeth, use marks tend to be located on the contact facets with adjacent teeth (mesially and distally).

The extent of use areas observed here are highly variable, ranging from 0.56 cm² to 19 cm² (mean = 4.8 cm²). Usually, bone retouchers present one or two use areas, in rare cases three or four. The retoucher with the largest use area includes marks covering nearly its entire surface (**Figure 10**; Trou du Diable: TDD-1365-CO1-Ret03).

Use marks are frequently concentrated and superposed (following Mallye et al., 2012). Repeated blows on the surface may have caused partial flaking and loss of cortical bone surface. When comparing sites, the retouchers from Trou du Diable present the most damage from use. The use intensity of the bone tools is likely related to the high number of stone tools recovered at Trou du Diable, as well as the extensive and repetitive sharpening observed on the lithic material (Di Modica, 2005). Nevertheless, interpreting these observations in light of cultural patterns must be made with caution, as the Trou du Diable faunal assemblage and those from the other historical collections is probably the result of the unfortunate mixing of Mousterian and Aurignacian materials during the excavations.

Stereomicroscopic examination of the surface of the retouchers resulted in the identification of several putative lithic chips embedded in some of the retouchers (**Figure 9B**). The EDX spectra of these lithic chips exhibit silicon peaks (**Figure 9C**). Unfortunately, this technique does not distinguish between different siliceous raw materials frequently used by prehistoric people (e.g., flint, quartz, quartzite, chert, phtanite). Other analyses are currently ongoing to further define the raw materials embedded within the bone in order to establish a closer link between the lithic industry and the bone tools.

Associated anthropogenic marks

Retouching marks are often associated with other anthropogenic modifications that occurred prior to the use of retouchers as tools. All breakage patterns on bone retouchers suggest fractures made on fresh bone (Chase, 1990; Villa and Mahieu, 1991; Lyman, 1994).

Scraping and cut marks related to butchery testify to the freshness of the bone fragments used as retouchers. The presence of cut marks on some retouchers suggests that prehistoric people removed meat, tendons and other tissues still attached to the bones prior its use as a retoucher. Sub-parallel striations have been observed in close association with the use areas. Identified as scraping marks, these striations were probably the result of periosteum removal to prepare the surface prior to use of the bones as retouchers (Verna and d'Errico, 2011; Manzon et al., 2012). This is demonstrated by the use marks overlapping the striations and cut marks. Taken together, the cut and scraping marks are evidence of the bone's freshness and the need for the periosteum to be removed prior to its use as a retoucher. None of the retouchers present scraping marks on the entire cortical surface, which indicates that the bone surface was cleaned only on the intended use area. However, the functional benefit of this surface cleaning is still unclear, especially since the retouchers were not all cleaned in the same way. In one case, refitted retouchers (see below), of which contemporaneity is certain, exhibit different surface treatments in two of the four retouchers (**Figure 11**; Abrams et al., 2014a; Abrams et al., 2014b).

Figure 10 The retoucher with the largest use area from Trou du Diable (TDD-1365-CO1-Ret03), with marks covering almost the entire surface © RBINS.

Figure 11 Refitting including four bone retouchers (represented in red, yellow, blue and orange) and two unused fragments (shown in green and purple). All belong to a shaft fragment of a right cave bear femur (Scladina Cave, unit 5).

Except in one example recovered at Trou du Diable, where carnivore tooth marks cross tool use marks, none of the retouchers exhibit clear evidence of animal modifications.

Species

High levels of fragmentation impeded many species identifications. However, the identifiable fragments belong to the same animals found elsewhere in Palaeolithic sites. Dominant species include horses and cervids *(Cervus elaphus* and *Rangifer tarandus)*, followed by aurochs/bison and mammoth/rhinoceros. Aside from these common species, two other taxa stand as unique: cave bear *(Ursus spelaeus)* and Neanderthal.

So far, seven retouchers made from cave bear remains have been recovered from Scladina unit 5 (Abrams et al., 2014a; Abrams et al. 2014b), of which four are associated within a single refitting (see **Figure 11**). While cave bears are often well represented within cave site faunal assemblages, it is still difficult to explain why prehistoric people used so few of their remains. The bones used as tools from Scladina point to the recovery of a relatively fresh carcass. Their acquisition could be the result of either hunting or scavenging. So far, there is no convincing evidence that leads us to favour one hypothesis over the other, except maybe the differential treatment of the tools, highlighted by presence of underlying scraping marks on two of the four retouchers. This could be evidence for a different preparation of the blanks or for an advanced state of decomposition of the cave bear carcass.

The study of the Belgian Paleolithic collections also resulted in the discovery of another infrequently used species. Neanderthal remains have been identified among several thousands of bone fragments collected on the terrace and within the 3rd Cave of Goyet (Wißing et al., 2016). These remains were unearthed during the excavations of Dupont in the late 1860s and were only recently recognised. Marks characteristics of use as tools were observed on several shaft fragments of Neanderthal hindlimbs (Rougier et al., 2016): one femur (Femur III; **Figure 12**) and three tibiae (Tibia III, IV, V).

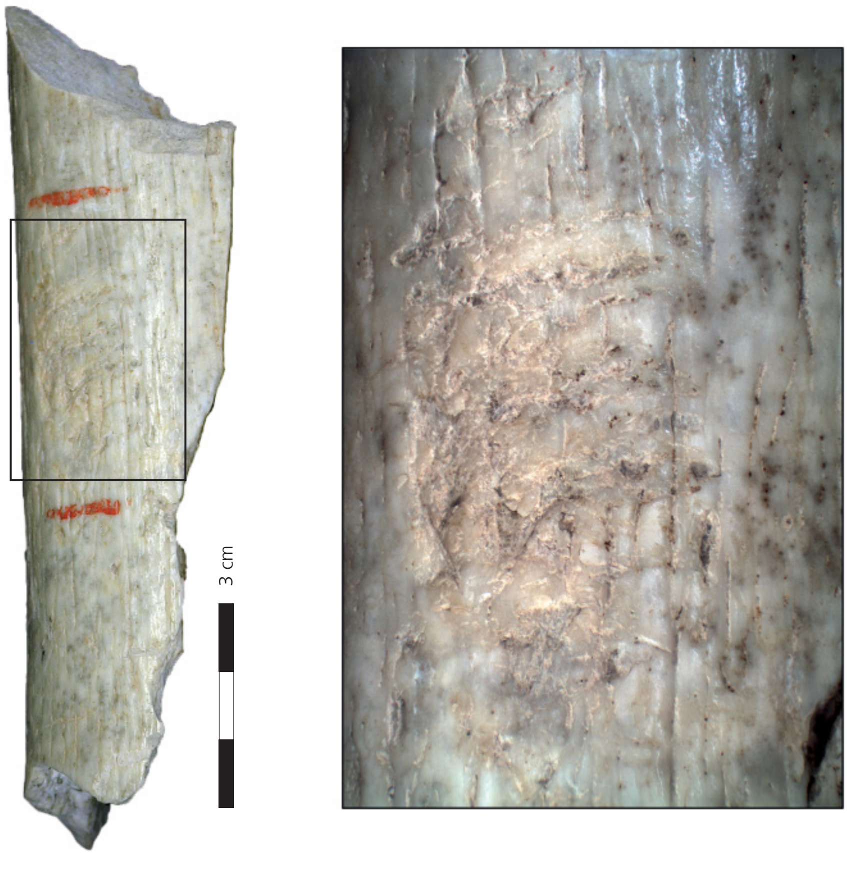

Figure 12 General view (A) and detail (B) of the functional surface of a retoucher made from a Neanderthal bone (Femur III, 3rd Cave of Goyet; E. Dewamme © RBINS).

The examples of cave bear from Scladina and Neanderthal from the 3rd Cave of Goyet are particularly enlightening when considering the processing of these species is similar to the other anthropogenically modified species *(Rupicapra rupicapra, Equus sp., Cervus elaphus, Rangifer tarandus)* in the assemblages. These discoveries seem to show that even if they are very rare, there is no species avoided by Neanderthals when looking for suitable bones to use as retouchers. The use of bear remains *(Ursus arctos* and *Ursus deningeri)* is documented in the Biache-Saint-Vaast deposits (Auguste, 2002) and other Neanderthal bone fragments were used as retouchers at La Quina (Verna and d'Errico, 2011) and Les Pradelles (Mussini, 2011).

Approaching the chaîne opératoire-refitting

Refitting fragments of retouchers makes possible an understanding of the *chaîne opératoire* and the creative thoughts of (stone) tool producers. A few refittings were possible on the Belgian collections studied here. The example from unit 5 of Scladina Cave is currently the most complete. It incorporates a cave bear femur where use marks were observed in combination with several breaks, cut marks and scraping marks. With the presence of these different anthropogenic modifications, it is possible to reconstruct the complete *chaîne opératoire* for this artefact, from the acquisition of the cave bear femur to the abandonment of the tools after use. The refitting associates four bone retouchers and two unretouched fragments. One unretouched fragment in the refit series is likely related to the reshaping of one of the bone retouchers (shaded purple in Figure 11).

In reconstructing the *chaîne opératoire*, we consider the cave bear femur as raw material modified through a number of processes. First, several cut marks attest to the cleaning of the bone through the removal of meaty tissues. After this cleaning process, the debitage took place: the two epiphyses were removed followed by the reduction of the shaft with the aim of producing the bone blanks. Once separated from the others, a blank was reshaped through a reduction of the length, which is suggested by the breakage pattern visible on the internal surface. Finally, scraping marks present on the use surfaces of two of the four retouchers suggest the subsequent removal of the periosteum prior to the use of the bone fragment as a retoucher.

The similarity in the size of the blanks, the observation of similar reshaping and cleaning traces and their association with the same portion of the bone used in the retouchers from other sites leads us to suggest that the *chaîne opératoire* observed in the cave bear femur from Scladina Cave involves the possible existence of a pre-conceptualization of the tool.

Conclusion and prospects for future research

The aim of this study was to better understand the role of bone tools, specifically bone retouchers, during the Middle Palaeolithic in Belgium. The study of animal bone collections from more than 20 archaeological sites led to the identification of at least 535 bone retouchers. The patterns in species preference and the *chaîne opératoire* of retoucher production were investigated. The bone retouchers made from a cave bear femur at Scladina Cave suggest predetermination in the production of these bone tools.

To date, none of the open air site assemblages that were studied yielded bone tools. Reasons for this absence are more likely related to poor preservation of organic materials at open air sites. In order to verify this, a review of additional collections from open air sites should be conducted (e.g., Godarville, Le Clypot, Saint-Symphorien quarries).

Limb bone shaft fragments were preferred over complete sections of bone shafts or complete bones. At present, the reason for this preference is unclear. Was it related to a better grip of the tool, to a technically added value of the tool or the function of the bone tool (retoucher, soft hammer, anvil)? To shed light on this question, an experimental study will be conducted in collaboration with the Natural History Museum of London, the Préhistomuseum and the *Centre d'Étude des Techniques et de Recherche Expérimentale en Préhistoire* (CETREP).

The use bones from rare species, such as cave bear and Neanderthal, appears to be similar to commonly hunted species like cervids and horses, suggesting that there is no particular distinction between them. Therefore, currently it is of little value to consider the symbolic treatment of some species in the context of bone retoucher use.

The lack of reliable stratigraphic contexts for most of the series (e.g., Trou Magrite and Trou du Diable) makes the cultural attribution of bone retouchers difficult. In order to further refine the chronological context, a new radiocarbon dating campaign is in progress, which includes several modified bones from Scladina, Trou du Diable, Trou Al'Wesse, Trou de l'Abîme and Engihoul. Nevertheless, in the current stage of knowledge, most of the bone retouchers seem to be associated with the Mousterian. Notwithstanding a direct date on a retoucher from Spy Cave, there is no obvious evidence for specialised Aurignacian bone retouchers, such as those with longitudinal scores or those made from carnivore teeth.

This study of Belgian Palaeolithic bone retouchers is still in progress, so the results presented here are only preliminary and will be further refined by a continued review of other collections. Nevertheless, some interesting patterns already seem to be emerging and add valuable information on the role of retouchers in the lives of prehistoric people.

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