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PROCUREMENT AND PROCESSING OF PLANT AND ANIMAL MATERIALS BY NEANDERTHALS:

exploring means and strategies

Results of a study based on an experimental approach and the archaeological analysis of several sites in Western Europe, carried out in the context of the "Des traces et des Hommes" PCR

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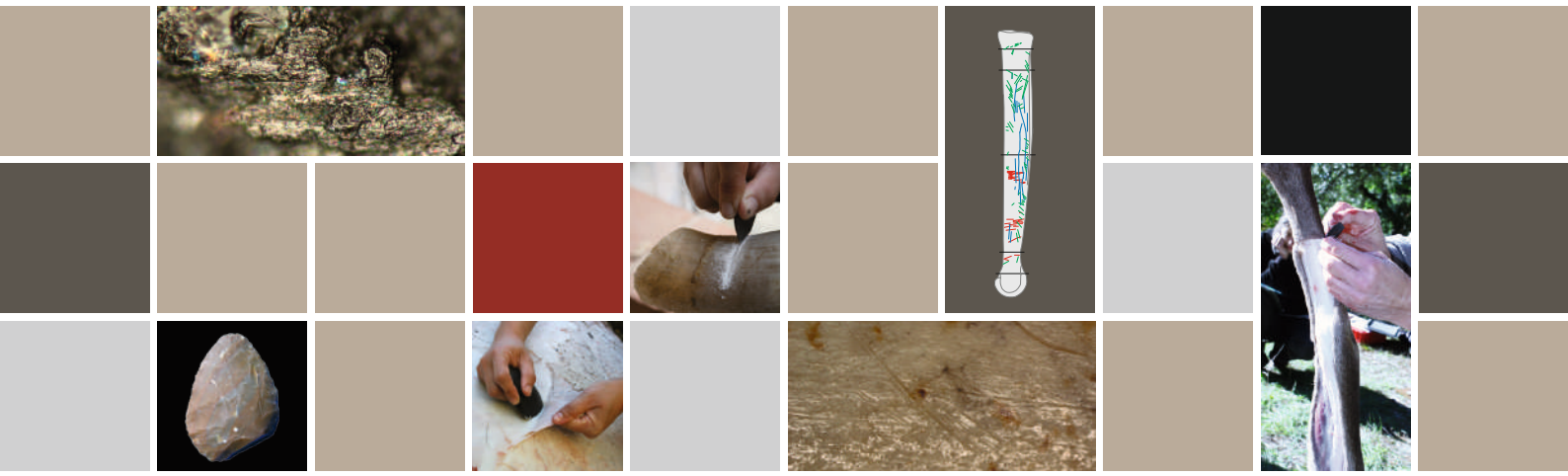

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indicate their use as intermediate pieces used in the indirect percussion of wood. Pieces with evidence of percussion on only one end may have been used in direct percussion. Known at some rare sites like Combe-Grenal, La Ferrassie, Axlor (Mozota Holgueras, 2012; Tartar, Costamagno, 2016) and Grotte du Noisettier (Oulad el Kaïd, 2016), their rarity in Mousterian contexts is probably due more to the ambiguous nature of their diagnostic features than any true scarcity (Tartar, Costamagno, 2016). Finally, the presence of a bone scraper with use-wear traces indicating wood scraping has been reported at Fumane (A5-A6, Romandini *et al*., 2015).

3 - Approaches to the acquisition and use of animal materials

(S. Costamagno, É. Claud, M.-C. Soulier, C. Thiébaut, M. Brenet, A. Coudenneau, M. Deschamps, C. Lemorini, V. Mourre, F. Venditti)

A - Approaches to hunting employed by Neanderthals in Western Europe

Bison, red deer, horse, ibex, chamois and other large and small ungulates are the classic prey animals exploited by Neanderthals. The study of several sites has shown that Neanderthal hunting was not always restricted to this category of animals. Very large ungulates were also sometimes exploited. Cutmarks have been found on megaloceros bones in assemblages XII and XVIIc at Bolomor in Spain (Blasco, Fernández Peris, 2012) and a piece from Moula demonstrates the use of the bones of this animal for utilitarian purposes (Valensi *et al.*, 2012). Several sites, located primarily but not exclusively in northern Europe, – have yielded megafaunal remains in abundance (mammoth, rhinoceros, straight-tusked elephant: for example La Cotte de Saint Brelade, Biache-Saint-Vaast, Mesvin IV, Spy, Tata, Ranville, Gröbern, and Lehringen); butchery marks have been identified on some remains at La Cotte de Saint Brelade, Biache-Saint-Vaast and Payre (Auguste, 1995; Daujeard, 2008; Smith, 2015), at Taubach (Bratlund, 1999), and at Bolomor and Preresa (Blasco, Fernández Peris, 2012; Yravedra *et al.*, 2012). In Germany, the exploitation of elephants is demonstrated by 28 lithic artefacts found in association with a carcass at Gröbern and a spear discovered between the ribs of a carcass at Lehringen (Weber, 2001). At Asolo in Italy, a mammoth was recovered in association with Mousterian tools (Mussi, Villa, 2008).

Although carnivores are present in Middle Palaeolithic faunal assemblages, evidence that they were exploited by Neanderthals is rare. There is evidence for the exploitation of wolf at Portel, La Cotte de Saint Brelade, Fumane, and Ciota Ciara (Gardeisen, 1999; Romandini *et al.*, 2014a; Smith, 2015; Buccheri *et al.*, 2016); fox at Chez-Pinaud, Bolomor, and Fumane (Jaubert *et al.*, 2008; Blasco, Fernández Peris, 2012; Romandini *et al.*, 2014a), lynx at Lazaret and at Bolomor (Valensi, Psathi, 2004; Blasco, Fernández Peris, 2012), cave lion at Grotta delle Fate and Bolomor (Valensi, Psathi, 2004; Blasco, Fernández Peris, 2012), and wildcat at Abric Romaní (Gabucio *et al.*, 2014b). Indications of the exploitation of bears are more common, including cave bear (Arcy-sur-Cure, Le Portel, La Cotte de Saint Brelade, Scladina, Taubach, Bocktein, Hohle Fels, Madonna dell'Arma, Ciota Ciara, Badalucco, Fumane: Gardeisen, 1994; David, 2002; Bratlund, 1999; Quilès, 2004; Münzel, Conard, 2004; Cauche, 2007; Kitagawa *et al.*, 2012; Abrams *et al.*, 2014; Smith, 2015; Buccheri *et al.*, 2016), brown bears (Regourdou, Biache-Saint-Vaast, Grotte delle Fate, Grotte de Manie, Fumane, Moscerini, Sant Agostino: Stiner, 1994; Auguste, 1995; Quilès, 2004; Valensi, Psathi, 2004; Cavanhié, 2011; Jéquier *et al.*, 2012; Romandini *et al.*, 2014), and, rarely, polar bear (Taubach: Bratlund, 1999) or Tibetan bear (Grotte de Cèdres: Bez, 1995) (see Armand, 2018, for a synthesis of this topic). Regarding small animals, there is evidence for the exploitation of leporids (Les Canalettes, Le Lazaret, Combe-Grenal, La Crouzade, Pié Lombard, Orgnac, Salpêtre de Pompignan, Gorham Cave, Cova Negra, Bolomor, Cova Beneito: Gerber, 1972; Chase, 1986; Guennouni, 2001; de Lumley *et al.*, 2004; Sanchis Serra, Fernández Péris, 2008; Cochard *et al.*, 2012; Morin, 2012), beaver at Taubach and Grotte Maggiore di

San Bernardino (Bratlund, 1999; Fiore *et al.*, 2004) and marmot at Kogelstein (Münzel, Conard, 2004). Birds were also exploited by Neanderthals, as illustrated by cutmarks observed on remains of falcon, vulture, golden eagle, crow, pigeon, and/or swan at Mandrin, Lazaret, Les Fieux, Grotte de la Hyène at Arcy-sur-Cure, Baume de Gigny, Combe-Grenal, Pech de l'Azé IV and I, and at Grotte du Noisetier in France (Mourer-Chauviré, 1975, 1989; Roger, 2004; Soressi *et al.*, 2008; Dibble *et al.*, 2009; Morin, Laroulandie, 2012; Gerbe *et al.*, 2014; Romandini *et al.*, 2014b), at Bolomor, Vanguard, and Ibex Cave in Spain (Sanchis Serra, Fernández Peris, 2008; Blasco, Fernández Peris, 2009, 2012; Blasco *et al.*, 2010; Finlayson *et al.*, 2012) at Rio Secco Cave and Fumane in Italy (Fiore *et al.*, 2004; Romandini *et al.*, 2014b; Peresani *et al.*, 2011a) and at Salzgitter-Lebenstedt in Germany (Gaudzinski, Niven, 2009). Tortoises are also included in the spectrum of fauna exploited by Neanderthals, for instance in assemblage IV at Bolomor and levels 19 to 15 at Gruta da Oliveira, which yielded a large number of remains, many of which present cutmarks, signs of fracture, and traces of burning and of consumption (Blasco, 2008; Nabais, 2011). With regard to aquatic fauna, indications of exploitation are markedly more rare and difficult to identify. The bones recovered at Grotte Vaufrey could indicate the exploitation of fish (Le Gall, 1989); Vanguard provides evidence for the exploitation of pinnipeds (Stringer *et al.*, 2008) and numerous mollusc shells have be found at the sites of Vanguard, Gorham cave, Bajondillo, Cueva de los Aviones, Antón, and El Cuco in Spain, at Figueria Brava in Portugal (Callapes, 2000; Zilhão *et al.*, 2010; Cortés Sánchez *et al.*, 2011a; Fa *et al.*, 2016; Gutiérrez-Zugasti *et al.*, 2017) and at Grotta Breuil and Moscerini in Italy (Stiner, 1994; Stiner *et al.*, 2000). For molluscs, there is evidence of selection amongst the shells, as well as traces of burning and intentional perforation that indicate that these resources were consumed by Neanderthals (Zilhão *et al.*, 2010). Terrestrial snails were also consumed at La Cueva 120 (Agusti *et al.*, 1992; Terradas, Rueda, 1998).

Most authors today agree that ungulates classically present in Middle Palaeolithic faunal assemblages (red deer, reindeer, horse, bison, ...) were acquired by hunting, with the possibility of occasional scavenging of carcasses when conditions permitted. With regard to hunting strategies and techniques, we can refer to those documented at sites dedicated to hunting and butchering of large bovids. At Mauran, La Borde, Les Fieux and Coudoulous in southwestern France, specific topographic features of the landscape (pit caves, bases of cliffs) were repeatedly exploited as natural traps for the acquisition of large numbers of bovids. This strategy was also originally proposed to explain the presence of mammoths at La Cotte de Saint Brelade (driving the herds toward the ravine: Scott 1980, 1986), but more recent studies have shown that, during periods of low sea level, a valley terminated at the entry of the site. A hypothesis of driving toward the end of this valley is preferred today (Scott *et al.*, 2014). At Salzgitter-Lebenstedt in Germany, the narrowing of the valley could have been used advantageously for intercepting reindeer (a minimum of 86 individuals has been determined) during their autumnal migration (Gaudzinski, Roebroeks, 2000). Acquisition of prey by driving parts of herds toward a natural trap is thus one hunting technique employed by Neanderthals (Farizy *et al.*, 1994; Gaudzinki, Roebroeks, 2000; Coumont, 2006; Rendu, 2007; Gerbe *et al.*, 2014; Jaubert *et al.*, in prep.). Although this technique requires close coordination amongst group members, it presents a double advantage: it avoids direct contact with potentially dangerous animals and it does not require throwing or thrusting weapons as the animals can be killed in the fall. At Les Fieux and Mauran, not a single point was clearly identified as a hunting weapon. Only two pieces bear fractures that could have been produced by impact. The scarcity or even absence of lithic hunting points at these sites suggests that the bison hunters of Mauran and Les Fieux would have, if necessary, finished off certain prey animals with heavy stone blocks or with wooden spears like those found at Lehringen and Schöningen (Germany), at Clacton-on-Sea (England), and at Ljubljansko Barje (Slovenia) (Movius, 1950; Oakley *et al.*, 1977; Dennel, 1997; Thieme, 1997; Gaspari *et al.*, 2011). In this context, the site of Coudoulous could be an exception with the

presence of two triangular elements in quartzite that were most certainly used as hunting weapons. The hunters at Coudoulous could have used at least two different techniques: driving part of the herd into a pit-cave and using stone weapons to hunt other types of prey, or as a means of defence in case of contact with bison.

The faunal assemblages from some sites contain only certain parts of animal carcasses (generally the meatiest parts) that were processed offsite by Neanderthals. These are Grotte du Noisetier, Les Pradelles, Chez-Pinaud, Saint-Césaire, Gatzarria, and Payre in France (Morin, 2004; Costamagno *et al.*, 2006; Rendu, 2007; Ready, 2010; Niven *et al.*, 2012), as well as Grotte XVI, Pech de l'Azé, Vaufrey, Abri des Pêcheurs, Baume Flandin, Abri du Maras, Lazaret, and Wallerteim in Germany, Fumane in Italy, and Abric Romaní in Spain (Grayson, Delpech, 1994, 2003; Gaudzinski, 1995; Valensi, Psathi, 2004; Martinez *et al.*, 2005; Daujeard, 2008; Moncel *et al.*, 2010; Romandini *et al.*, 2014a). These sites have been interpreted as long-term or seasonally occupied locations, or as butchery camps for secondary processing of carcasses. At Wallerteim, more than sixty bisons and horses were acquired by hunting of small groups with the selection of adult individuals (Gaudsinski, 1995), indicating that Neanderthals did not choose their prey at random, but were capable of exercising true selectiveness of even the fittest and most dangerous animals.

With regard to the sites of Bayonne le Prissé, Saint-Césaire, Chez-Pinaud, Fonseigner, and Grotte du Noisetier, a holistic use-wear study of the lithic artefacts has been conducted. The level at Payre benefited from a focused use-wear analysis of triangular elements. Of 298 pieces studied, none presented use-wear or damage unambiguously indicative of use as a hunting weapon, with the exception of a single point from Chez-Pinaud that presented a burin fracture on the distal end and potential hafting traces (see Part II, chapter 2.4).

How should one interpret this scarcity of points used as hunting projectiles? Is it perhaps the case that the samples analysed in our study are dominated by blanks that are ill suited to the production of such points? This hypothesis seems reasonable for the assemblages in which only bifaces and flake cleavers have been studied, but also for the assemblages from Mauran, Saint-Césaire, and Les Fieux, in which debitage is oriented toward the production of backed pieces and relatively thick pseudo-Levallois points (Thiébaut, 2005) with morphologies that are incompatible with effective use as projectiles. All the same, one of the largest assemblages of points that could have served as hunting weapons comes from a level at the site of Beauvais (Coudenneau, 2013). Of the 428 points studied, 21 show traces of use in diverse activities and 10 bear removals on the distal ends comparable to those observed on points used experimentally as projectiles. They are unmodified pseudo-Levallois points, not even thinned, derived from a Discoid debitage sequence comparable to those noted at Mauran and Les Fieux. If these points really served as projectiles, they would testify to the strength of technological tradition amongst Neanderthal groups in the hunting techniques used.

At Fonseigner, in contrast, certain blanks (Mousterian points with axial symmetry) are morphologically compatible with use as hunting weapons. Some, relatively thin, blanks at Saint-Césaire or at Chez-Pinaud could also have been shaped by retouch into Mousterian points. However, in these assemblages, no definite armature point was identified. Other sites rich in points that were analysed also failed to provide any element that was definitively used as a hunting weapon. Such is the case, for example, at Terdonne and Spy, where the Levallois and Mousterian points show no clear signs of impact. At these two sites, from which a combined total of 119 unmodified Levallois points and 82 Mousterian points were analysed, only eleven pieces displayed fractures of the distal end that might have resulted, amongst other hypotheses, from use as hunting weapons (Coudenneau, 2013).

Several other European sites have yielded elements identified as points used in hunting, more or less numerous (table 61).

	Site	Impact traces	Uncertain impact traces	Related tool types
Belgium	Spy		1	Mousterian point
Netherlands	Maastricht-Belvédère (site K)	1		retouched and pointed flake
Germany	Sesselfelsgrotte	28		bifacial scraper, scrapers, points, flake and blade fragments
North France	Beauvais "La Justice"		10	pseudo-Levallois points
	Bettencourt-Saint-Ouen (N2b, a, N1)		1	Levallois point
	Bettencourt-Saint-Ouen (N2b)	6		Levallois points
	Biache-Saint-Vaast	20		convergent scrapers, points
	Therdonne		3	pseudo-Levallois points
North Center France	Angé		5	Mousterian points
South Western France	Bouheben	6		Mousterian points, convergent scrapers
	Cantalouette II	1		point
South Eastern France	Abri du Maras	5	6	Soyons points, Levallois points, blade and flake fragments
	Mandrin (layer E)	71		unmodified and retouched points (including micro and nano-points)
	Mandrin (layer D)	31		unretouched pseudo-Levallois points, truncated pseudo-Levallois points and Levallois points (classic points and unmodified and retouched micro-points)
	Mandrin (layers B and C)	11	6	unretouched points and flakes
	Mandrin (layer F)	3	1	Levallois and Mousterian points
Italy	Asolo	1		unretouched point
	Ciota Ciara cave	1		convergent scraper (in quartz)
	Oscurusciuto	6		Mousterian points
Iberian Peninsula	Abri del Pastor	8		retouched points (in flint)
	Amalda		3	Mousterian point, pointed flake, retouched Levallois point (in flint)
	Arlanpe	1		Levallois point (in flint)
	Axlor (N, M, D)	5		retouched points (in flint)
	Cova Eiros	2	3	Levallois points (in quartzite)
	Cueva Morín (layer 16)	5		Mousterian point, Levallois points and pointed flake (in flint)
	El Castillo	7		Mousterian points (in flint)
	La Verde		1	Mousterian point (in silicified sandstone)
	Lezetxiki	2		retouched points (in flint)

Table 61 - Published data on assemblages from the Middle Palaeolithic of Western Europe that have yielded armatures with impact damage (possible or definite), and the types of pieces that present such traces. See Annex 1 for the literature references.

In Germany, 28 pieces of varied type from the site of Sesselfelsgrotte could have served as hunting weapons, and their use as both thrusting and throwing arms is seen as possible (Rots, 2009). The on-going study by V. Rots (2015b) of the lithic industry at Maastricht Belvédère (site K) demonstrates the use of a single point as a hunting weapon. In the northern France, six Levallois points from the site of Bettencourt-Saint-Ouen (Somme; Caspar *in* Locht *et al.*, 2002; Rots, 2015b), and, at most, 20 pieces from Biache-Saint-Vaast (Pas-de-Calais; Rots, 2013) bear impact damage. A bit farther south, five Mousterian points from the site of Angé (Loir-et-Cher) present fractures and lateral scarring that are compatible with this mode of use (Soressi, Locht, 2010; Locht *et al.*, 2015).

In southwestern France, the assemblages that have yielded points with traces of impact or potential traces of impact are very rare: at the open-air site of Bouheben (Landes), six Mousterian points of the 100 analysed present such fractures (Villa, Lenoir, 2006). A point interpreted as a projectile by J. Rios was noted at the site of Cantalouette II (Bourguignon *et al.*, 2008).

For the southeast, if we exclude the dubious result reported by B.L. Hardy at Abri du Maras (Hardy *et al.*, 2013; Part II, chapter 4.2.F), the only available study is that of L. Metz, in her doctoral thesis (2015) on the site of Mandrin. Layer E of the site, notably, yielded a highly unique lithic assemblage (numerous points, standardized and tending toward the microlithic scale). At least 15.5 % of these points could have been used as wounding or penetrating arms, and more than a third of the small points (called micro- and nanopoints) were found to bear diagnostic impact damage. Given the small dimension of these points, their use in bow-hunting is hypothesized.

Under the new interpretive program of the Musée d'Orgnac, we (C.T., E.C.) were led to examine the points from several sites in the Rhône Valley (Abri Moula, Abri des Pêcheurs, Abri du Maras). At least four of them bear damage indicative of probable use as arms. Our observations join those of L. Metz, who identified several points with impact damage at Abri du Maras (Metz, 2015: 131-138, volume 2).

In northern Spain, the data are more abundant as several sites have yielded points with impact damage, still in small quantities, the proportion of points being rather low: Cova Eiros (Lazuen *et al.*, 2011; Lazuen 2012b), Cueva Morín, El Castillo, La Verde, Lezetxiki (Lazuen, 2012a, 2012b), Arlanpe (Rios-Garaizar, 2013), Axlor (Rios-Garaizar, 2016), Abri del Pastor (Galvan Santos *et al.*, 2007-2008), and to a lesser extent Amalda (Rios-Garaizar, 2010).

Finally, in Italy, six Mousterian points from the site of Oscurosciuto bear evidence of impact (Villa *et al.,* 2009), as does a convergent side scraper in quartz from the cave of Ciota Ciara (Daffara *et al.*, 2014). A Levallois point bearing an impact fracture was reported at the site of Asolo, which yielded a proboscidian carcass in association with several flint artefacts (Mussi, Villa, 2008); however, the step terminating bending fracture is only 0.8 mm, very small by the criteria commonly applied (see Part I).

The presence, at Beauvais (Coudenneau, 2013) and in layer D at Mandrin (Metz, 2015), of fractures interpreted as evidence of impact or potential impact on pseudo-Levallois points, may be reasonably called into question given their limited length, substantial thickness, and overall considerable mass. These points constitute pieces that are *a priori* little suited to hunting. A methodological revision may be necessary, as it seems possible that the damage observed on these pieces is the result of an untested mode of use other than hunting or a natural phenomenon other than trampling (the effects of which have been well documented).

The very anecdotal presence or even the total absence of points that clearly show signs of impact in certain regions, like southwestern France, would seem to indicate that certain groups used, primarily or exclusively, other forms of hunting weapons, such as spears or points made of wood, and/or made use of traps in the form of cliffs or pits. As for other regions, with the exception of layer E at Mandrin, we are in agreement with L. Metz that the bibliographic data on impact damage is to be regarded with caution because they are frequently the result of an "estimate that is optimistically high for this phenomenon, which is little evidenced in the archaeological assemblages of the Eurasian Mousterian" (Metz, 2015: 15). Doubts are often raised regarding the actual function of the points presented as impact-damaged due to the small number of such pieces, which may suggest possible taphonomic convergence (Pargeter, 2011; Rots, Plisson, 2014; Part II, chapter 2.3). To this can be added the scarcity of photographic evidence, the poor quality of the photographs that are sometimes provided, the diagnostic criteria employed, which are often not clearly presented, and even problems of terminology (Coppe, Rots, 2017).

Our analyses and our review of the available literature have raised one point that is cause for particular caution, which has also been articulated by L. Metz: the absence or extreme rarity of impact damage on points that have a morphology compatible with use as hunting weapons, while, in contrast, damage interpreted as the result of presumed impact is present on pieces with an array of morphologies, sometimes thick and slightly pointed.

B - The exploitation of carcasses

a - Summary of the use-wear data

Of the 424 active zones identified on which activity was determined, 279 are related to butchery activities (table 51). In a broad sense, this activity clearly dominates the spectrum of activities performed at the study sites. It has been identified at all of the study sites subjected to comprehensive analysis (table 62), at frequencies that are variable but always substantial, especially if we include that the tools used in scraping hard animal materials could correspond to a phase of butchery (see discussion below).

Cutting accounts for 92 % of the active zones if we include those that served both in cutting and another mode of activity (scraping or percussion) (figure 211), percussion represented in only 8 % of cases. The latter action is perhaps slightly underestimated, as there is a substantial number of such pieces that were used on materials that are medium-hard to hard that could have been wood or carcasses (15 flake cleavers from Abri Olha I and II, El Castillo and Gatzarria).

Series	Number of active zones used for butchery by cutting	Number of active zones used for butchery by percussion	Number of active zones used for butchery by cutting and scraping	Number of active zones used for butchery by cutting ad percussion	Number of active zones possibly used for butchery by scraping hard material	Total number of active zones	Frequency (%)
Bayonne le Prissé (PM1)	10					10	100
Bayonne le Prissé (PM2)	4					5	80
Chez-Pinaud (US 06 and 07)	92	3		1	4	170	59
Coudoulous (layer 4)	2		26		3	64	48
Fonseigner (Dsup)	30				(1)	46	65
Grotte du Noisetier	17			1		21	86
Les Fieux (layer K)	18	1			21	52	77
Mauran (XV 2 / layer 2)	28				9	57	65
Saint-Césaire (level Egpf)	18	5				27	85

Table 62 - Number of active zones interpreted as having served in butchery and the frequency of this activity according to the assemblages studied (including only those assemblages subjected to complete analysis).

As it is particularly difficult to assign a tool used in butchery to a precise butchery task, we constrain ourselves here to discussing the results of use-wear analysis in terms of mode of action (cutting, percussion, scraping) rather than to specific acts or phases of butchery.

For the same reasons enumerated in the preceding chapter (Part II, chapter 4.2), we have not included the results of several studies that we consider to have questionable methodologies: La Quina (Hardy, 2004), Payre (Hardy, Moncel, 2011), Abri du Maras (Hardy *et al.*, 2013), Inden-Altdorf (Pawlik, Thissen, 2017). The results of studies conducted in the 1980s, included in the comparisons, must also be approached with some caution given the concerns that have since been raised about their results (see Part II, chapter 4.1).

b - Butchery by cutting

Cutting has been identified on 257 active zones. Certain of these zones present, in addition to traces of cutting, traces linked to use in another mode of action, such as scraping (at Coudoulous, 26 active zones) and percussion (two pieces, at Grotte du Noisetier and at Chez-Pinaud). Butchery by cutting is evidenced in high proportions at all of the sites that were subjected to comprehensive analyses (table 62), as well as on a flint biface at Combe Brune 2, two flint bifaces at La Conne de Bergerac and six points at Payre.

Traces of cutting were detected on the different materials studied, with the exception of ophite; only flake cleavers in this material were analysed and showed traces of percussion. Pieces made of flint, quartzite, schist, lydite, and sandstone-quartzite were thus used as knives in butchery (table 63).

The tools interpreted as butchery knives in our study assemblages present varied techno-typological characteristics (table 64, figures 217-226): unmodified flakes from bifacial reduction, side scrapers (some of which were made on debitage flakes), bifaces, denticulates, and different types of points, dominated by pseudo-Levallois points. Three additional active zones on bifaces that were used to cut hide, based on the pointed morphology of the pieces and the presence of a second active zone used in butchery, could have been used in skinning rather than in hide-processing (see Part II, chapter 2.2.C; figures 235[h]-236). Other categories less frequently identified as butchery knives include: Clactonian notches (one at Mauran and one at Les Fieux), retouched flakes (one at Mauran and one at Les Fieux) and endscrapers (two at Les Fieux). Pieces that were used in cutting and in scraping include flakes (21 active zones), two side scrapers, and one backed knife, all in quartz-quartzite and all from the site of Coudoulous. As for pieces associated with both cutting and percussion, there is one naturally-backed knife in flint (Chez-Pinaud) and one flake in schist (Grotte du Noisetier).

We have not detected evidence for cutting – and in a more general sense traces of continuous contact – on flake cleavers. Given the fact that these tools are for the most part not well enough preserved to have maintained traces of use other than those, very pronounced, traces tied to use in percussion, it is not impossible that certain flake cleaver edges were used in other modes of action, including in butchery-knive. Even so, our own experiments have shown flake cleavers to be of little use in precise cutting tasks due to their considerable dimensions and weight.

This variety of forms is present in each assemblage and could reflect the employment of diverse butchery activities (figures 217-227):

- at Bayonne le Prissé (figures 217-218[a-b]), flakes, a pseudo-Levallois point, and bifaces from the PM1 assemblage, a Mousterian point (perhaps two) and two side scrapers in the PM2 series;
- at Chez-Pinaud (figures 219-222), unmodified flakes from biface manufacture, side scrapers on two categories of flake, bifaces, pseudo-Levallois points, denticulates, a backed knife, and a Levallois point;

	Flint	Quartzite	Quartz or quartzite	Ophite	Schist	Lydite	Sand-stone / quartzite	Undetermined	Total	Total per activity
WOOD PROCESSING										
Woodworking (longitudinal motions)	0		5						5	68
Probable woodworking (longitudinal motions)	13	1	3						17	
Woodworking (scraping)			6						6	
Probable woodworking (scraping)	23		9						32	
Probable woodworking (percussion)	3	2		3					8	
ANIMAL MATERIAL PROCESSING										
Hunting points			2						2	2
Butchery, cutting (+ scraping at Coudoulous)	47		26				1		74	279
Probable butchery (cutting)	57	1	5			1			64	
Butchery, cutting (non micro-polish)	77	20	5		7	2			111	
Probable heavy butchery (cutting)	4	1	1						6	
Probable heavy butchery (percussion)	9	9		3				1	22	
Probable butchery (cutting + percussion)	1								2	
Hide working (cutting)	20		1						21	34
Hide working (scraping)	7	1	2						10	
Probable hide working (piercing)	1	1							2	
Hide working (mixed action)	1								1	
Scraping of a hard and organic material (bone)	26	2	12			1			41	41
UNDETERMINED ACTIVITIES										
Undetermined activity (cutting)	0	1	1						2	68
Undetermined activity (scraping)	7	1							9	
Undetermined activity (piercing)	19	1	1						21	
Undetermined activity (intermediate piece)	2								2	
Undetermined activity (percussion)	1	12		3					16	
Undetermined activity (mixed motion)	1								1	
Undetermined activity + undetermined motion	9		6			2			17	
Total	**328**	**53**	**85**	**9**	**9**	**6**	**1**	**1**	**492**	**492**
%	**66.8**	**10.8**	**17.0**	**2.0**	**2.0**	**1.0**	**0.2**	**0.2**	**100**	

Table 63 - Number of active zones by raw material on pieces bearing traces of use, according to the activities identified (excluding traces of undetermined origin and zones used on mineral materials).

	Number of active zones	%
Unretouched flakes (excepted manufacturing and resharpening flakes)	100	39
Backed pieces with an unretouched edge (cortical, core edge or retouched back)	14	5
Levallois points	2	1
Pseudo-Levallois points	15	6
Mousterian points	3	1
Denticulates	26	10
Clactonian notches	2	1
Scrapers	33	13
Scrapers on biface manufacturing flakes	5	2
Retouched flakes	2	1
Bifaces	25	11
Endscrapers	2	1
Limace	1	0,4
Biface manufacturing flakes	24	9
Resharpening and notching flakes	3	1
Total	**257**	

Table 64 - Types of tools interpreted as butchery knives. See Annex 1 for the literature references.

- at Fonseigner (figure 224), flakes from full debitage and from core preparation and maintenance, a Levallois point, side scrapers, Mousterian points, and bifaces;
- at Grotte du Noisetier (figure 218[a-f]), flakes from full debitage (including a Levallois flake), a core-edge flake, ordinary flakes, and side scrapers;
- at Les Fieux (figure 225[a-c]), a Levallois flake, pseudo-Levallois points, ordinary flakes, end-scrapers, denticulates, a notched piece, and a retouched flake;
- at Mauran (figure 226), denticulates, unmodified flakes, pseudo-Levallois points, a side scraper, a notched piece, a retouched flake, and a *limace*;
- at Saint-Césaire (figure 227), flakes from full debitage, core-edge flakes, naturally-backed knives, an unmodified flake, backed flakes, denticulates, and notched pieces (retouching and recycling flakes).

The active zones are more often unmodified (60 %, 154 zones) than retouched. The modified edges, whether on bifaces, denticulates, or scrapers, bear removals that range from shallow to semi-abrupt. The edge angles are moderate, with values usually below 50°. The active zones are long, and, at the scale of a single assemblage, longer than those used in scraping. Preference for a long cutting-edge may have been an important element in the selection of tools to be used as knives in butchery. At Chez-Pinaud, for example, the biface manufacturing flakes that were selected were amongst those with the longest cutting edges (Claud, 2008, 2014a). The morphology of the active zones in plan view can be pointed, convex, rectilinear, or denticulated. The active zones also frequently display a zone of convergence (figures 217-227), on shaped tools, retouched pieces, and unmodified pieces alike. This might be in the form of a point or angle, situated in the middle of the active zone (off-set flakes, denticulates) or at an extremity (backed knives, unmodified flakes), adjoining the platform, for example. This angle, point, or tooth, in the case of denticulates, facilitated penetration of the tissues and concentrates the force in a sharp and precise cutting zone. These characteristics (outline, angle of cutting-edge) make for tools that are both penetrating and sharp, and therefore highly effective in butchery. Tool profiles are often rectilinear, but can also be concave, convex, or sinuous. We have observed in experimental butchery that variations in this feature have little impact on the performance of butchery activities, and more generally on the cutting of a soft material, though a rectilinear outline is important for sawing more hard materials. The cross-section is usually biplanar, sometimes plano-concave (denticulates), or slightly plano-convex (certain scrapers and bifaces). The presence of a backed or a dulled prehension zone is frequent. Backing can be natural, the result of debitage or retouching, or even the product of very abrupt, short retouch creating a narrow backing, as on certain flakes from Saint-Césaire. A combination of natural / debitage backing and retouch backing is sometimes observed. This abrupt section may (or may not) be associated with a platform that might complete the prehension zone. In the case of bifaces, a natural or abruptly-retouched butt often forms the prehension zone. Even so, the presence of a feature that might function as a backing is far from systematic: it is most notably absent on the very large majority of biface manufacturing flakes from Chez-Pinaud (a single one presents a combined natural / retouched backing), from certain very symmetrical bifaces (at Chez-Pinaud, notably) and from a considerable number of unmodified and retouched tools at Fonseigner (scrapers, flakes, points) (figures 219-224). Given that the presence of a backing allows for greater force to be applied, the tools that lack backing could have served for lighter cutting activities, precise and occasional work, or they could have been hafted; the use of a protective piece of hide could also be envisioned. It is also at these two sites that a few pieces were identified that bear traces compatible with hafting: two Mousterian points and a convergent side scraper (Part II, chapter 2.4). With regard to the biface manufacturing flakes, their low cutting angle (between 20° and 30°) makes their edges fragile and ill suited to cutting activities that involve the application of force and regular contact with harder materials. Retouching them into scrapers certainly renders them more resistant, resulting in edge-angles that measure between 30° and 40°.

Bayonne le Prissé PM1
(photographs: EC)
a - 21 737, flint
b - 12 093, flint
c - 22 329, flint
d - 21 715, flint
e - 20 746, flint
f - 22 302n, flint
use: cutting a soft to medium-hard material

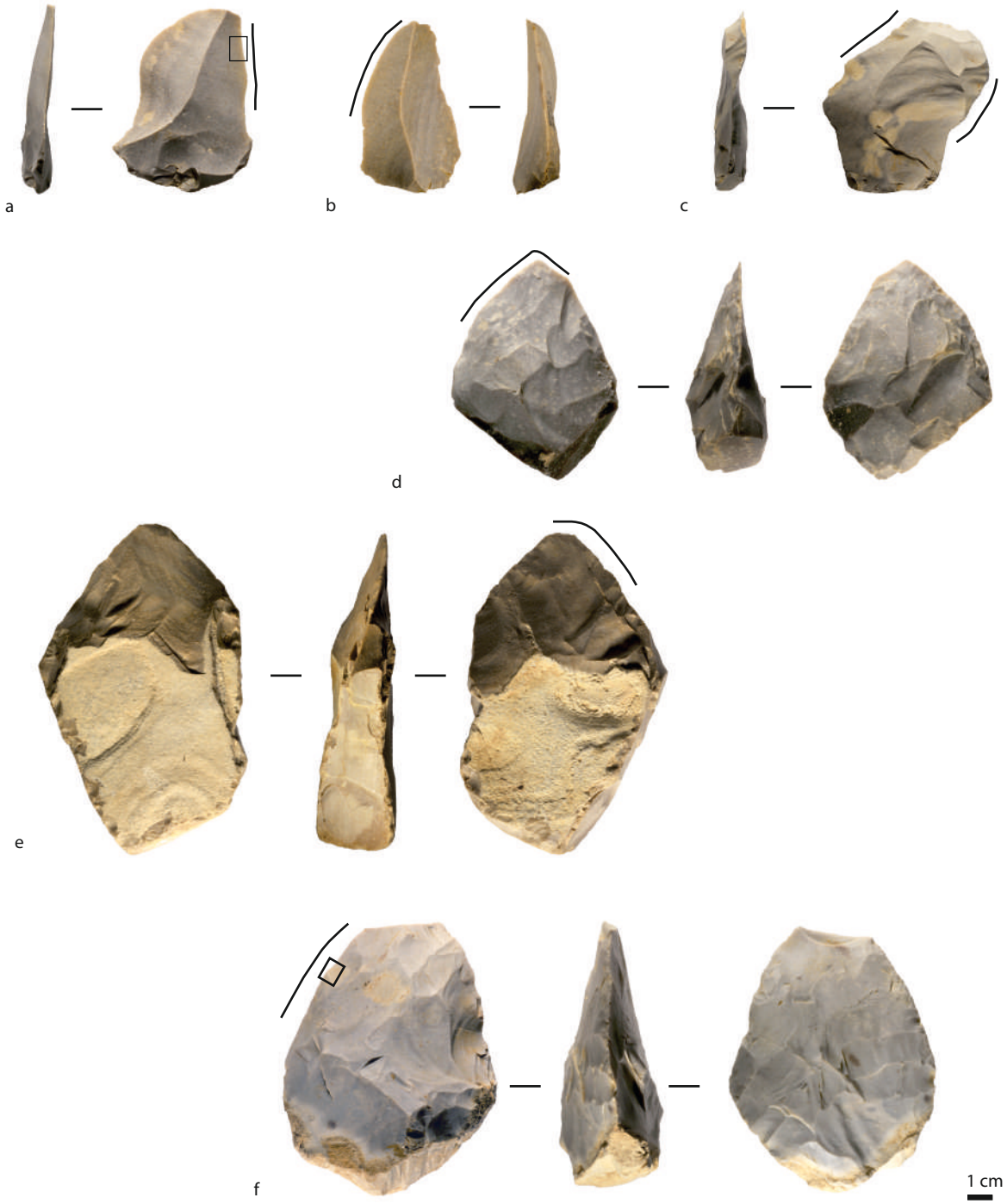
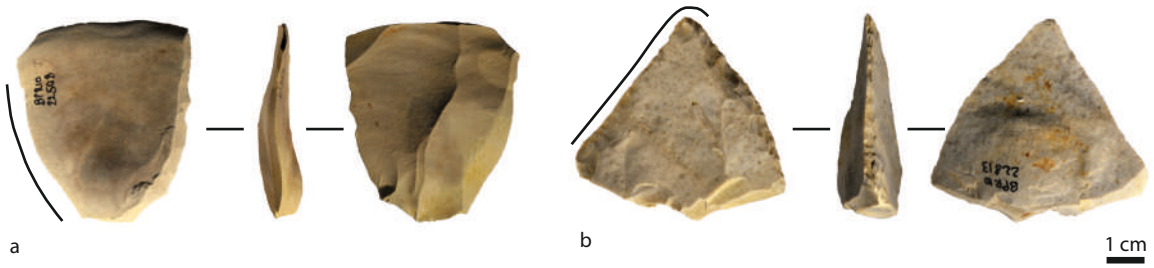


Figure 217 - Unmodified flakes and bifaces from the site of Bayonne le Prissé PM1 used or probably used in cutting in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 172[a-b] (CAD: É. Claud and M. Coutureau).

Bayonne le Prissé PM2
(photographs: EC)
a - 22 508, flint
b - 22 813, flint
use: cutting a soft to medium-hard material



Grotte du Noisetier
(photographs: EC; drawing: P. Allard)
a - NS 09 C14 c2S 226, quartzite
b - NS13 E11 c1 142, schist
c - NS07 C15 c2 262, lydite
d - 65NS 16C 1 51, quartzite
e - 65NS 16 D1 44, schist
f - NS 05 D13 c1 134, quartzite
use: cutting a soft to medium-hard material

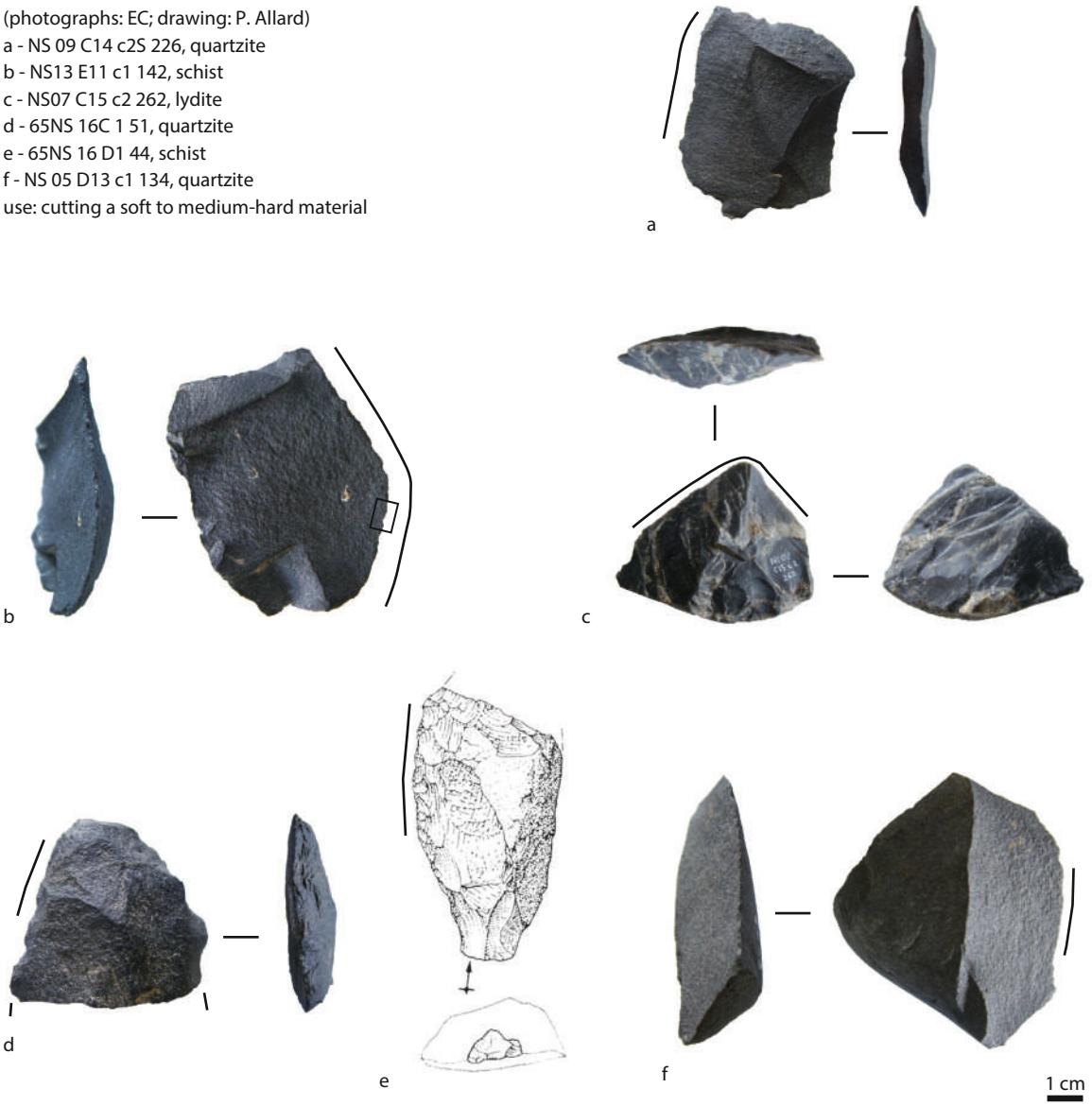


Figure 218 - Unmodified flakes and retouched tools from the sites of Bayonne le Prissé PM2 and Grotte du Noisetier, used or probably used in cutting in the context of butchery. The black rectangle indicates the location of the photograph of the use-wear traces presented in figure 174c (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(photographs: EC; drawing: S. Pasty)
a - CPN E14 965, flint
b - CPN E19 608, flint
c - CPN D19 927, flint
use: cutting a soft to medium-hard material
d - CPN E16 538, Turonian flint
e - CPN E14 636, flint
f - CPN F14 52, flint
g - CPN E16 711, flint
use: cutting resistant meaty materials

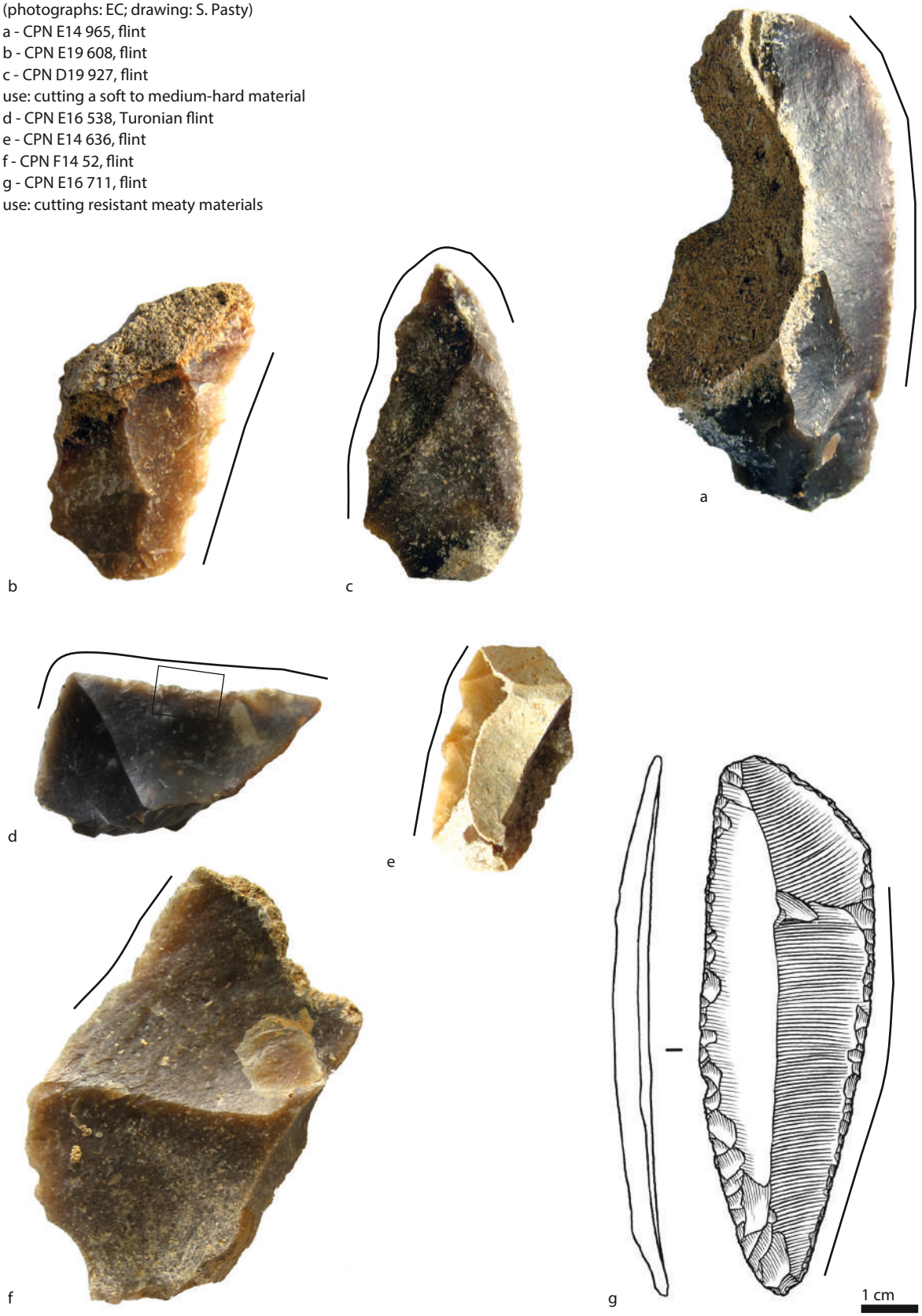


Figure 219 - Unmodified flakes and retouched tools from the site of Chez-Pinaud used or probably used in cutting in the context of butchery (continued in the next figure). The black rectangle indicates the location of the photograph of the use-wear traces presented in figure 172[c] (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(photographs: EC; drawing: S. Pasty)
a - CPN E18 32, flint
use: cutting meat
b - CPN D19 880, flint
c - CPN E14 701, flint
d - CPN E15 164, Turonian flint
use: cutting a soft material
e - CPN D19 854, flint
use: cutting a soft (G) and meaty (D) material
f - CPN E12 289, flint
g - CPN D16 343, Turonian flint
use: cutting a soft to medium-hard material

Figure 220 - Unmodified flakes and retouched tools from the site of Chez-Pinaud used or probably used in cutting in the context of butchery (end). The black rectangle indicates the location of the photograph of the use-wear traces presented in figure 172[d] (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(drawings: S. Pasty and F. Brenet)
a - CPN F15 111, sandstone-quartzite
use: cutting meat
b - CPN E18 30, flint
use: cutting a soft to medium-hard material
c - CPN F15 117, flint
d - CPN E14 545, flint
use: cutting a cutaneous or meaty material

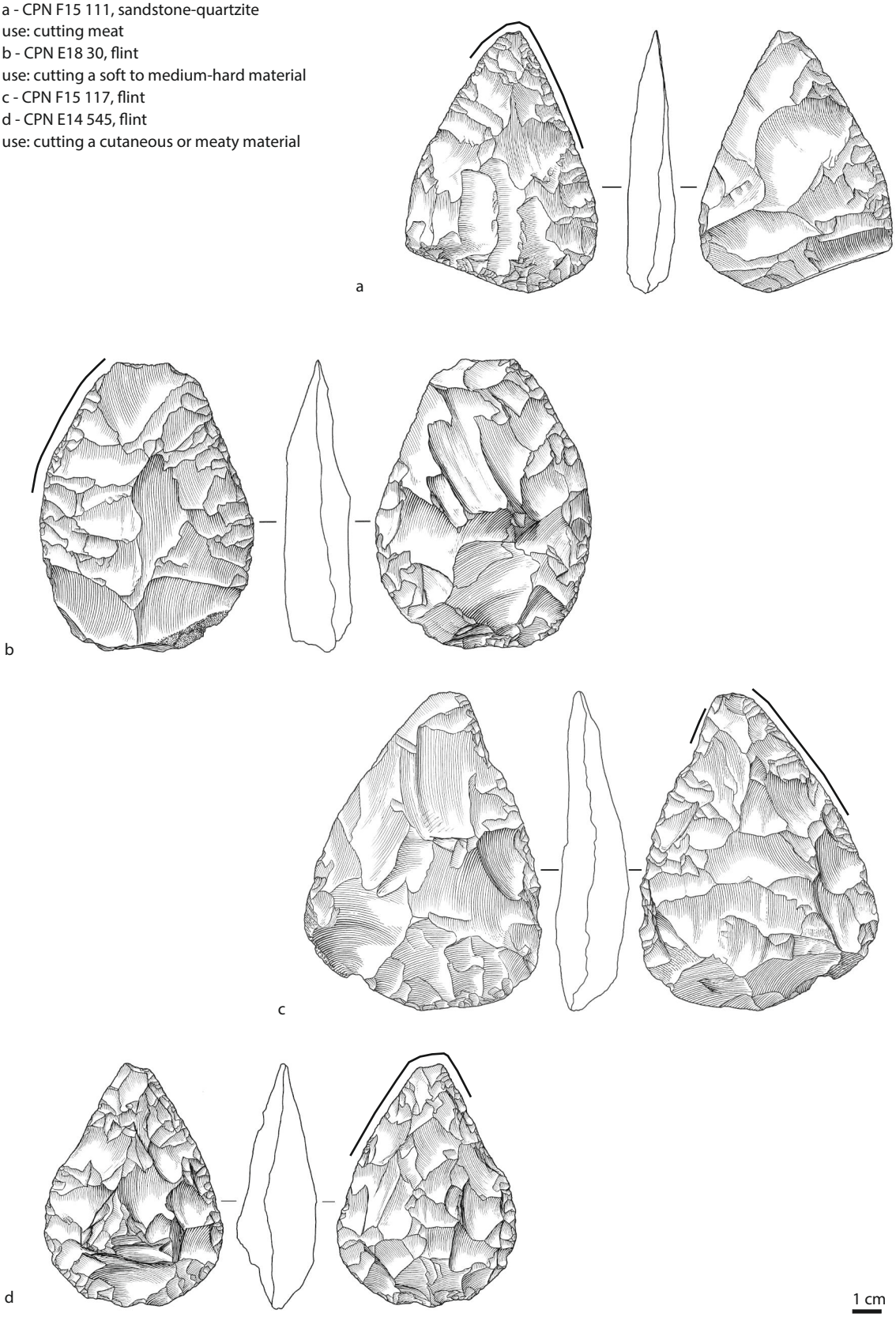


Figure 221 - Bifaces from the site of Chez-Pinaud (continued in the next figure) used or probably used in cutting in the context of butchery (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(drawings: S. Pasty and F. Brenet)
a - CPN E13 624, flint
use: cutting soft material
b - CPN F16 73, flint
use: cutting soft to medium-hard material
c - CPN E14 301, flint
use: cutting cutaneous or meaty material
d - CPN E15 324, flint
use: cutting soft to medium-hard meaty material

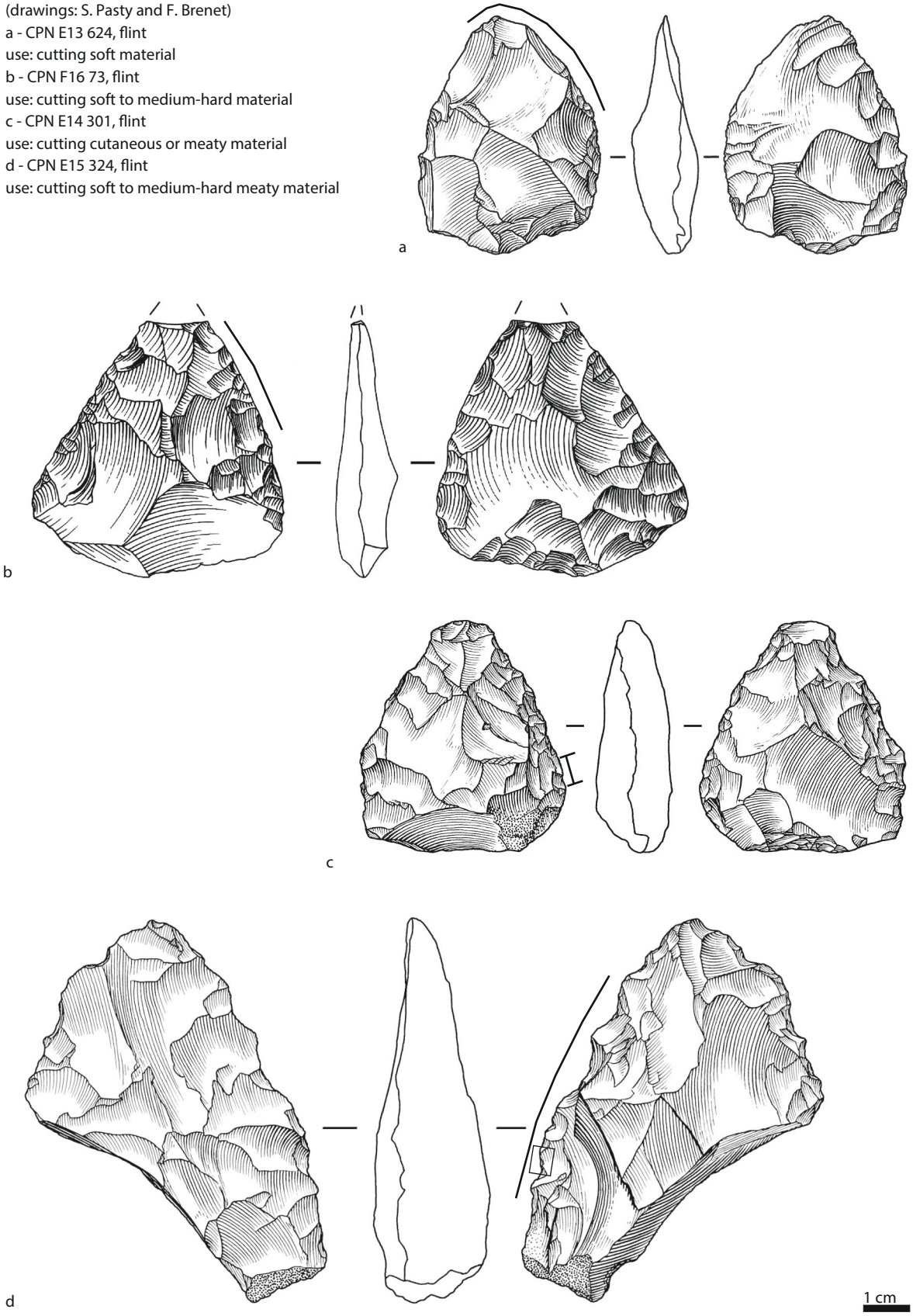


Figure 222 - Bifaces from the site of Chez-Pinaud (end) used or probably used in cutting in the context of butchery (CAD: É. Claud and M. Coutureau).

Combe Brune 2
(photographs: EC)
CB2 61010, flint
use: cutting a soft material

La Conne de Bergerac
(drawings: F. Brenet; photographs: EC)
a - BDS 01, s41 c2/3 6073, flint
use: cutting a soft material
b - BDS Z2 6072, flint
use: cutting cutaneous or meaty materials

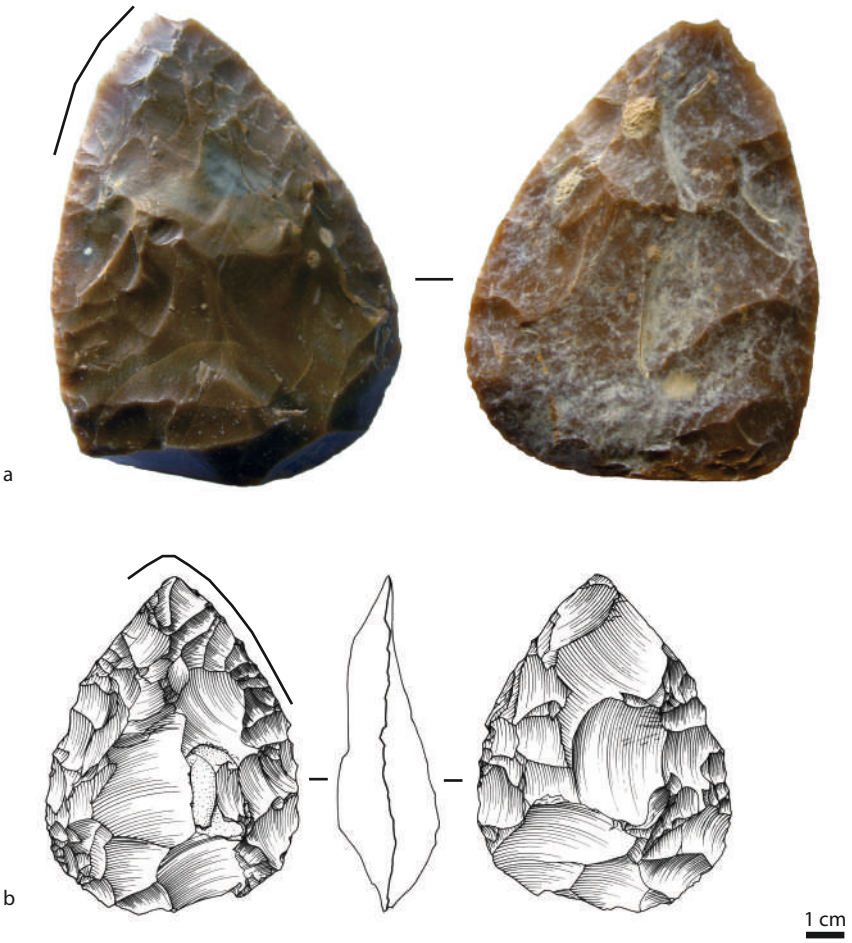


Figure 223 - Bifaces from the sites of Combe Brune 2 and La Conne de Bergerac used or probably used in cutting in the context of butchery (CAD: É. Claud and M. Coutureau).

Fonseigner
(drawings: J.-M. Geneste)
a - Fons 77 Dsup 13 30, flint
b - Fons A6 01 Dsup 3, flint
c - Fons 77 Z2 Dsup 03, flint
use: cutting meat
d - Fons 77 Z4 Dsup 01 12, flint
use: cutting soft to semi-hard materials like hide and meat
e - Fons 77 A4 85 Dsup 14, flint
use: cutting soft to medium-hard material
f - Fons Z3 106 Dsup 9, flint
use: cutting soft to medium-hard materials like hide and meat
g - Fons 77 A5 65 Dsup 11, flint
h - Fons 77 22 Dsup 13, flint
i - Fons 3 Z1 Dsup 4, flint
use: cutting resistant meaty materials

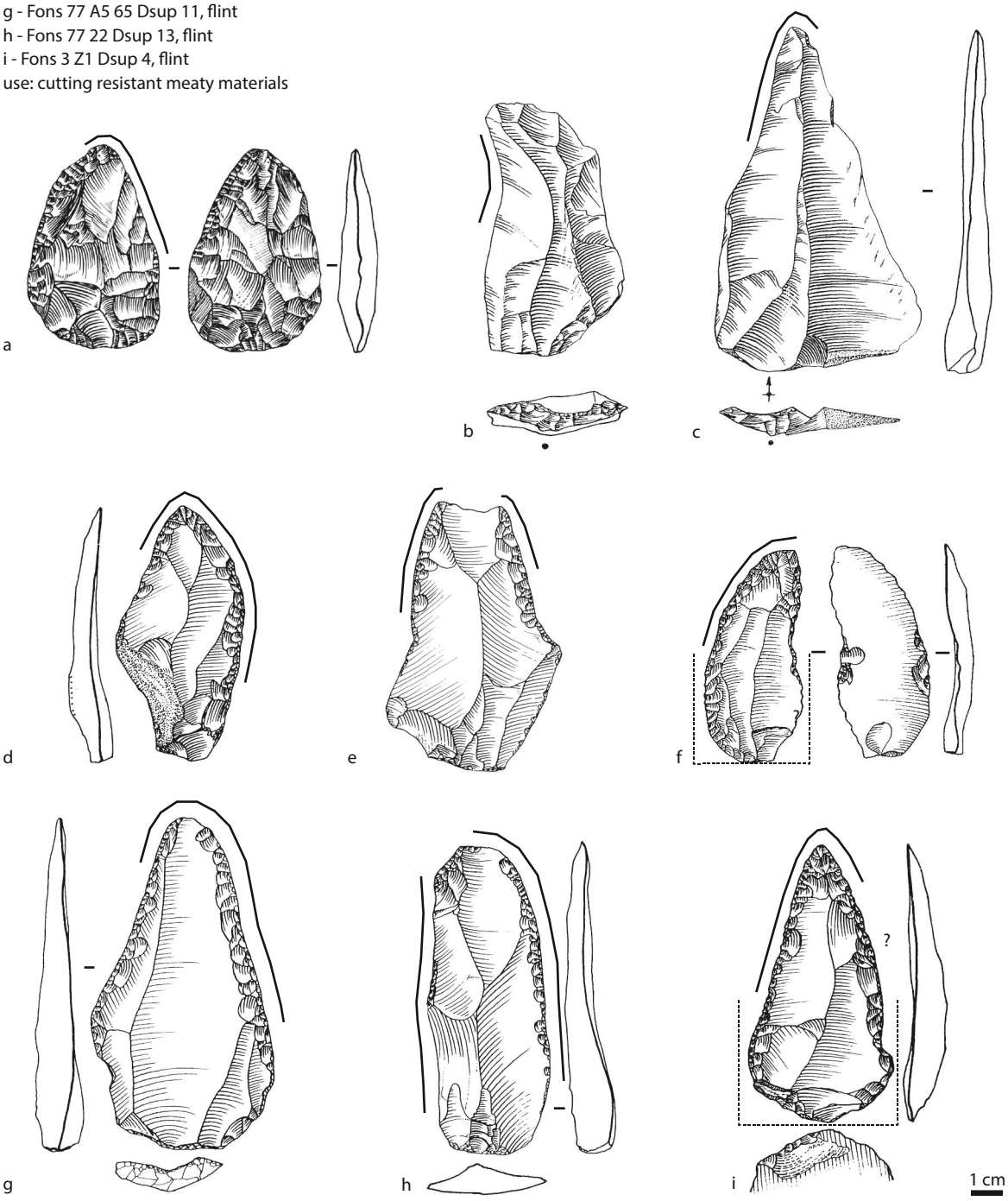
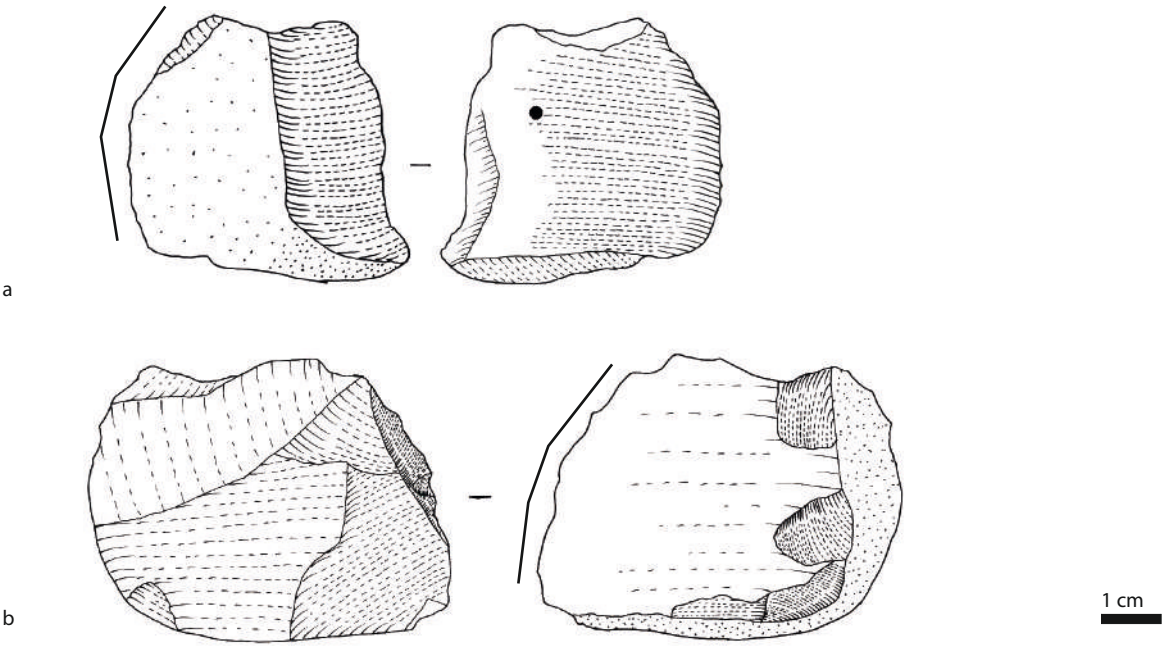


Figure 224 - Biface, unmodified flakes and retouched tools from the site of Fonseigner used or probably used in cutting in the context of butchery (CAD: É. Claud and M. Coutureau). The dotted zone indicates the potential location of hafting.

Coudoulous
(drawings: FV)
a : Cou I J 10 6b6, quartz
use: cutting meat and gripping contact with hide (point)
b : COU 4 #65, quartz
use: cutting meat



Les Fieux
(photographs: CT)
a - K 30 068, quartzite (side scraper)
use: cutting a soft material
b - K 30 859, flint
c - K 35 610, flint
use: cutting a soft to medium-hard material

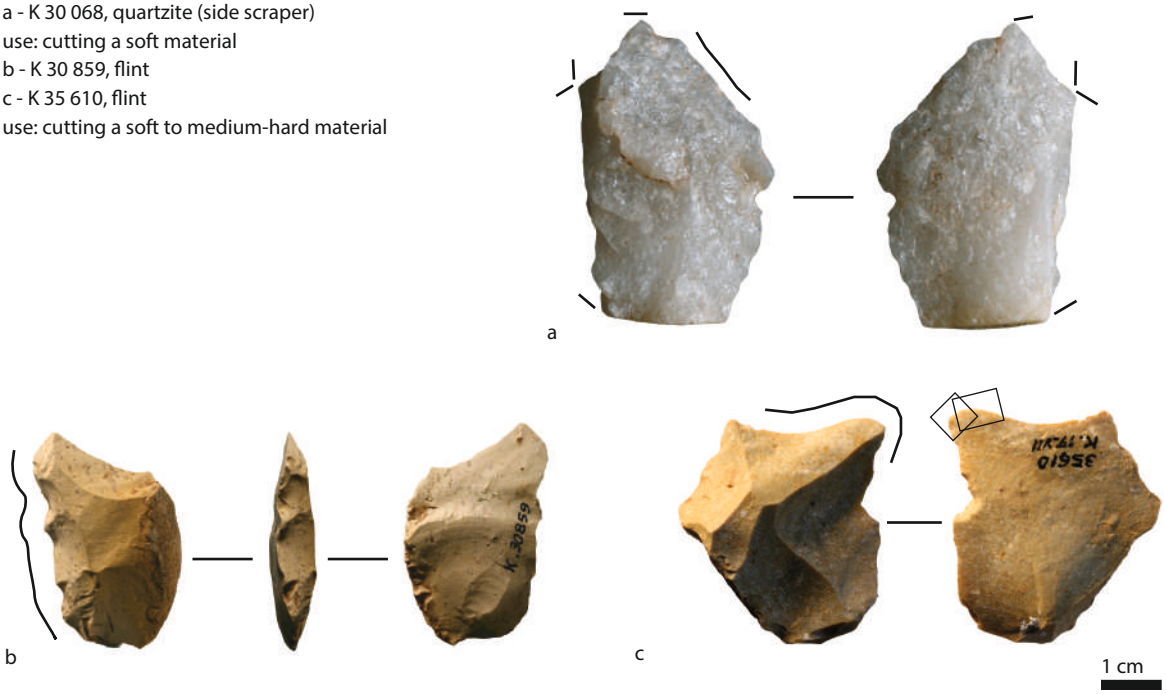


Figure 225 - Unmodified flakes and retouched tools from the sites of Coudoulous and Les Fieux used or probably used in cutting in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 174[a-b] (CAD: É. Claud and M. Coutureau).

Mauran
(photographs: CT)
a - D 77 D10 45, quartzite
b - M95 3, flint
c - M81 SV 118, flint
d - M75 II C13 121, quartzite
use: cutting a soft to medium-hard material

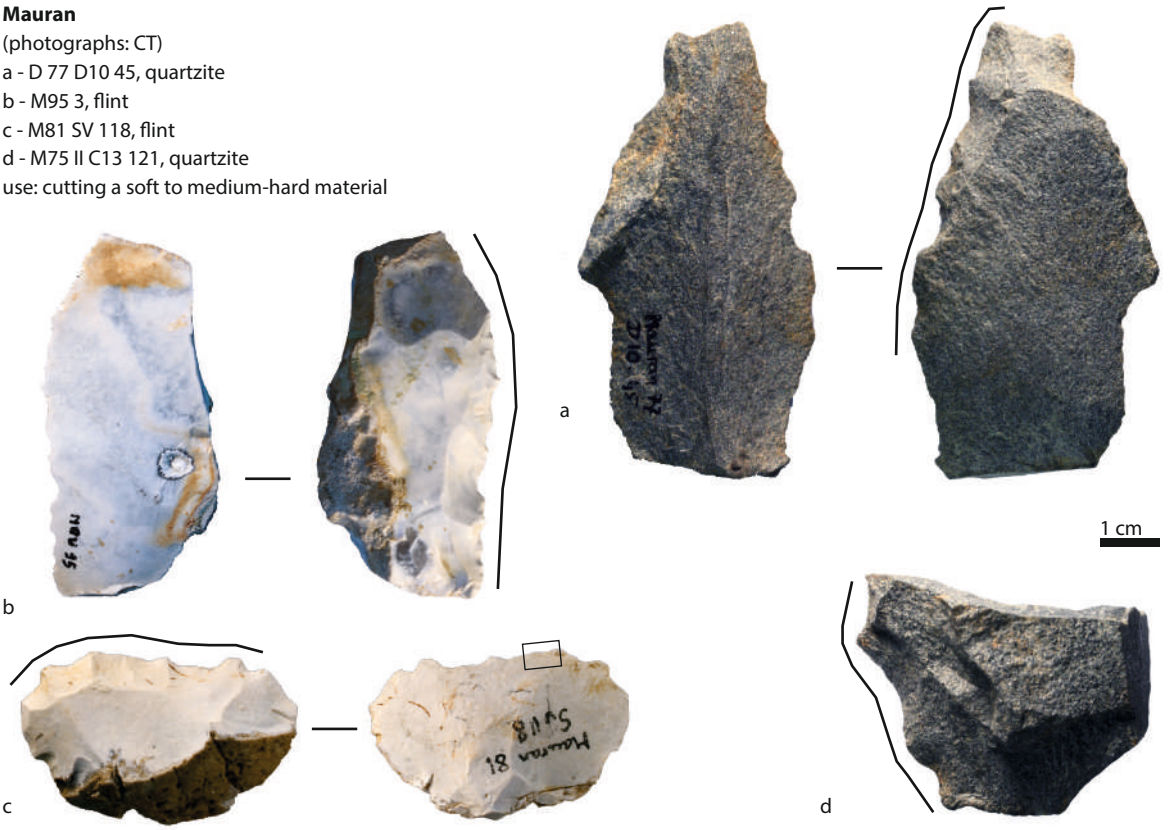


Figure 226 - Denticulates from the site of Mauran used or probably used in cutting in the context of butchery. The black rectangle indicates the location of the photograph of the use-wear traces presented in figure 174e (CAD: É. Claud and M. Coutureau).

Publications noting the presence of tools in the Middle Palaeolithic of Western Europe that served or could have served in cutting for butchery purposes are numerous (table 65). In fact, evidence of this activity has been recognized in all of the assemblages subjected to comprehensive analysis, with the exception of Corbiac, Pech de l'Azé I and IV, Grotte du Renne, and Les Pradelles (Anderson-Gerfaud, 1981; Beyries, 1987a), and these studies are not without methodological problems (see Part II, chapter 4.1). Aside from the open-air site of Corbiac, these sites have preserved abundant faunal remains that indicate substantial butchery activities, evidenced directly by the numerous butchery marks on the bones (Costamagno *et al.*, 2006; Rendu, 2010; Hodgkins, 2012; Niven, 2013). At Les Pradelles in particular, occupation was focused on reindeer butchery (see Part II, chapter 3.1; Costamagno *et al.*, 2006; Meignen *et al.*, 2007; Rendu *et al.*, 2011). Thus, at this site, the absence of use-wear traces indicative of butchery does not accurately reflect the site function. It is possible that a certain number of the tools from these sites that were categorized as unused or used on an undetermined material were actually used in butchery. As noted elsewhere in this publication (see Part I), simple unmodified flakes make excellent butchery tools, and were often excluded from these use-wear analyses.

Some few sites in Western Europe provide evidence for the use of materials other than flint in the production of butchery tools: quartz at Tunnelhölle and Lurgrotte in Austria (Derndarsky, 2006; 2008), rock crystal at Champ-Grand in south-eastern France (one side scraper; Plisson, 2008), quartz and quartzite at Axlor, Cueva Morín, Cova Eiros and San Quirce in Spain (Lazuén, Gonzales-Urquijo, 2014; Lazuén, 2012a; Clemente-Conte *et al.*, 2012) and schist at Axlor and Cueva Morín

	Site	Tool types
England	La Cotte de Saint Brelade	scraper and biface resharpening flakes
Belgium	Rémicourt	elongated flakes
	Spy	Mousterian points
Netherlands	Maastricht-Belvédère (site J)	unretouched flakes
	Maastricht-Belvédère (site K)	Levallois points
	Maastricht-Belvédère (sites B-G)	core edge flakes and blades
Germany	Lehringen	Levallois flakes
	Lichtenberg	bifacial backed tools
	Sesselfelsgrotte	bifacial tools (among others), sometimes hafted
Austria	Lurgrotte	cortical backed knives
	Tunnelhölhe	unretouched flakes
Northern France	Attilly "Bois de la Bocquillière"	preferential Levallois flakes, retouched or not
	Beauvais "La Justice"	pseudo-Levallois points
	Bettencourt-Saint-Ouen	unmodified or retouched Levallois points
		unmodified or retouched Levallois points
	Biache-Saint-Vaast	short and non convergent scrapers
		Levallois flake, retouched Levallois point, simple, double and convergent scrapers (tools with asymmetric convergent edges, sometimes hafted)
	Corbehem	cortical backed knives
	Fresnoy-au-Val	Levallois point
	Havrincourt "Les Bosquets" (sector 2)	unretouched flakes, blades, cortical and retouched backed knives
	Havrincourt "Les Bosquets" (sector 1)	preferential Levallois flakes, retouched or not
	Hermies "Le Tio Marché" and "Champ Bruquette"	preferential Levallois flakes
		preferential Levallois flakes
	Le Pucheuil	"Le Pucheuil" flakes
	Riencourt-lès-Bapaume	unretouched blades
	Saint-Amand-les-Eaux	bifaces and biface manufacturing flakes (unmodified or retouched)
	Therdonne	Levallois points
South Western France	Bayonne Jupiter	unretouched flakes (various types: semi-cortical flakes, cortical backed flakes, core edge flakes, flakes from full debitage, pseudo-Levallois points), pseudo-Levallois point with a retouched back, scrapers
		scrapers, pseudo-Levallois, point, biface
	Bourg-Charente	unretouched flakes (cortical backed knives, core edge flakes, pseudo-Levallois points), retouched backed flakes, denticulate
	Bout des Vergnes	unretouched flakes, bifaces, scraper, backed knives
	Canolle	unretouched flakes, scraper, bifaces, mousterian point, retouched backed knife, biface manufacturing flakes
	Cantalouette II	undetermined
	Combe-Grenal (layers 3 or F)	cortical backed knife
	Grotte XVI	bifaces
	Chez-Pinaud (US 22)	Quina scrapers, scraper manufacturing flakes, retouching flakes, recycling flakes (retouched or not)
	La Mouline	unmodified and retouched flakes (full debitage flakes, core edge flakes, pseudo-Levallois points, cortical backed knives, semi-cortical flakes)
	Abri du Musée	pieces with tranchet blow, tranchet blow flakes
	Latrote	bifaces, denticulates, scrapers, mousterian points
	Les Bessinaudes	semi-cortical flakes, pseudo-Levallois points, cortical backed knives, flakes from full debitage, double scraper on an elongated flake, thinned piece, retouched flake, scrapers (including convergent ones)

	Site	Tool types
South Western France	Les Tares	scrapers with Quina retouch, retouching flakes
	Romentères	a flint flake
	Vaufrey	cortical backed knife and denticulates
	Vieux-Coutets	unretouched flakes from full debitage, scrapers, endscrapers
South Eastern France	Baume Vallée	unretouched flakes
	Champ-Grand	scraper (in rock crystal)
	La Combette	unretouched flakes, rare retouched flakes, with a straight delineation and a plano-concave section
	Pié-Lombard	cortical backed knives
Italy	Grotta Breuil (layers 3 and 6)	unretouched flakes, rare retouched flakes, often semi-cortical and with straight profile, biplanar section and various delineations
	Grotta Breuil (layer XX)	unmodified semi-cortical flakes, cortical backed knife (among others)
	Ciota Ciara cave	indet. (scrapers, mousterian points, notched piece?)
Spain	Abric Romaní (levels H, I, Ja)	flakes, denticulates, scraper
	Abric Romaní (level 0)	retouched Levallois point (traces on the unretouched edge), unretouched Levallois point
	Abric Romaní (level M)	unretouched flakes
	Amalda	unretouched flakes (including Levallois flakes)
	Arlanpe	undetermined
	Axlor	scraper resharpening flakes (unretouched)
	Bajondillo cave	unretouched flakes and blades (two with a retouched prehension area)
	Cova Eiros	unretouched flakes (quartz or quartzite)
	Cueva Morín (layer 16)	scraper resharpening flakes (unretouched), unmodified flake, retouched flake, quartzite scraper
	Cueva Morín (layer 18)	scraper resharpening flakes (unretouched)
	El Salt	unretouched flakes (semi-cortical flakes, Levallois flakes, core edge flakes, cortical backed knives)
	La Quebrada	Levallois micro-flakes
	San Quirce	unretouched flakes, choppers

Table 65 - Published data on Middle Palaeolithic assemblages in Western Europe that have yielded butchery knives, and the relevant types of pieces.

(Lazuén, 2012a; Lazuén, Gonzáles-Urquijo, 2014). None of the available publications indicate a particular raw-material economy, such as the preference for a specific material for the performance of particular butchery activities. At present, butchery marks on bone also provide no information relevant to these discussions.

The techno-typological characteristics of knives in our study samples seem to vary in line with different groups and technological traditions. Unmodified flakes are very often mentioned and derive from various methods of reduction: recurrent and preferential Levallois, micro-Levallois, Discoidal, lamellar, and the Le Pucheuil (secondary debitage) type. Unmodified butchery knives therefore display great variation in dimensions and morphologies: pseudo-Levallois points, backed core-edge flakes, cortically backed knives, Levallois flakes, Levallois points, semi-cortical flakes, Kombewa flakes, laminar flakes or blades. Flakes resulting from production (shaping, retouch, or recycling) of side scrapers – notably of the Quina type – and of bifaces or bifacial pieces also in some cases bear evidence of use in butchery (Frame, 1986; Geneste, Plisson, 1996; Coudenneau, 2005; Claud *et al.*, 2012; Claud, 2014a; Lazuén, Gonzáles-Urquijo, 2014; Bourguignon [ed.], in prep.).

Saint-Césaire
(drawing: CT; photographs: EC)
a - H4 (I) Egpf 27 28, flint
b - H5 (II) Ejpf 27, flint
c - G5 IV Egpf 27 263-30-43 3, flint
d - G5 (II) 27 269-76-73 3, flint
e - D4 III Egpf 28 276-61-50 6, flint
f - I4 (I) Ejpf 27, flint
use: cutting a soft to medium-hard material
abrupt marginal retouch

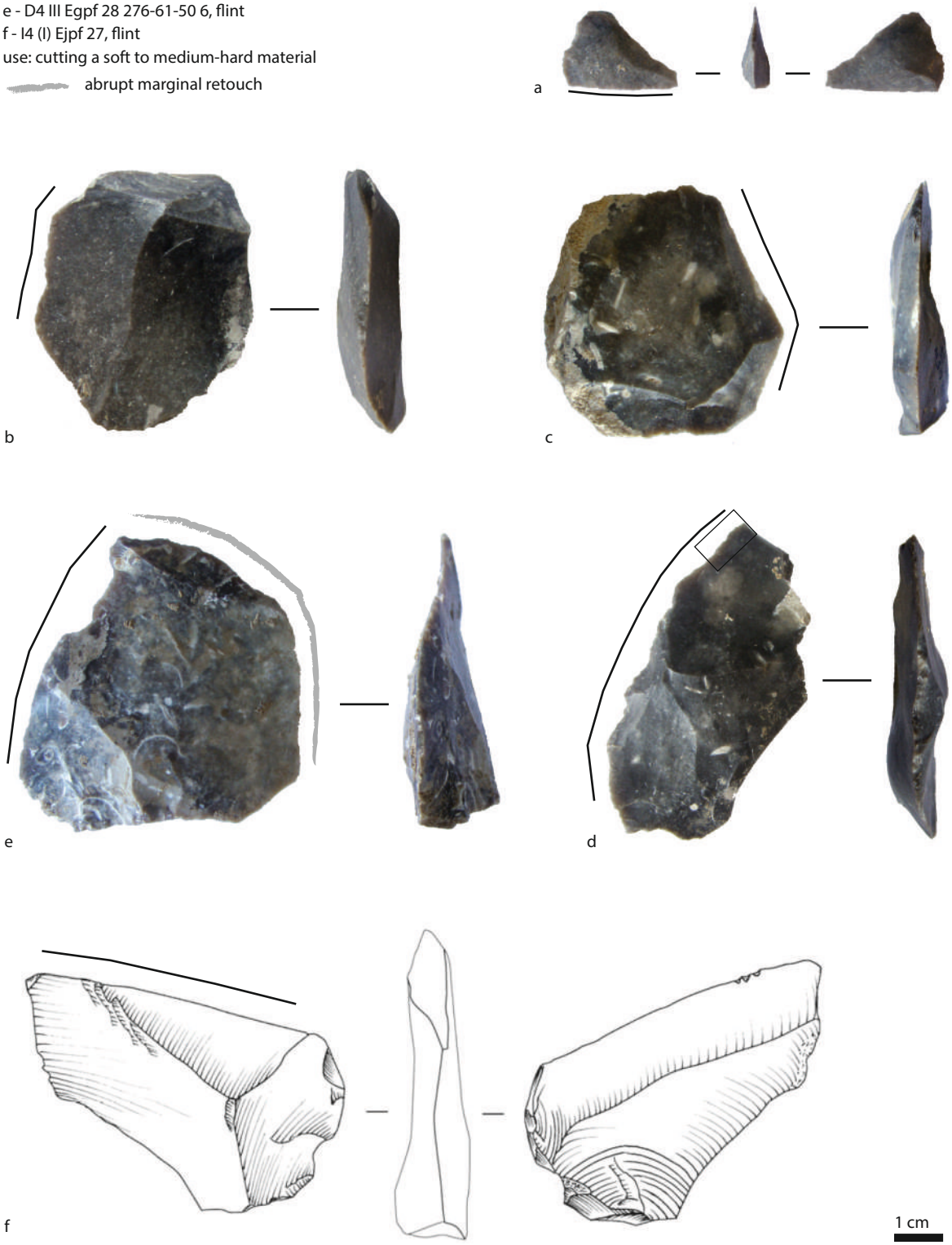


Figure 227 - Unmodified flakes (including resharpening flakes, a) and denticulates from the site of Saint-Césaire used or probably used in cutting in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 175[c] (CAD: É. Claud and M. Coutureau).

Shaped and retouched tools are also subject to great variation in form. In our study samples, traces of cutting in butchery activities were regularly observed on bifaces and bifacial pieces (Veil *et al.*, 1994; Soressi, Hays 2003; Coudenneau, 2005; Rots, 2009; Bernard-Guelle *et al.*, 2010, 2014; Colonge *et al.*, 2015; Ihuel [ed.], 2016; Bourguignon [ed.], in prep.). Side scrapers are frequently mentioned as butchery knives and made on a variety of blanks: Levallois flakes, flakes from Quina debitage, biface manufacturing flakes, flakes from side scraper resharpening / recycling, etc. The types of side scrapers are equally varied with some widely shared morphological characteristics, such as the presence of two convergent cutting edges, with two retouched edges or one edge left unmodified (Claud *et al.*, 2012; Rots, 2013; Chadelle *et al.*, 2016). Retouched Mousterian points and Levallois points used in butchery are rare, but do occur at Spy (Coudenneau, 2013), Biache-Saint-Vaast (Rots, 2013), Bettencourt-Saint-Ouen (Locht *et al.*, 2002), Canolle (Bourguignon [ed.], in prep.), Latrote (Bernard-Guelle *et al.*, 2010) and Abric Romaní, level 0 (Gauvrit Roux, 2013). Such is also the case for denticulates, used as butchery knives at just four sites: Grotte Vaufrey (Beyries, 1987a), Bourg-Charente (Connet *et al.*, 2016), Latrote (Bernard-Guelle *et al.*, 2010) and Abric Romaní (Martinez-Molina, 2005). At Abric Romaní, they were used in skinning, disarticulation, and probably defleshing (Martinez-Molina, 2005). Finally, the use of knapped cobbles in quartz and quartzite for the cutting of meat has been observed at one site, San Quirce (Clemente-Conte *et al.*, 2012).

The diversity of blanks used for making butchery tools can be seen across sites, regions, and time periods, but it can also be seen, as our study samples show, within the same assemblage. In fact, numerous sites that have been subjected to comprehensive lithic analysis contain butchery knives on varied blanks:

- Biache-Saint-Vaast: Levallois flake, retouched Levallois points, simple side scrapers, double side scrapers, and convergent side scrapers (Rots, 2013);
- Bourg-Charente: unmodified flakes (backed asymmetrical flakes, cotically backed knives), retouched backed knives, and denticulates in flint (Connet *et al.*, 2016);
- Canolle: unmodified debitage flakes, biface manufacturing flakes, side scrapers, bifaces, Mousterian points, backed knives (Bourguignon [ed.], in prep.);
- Les Bessinaudes: semi-cortical flakes, pseudo-Levallois flakes, cortically backed knives, flakes from full debitage, a double side scraper on an elongated flake, a thinned piece, a retouched flake, convergent side scrapers, side scrapers (Chadelle *et al.*, in prep.);
- Les Tares: Quina and non-Quina retouched side scrapers, backed knives, and scraper retouching flakes (Geneste, Plisson, 1996);
- Chez-Pinaud US 22: Quina side scrapers, flakes from side scraper manufacture – shaping, retouch, and decortication (Claud, *et al.*, 2012);
- Latrote: bifaces, denticulates, side scrapers, Mousterian points (Bernard-Guelle *et al.*, 2010, 2014);
- Bayonne Jupiter PM1: unmodified flakes (some semi-cortical or cortically backed knives and core-edge flakes), side scrapers, and a pseudo-Levallois point with knapped backing (Cologne *et al.*, 2015);
- Bayonne Jupiter PM2: side scrapers (certain used on the unmodified edge), a pseudo-Levallois point, and a biface (Cologne *et al.*, 2015);
- Abric Romaní: denticulates, flakes, a side scraper (Mártinez-Molina, 2005).

The active zones are rarely described in detail, but when they are, several features are frequently mentioned or directly observable in the photographs or drawings provided: the edges are frequently unmodified, the outlines in plan view are varied (convex, pointed, rectilinear, denticulate, irregular, ...), the cutting angle closed to half-open (between 25° and 50°), the profiles are frequently rectilinear, and the cross-sections often biplanar or plano-concave (for the latter details, see Lemorini, 2000; Claud *et al.*, 2012; Coudenneau, 2013; Claud *in* Goval *et al.*, 2013; Claud *in*

Chadelle *et al.*, in preparation; Claud, 2014a). With regard to the prehension areas, a considerable number of studies have shown the frequent but rarely systematic use of a natural zone (cortical or semi-cortical backing, platform) suited to use with a bare hand, notably on unmodified flakes (at Lugrotte, Maastircht-Belvédère site B-G, Le Pucheuil, Corbehem, La Cotte de Saint Brelade, Bourg-Charente, Grotte Vaufrey, Combe Grenal level 3 or F (13), Pié-Lombard, Bout des Vergnes, Canolle, La Mouline, Les Bessinaudes, Chez-Pinaud US 22, Les Tares, Bayonne Jupiter PM1 and PM2, Grotta Breuil XX). Several assemblages contain butchery tools with potential prehension zones prepared by retouch, sometimes in continuity with the platform or an overshot or cortical backing, often positioned opposite the active zone. The retouch is discrete, semi-abrupt to abrupt, and marginal to short. Sometimes simple rubbing was used to create a backed knife, more than a real retouch. The blanks are varied: flakes from Discoidal debitage (Bourg-Charente, Bayonne Jupiter PM1) or Levallois debitage, unmodified or retouched (Saint-Amand-les-Eaux, Havrincourt sector 1, Atilly, Hermiès, Canolle), biface manufacturing flakes (Saint-Amand-les-Eaux) and bifacial pieces (Lichtenberg). In contrast, traces of hafting have been observed on some of the knives from Sesselfelsgrotte, Biache-Saint-Vaast and on the majority of Levallois points from Bettencourt-Saint-Ouen that were used in butchery (Rots, 2009, 2015b).

The characteristics of butchery knives defined in our study sample are thus coherent with the published data for sites in Western Europe. Various raw materials, blanks, and types of tools were used (figure 239, table 70), but some strong trends can be observed with regard to morphology. The edges are most often unmodified and of low angle and, when they are retouched, the retouch is to semi-abrupt, maintaining an edge angle that is low to moderate (around 45°); the sides are often convergent or come to a point; prehension zones, natural or retouched, may be present, and it appears (to varying degrees of certainty) that certain pieces were hafted.

The diversity of raw materials used to these ends can be partly attributed to local availability. The diversity, notably typological, of butchery knives at the intra-site level could be explained by the following factors, or some combination of them:

- a functional complementarity of pieces, with different tools being used for different butchery operations, as J.-M. Geneste and H. Plisson (1996) have proposed for the assemblage at Les Tares on the basis of the morphological characteristics of the tools, unmodified and retouched, and more or less heavy and sharp;
- a specific function for tools like bifaces, a hypothesis that is supported by the technological skill necessary for their production, the longevity of these pieces, and their frequent transport at a regional / territorial scale (see Claud, 2008 for an overview and Part II, chapter 4.4.C);
- retouching or resharpening of active zones, in order to make them stronger and sharper, or more pointed. This could notably be the case for bifaces or bifacial scraper flakes, that were sometimes retouched into scrapers (Chez-Pinaud US 06/07 and US 22, Claud *et al.*, 2012; Claud *et al.*, 2014a), as their unmodified edges were thin and fragile (20°-25°); pseudo-Levallois points and core-edge flakes retouched into denticulates at Saint-Césaire, Mauran, and Les Fieux, or even certain side scrapers at Fonseigner. Additionally, the retouching of unmodified edges that bear traces of use in cutting fleshy material into denticulates has been observed on two notched pieces at Saint-Césaire and one denticulate that presents traces from cutting flesh on an unretouched portion interrupted by the denticulate retouch.

The inter-site techno-typological diversity of butchery knives, on the other hand, certainly reflects a diversity of technological traditions amongst Neanderthal groups. Let us take, for example, Les Fieux, Mauran, and Saint-Césaire on one hand and Chez-Pinaud US 06/07 on the other. Bison was the primary prey animal at all four sites, but the Neanderthals at the first set of sites used denticulates, while those at the second used scrapers and bifaces.

c - Butchery by percussion

Traces indicative of percussion against medium-hard to hard and hard organic materials were observed on only 22 active zones (table 51) on pieces from at the sites of El Castillo, Abri Olha I, Saint-Césaire, Chez-Pinaud and, to a lesser extent, Les Fieux (a single piece). At the first two sites, this mode of use was identified on 13 flake cleavers in ophite and quartzite, with the traces localized on the transverse distal edge (tables 58, 63, figures 228-229). The nine other tools, in flint, are of varying morphology: four unmodified flakes, two core-edge flakes and one with a cortical back, two denticulates, one Clactonian notch, a side scraper, and a *bec* (figures 229-230).

Macro use-wear, consisting of highly developed scarring (see Part II, chapter 2), has been linked to percussive activities in the exploitation of animal resources: expedient butchery (rapid deflesh-ing, forceful disarticulation) and/or, in the case of flake cleavers, the fracturing of bones (axial skeleton, long bones).

The scarring on flake cleavers, extensive and of large dimensions, stands in contrast to that observed on most of the other tools that were used in percussion. The intensity of the use-wear, combined with the probable hafting of the flake cleavers (see Part II, chapter 2) suggests that these pieces functioned differently from others that were probably not hafted.

On one hand, the flake cleavers would be employed, according to our experimental comparisons, to stages of forceful disarticulation (separating the skull from the vertebral column, for example) or fracturing (ribs, sternum, or long bones of even large ungulates). The edges that were used are heavily altered by scarring, and therefore difficult to describe. Nonetheless, the intact portions allow us to observe that the original active zones were convex in plan, rectilinear in profile, and biplanar in section. The average angle of these active edges is 54° ± 9°.

The other tools, probably held with the bare hand, present a lesser extent of alteration by use, likely related to their modes of use in disarticulation or defleshing. They could nonetheless have served to fracture the sternum of an animal of smaller size, such as a cervid. They systematically present a prehension zone adapted to the bare hand that is positioned opposite the active zone: a cortical and/or retouched back or even, in the case of a notched piece at Saint-Césaire, a back created by abrupt marginal retouch associated with a cortical surface. The active zones are unmodified, or modified into denticulates or side scrapers (Chez-Pinaud) or notched type. The side scraper from Chez-Pinaud bears shallow retouch on the active zone, which is convex in shape. In contrast, the unmodified (lateral left) edge on the side scraper from Saint-Césaire was the one used for butchery; alongside a core-edge back the semi-abrupt to abrupt retouch localised on the distal end forms a concave surface ideal of prehension. The active zones are of varied morphology in plan view (convex, rectilinear, denticulated, and, more rarely, concave, and pointed, see figures 228-230) and in profile (rectilinear, convex, concave) and are most often biplanar in section. The average angle of the cutting edge is 50° ± 7°.

The two pieces that bear traces of mixed modes of action and were probably used in butchery (a racloir from Chez-Pinaud and an unmodified flake in schist from Grotte du Noisetier, figures 229^{c}-230) could have been used for disarticulation and defleshing, by both percussion and cutting.

Unmodified or retouched tools that bear traces of percussion against a hard organic material and could have been used in butchery activities are rare in published studies (table 66). There are, however, some exceptions. One such example is from the Northern European site of Atilly "Bois de la Bocquillière", a double side scraper on a preferential-Levallois flake with partial retouch that bears scarring on its right edge (43°) indicative percussive contact with a hard material could have been used in forceful disarticulation. Similar traces have been observed on the retouched convex edge (46°) of a flake from Saint-Amand-les-Eaux, on which the opposing edge bears retouch by inverse, abrupt removals followed by crushing, forming a potential prehension zone. At Hermiès,

	Site	Tool types
Germany	Sesselfelsgrotte	notched pieces (possible use)
	Salzgitter Lebenstedt	*Faustkeile* ("bone breaking")
Northern France	Attilly "Bois de la Bocquillière"	double scraper with a partial retouch on a preferential Levallois flake
	Havrincourt "Les Bosquets" (sector 1)	preferential Levallois flake (used by cutting and maybe scraping) (possible use in percussion)
	Hermies "Le Tio Marché"	preferential Levallois flakes
	Saint-Amand-les-Eaux	retouched backed flake
North Center France	Le Fond des Blanchards	*hachoir* (large bifacial scraper)
South Western France	Bayonne Jupiter	biface(s) with a natural base and a distal transverse edge
	Chez-Pinaud (US 22)	Quina scrapers, scraper recycling flakes (traces on the platform)
	La Mouline	flake (possible use)
	Les Bessinaudes	biface(s) with a natural base and a distal transverse edge, unretouched semi-cortical flake
	Romentères	choppers (quartzite)
Spain	Badaran	flint flake cleaver (possible use)

Table 66 - Published data on Middle Palaeolithic assemblages in Western Europe that have yielded traces of percussion against a hard material, probably organic (butchery activity?) and the types of pieces that present such traces. See Annex 1 for the literature references.

L. Vallin *et al.* (2006) have interpreted the large removals on certain preferential-Levallois flakes as the result of percussive action on hard materials, in some cases as intermediate pieces for splitting bone. A reanalysis of some of these flakes (Claud *in* Goval, Hérisson [dir.], in prep.; Vallin [dir.], in prep.) showed that the proposed indirect percussion is unlikely, based in large part on the absence of evidence of percussive force on the end opposing the active zone. It seems more likely that these pieces were used in butchery activities, but in direct percussion on a carcass. This method of bone fracture or disarticulation can be inferred from extensive edge damage, while defleshing is more likely to produce less pronounced scarring. The two pieces bearing the clearest such traces have unmodified edges with an angle between 35° and 55° (measurements taken on either side of the damaged area). No trace of hafting was detected on these pieces but the presence, on the preferential-Levallois flakes, of abrupt retouch adjacent to the platform on one or both sides could be related to prehension of these tools, facilitating either use with the bare hand (in a limited manner) or hafting. The preservation state of the assemblages does not allow for a study of prehension. To conclude the examples in Northern Europe, the *Faustkeile* that could have been used to fracture bone at Salzgitter Lebenstedt (Germany, Let, 1988 *in* Steguweit, 2003), and the two notched pieces used in percussion at Sesselfelsgrotte could have been used on wood or bone, though the hardity of the materials worked is not mentioned (Rots, 2009: 45, fig. 9).

A bit farther south, the site of Fond des Blanchards (level D1) yielded a very large bifacial side scraper or *hachoir* with a convex cutting edge opposed to a thick end that served as a zone of prehension. It bears traces of percussion against a hard organic material of the osseous type (Coudenneau *in* Lhomme *et al.*, 2007). From the Quina level at Chez-Pinaud (US 22), several recycled flakes bear traces of percussion against a hard organic material, indicating that side scrapers, prior to being recycled, were used in this manner, probably for forceful disarticulation or defleshing (Claud *et al.*, 2012). Identical traces were observed on two side scrapers recycled by notches, which demonstrates that the scrapers were used in percussion just before and after recycling. The scrapers, unifacial or bifacial, bear scaled and/or stepped retouch or notches and possess edge angles between 44 and 62° (53° ± 9°). The complete pieces possess a thick cortical back opposite the active zone. In this level at Chez-Pinaud, reindeer is the predominant species (Niven *et al.*, 2012) as is likely the case of level D1 at Fond des Blanchards (Bemilli *in* Lhomme *et al.*, 2007).

Abri Olha I
(photographs: EC)
a - no. 2916, ophite
b - no. 1, quartzite
c - no. 2714, ophite
use: percussion against a hard organic material

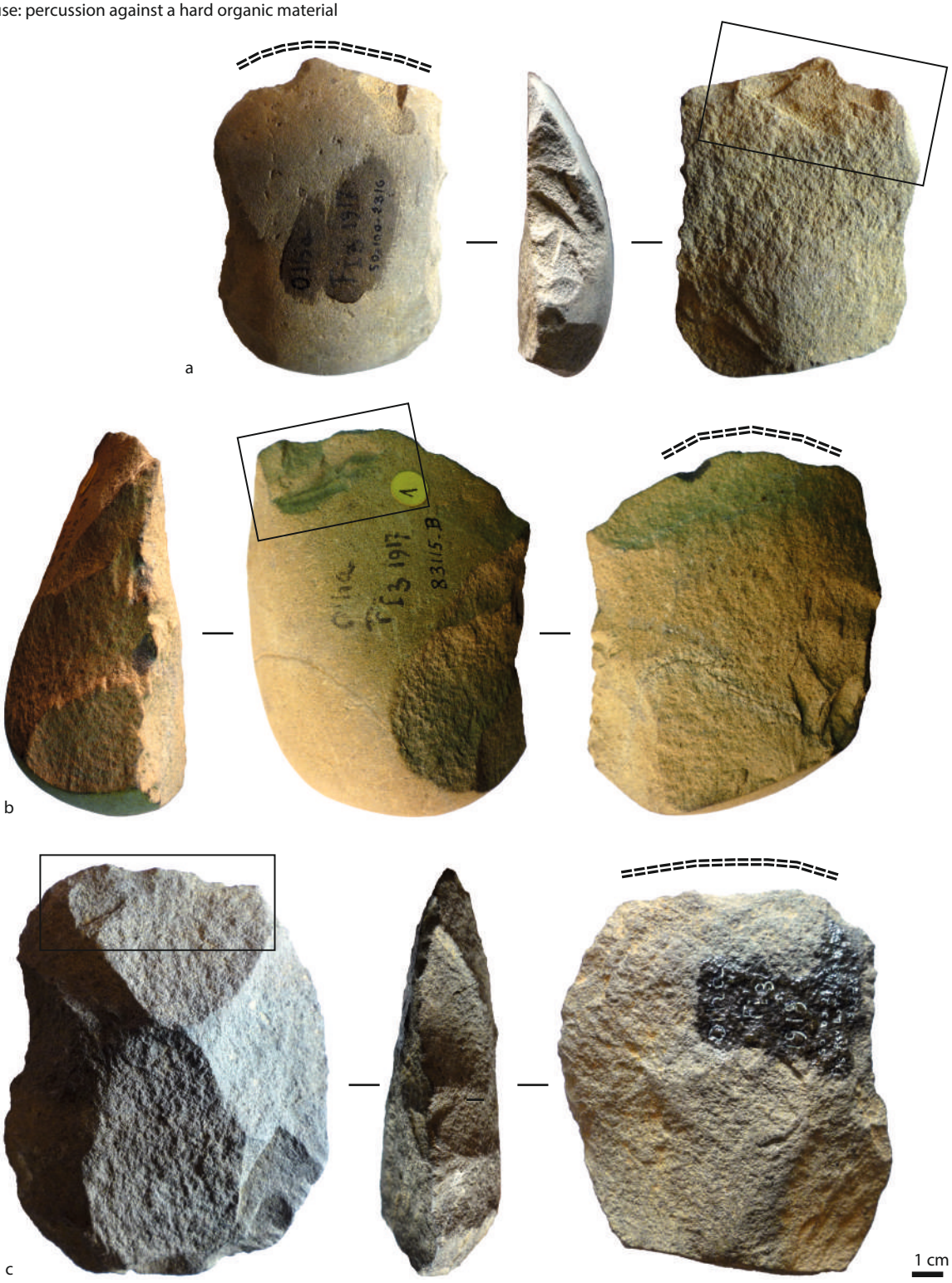
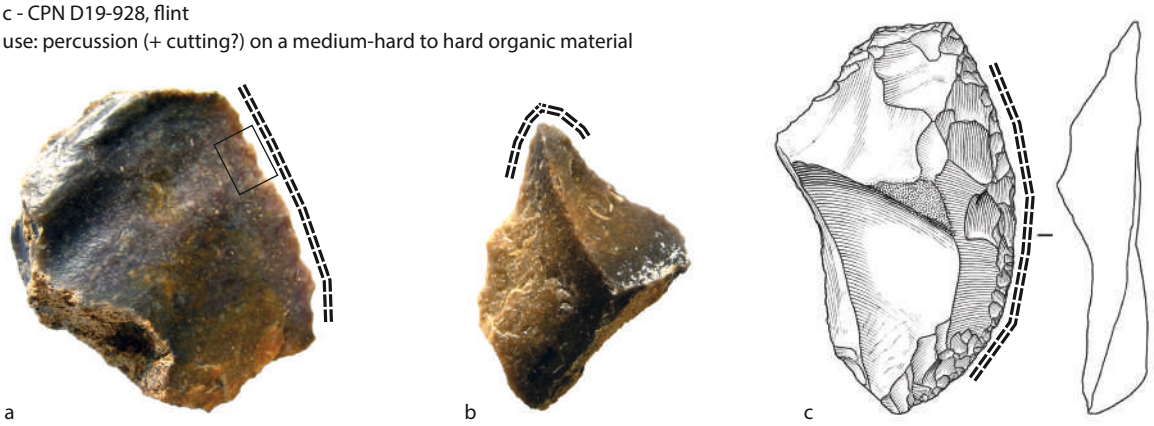


Figure 228 - Flake cleavers from the site of Abri Olha I bearing traces of percussion against hard organic materials, and probably used in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 176[a-c] (CAD: É. Claud and M. Coutureau).

Chez-Pinaud
(photographs: EC)
a - CPN E15 63, flint
b - CPN D16 270, flint
use: percussion against a hard organic material
c - CPN D19-928, flint
use: percussion (+ cutting?) on a medium-hard to hard organic material



El Castillo
(photographs: EC)
a - A 112, quartzite
b - A36, quartzite
use: percussion against a hard organic material

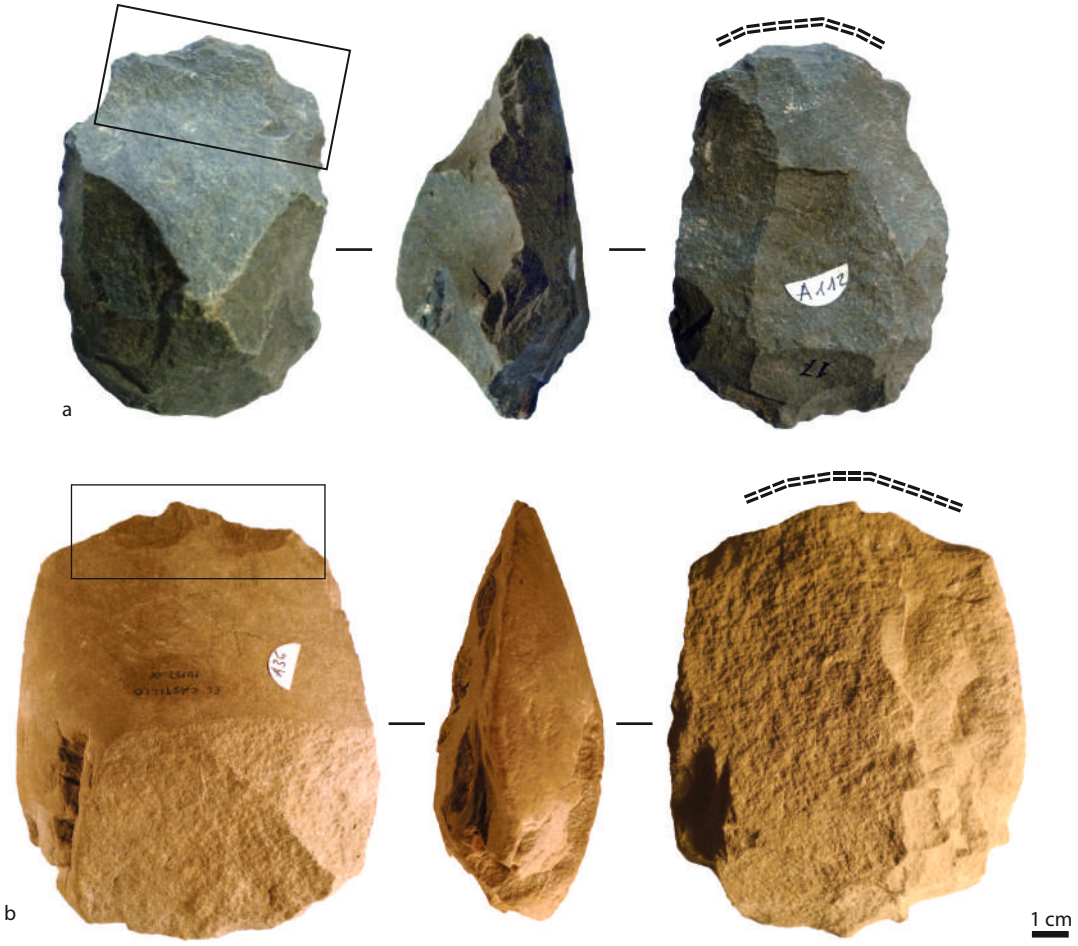
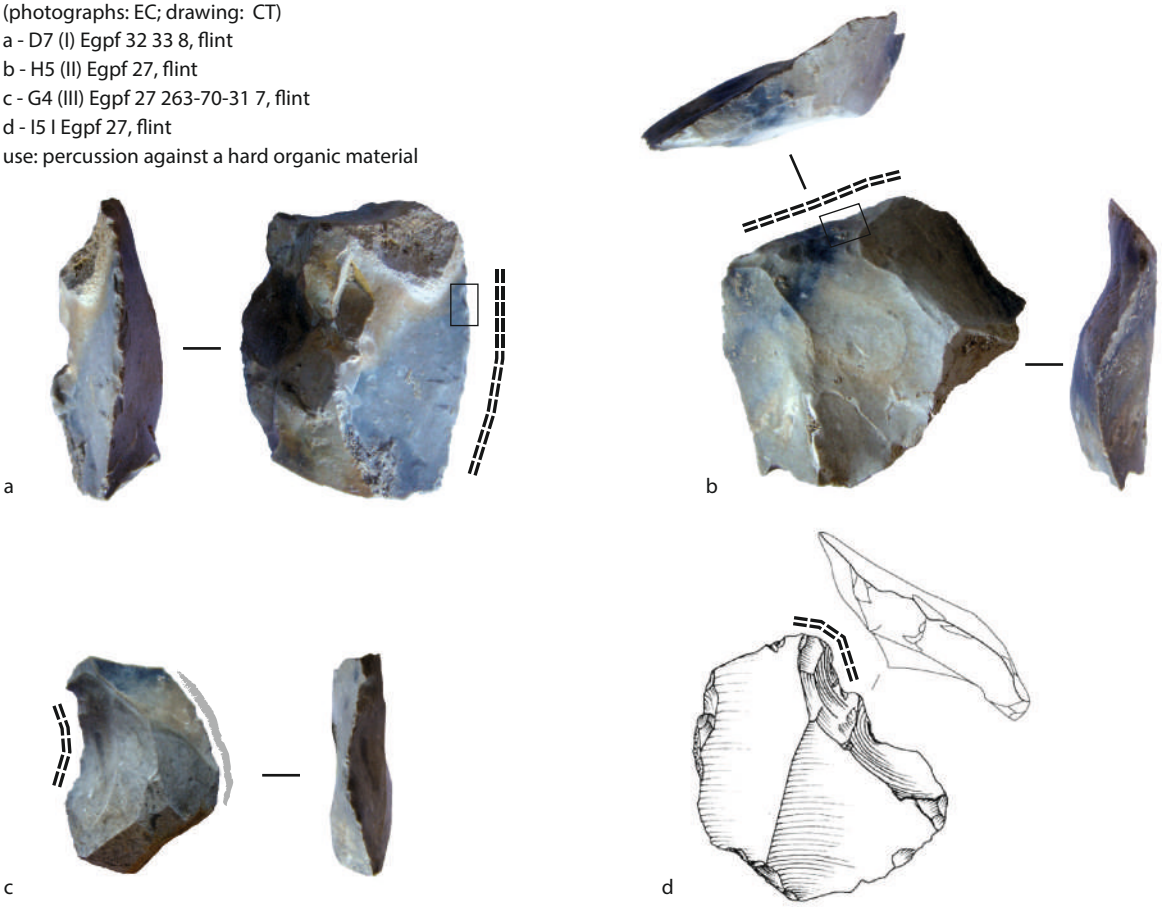
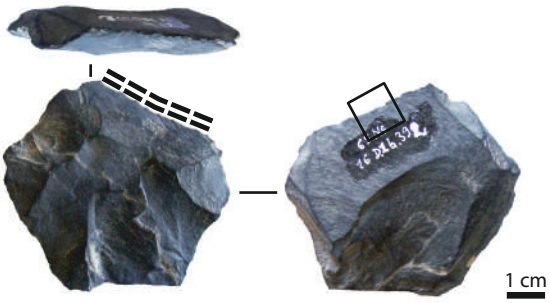


Figure 229 - Retouched tools from the site of Chez-Pinaud and flake cleavers from El Castillo bearing traces of percussion against hard animal materials and probably used in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 176[f-g] (CAD: É. Claud and M. Coutureau).

Saint-Césaire
(photographs: EC; drawing: CT)
a - D7 (I) Egpf 32 33 8, flint
b - H5 (II) Egpf 27, flint
c - G4 (III) Egpf 27 263-70-31 7, flint
d - I5 I Egpf 27, flint
use: percussion against a hard organic material



Grotte du Noisetier
(photographs: EC)
65NS 16 D 1b 292, schist
use: percussion against a hard organic material
(+ cutting?)



Les Fieux
(photograph: CT)
K30276, flint
use: percussion against a hard organic material

Figure 230 - Unmodified flakes and retouched tools from the sites of Saint-Césaire, Grotte du Noisetier and Les Fieux bearing traces of percussion against hard animal materials and probably used in the context of butchery. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figure 177 (CAD: É. Claud and M. Coutureau).

A large flake from La Mouline bears, on its transverse convex distal edge, scars interpreted as the result of use in percussion against a medium-hard material, but the photograph provided shows that the traces are very similar to those obtained experimentally on edges used in percussion for disarticulation or defleshing of a carcass (Pasquini, 2008). It is therefore possible that this piece served in the latter activities rather than in percussion on wood. Some kilometres to the south, at Bessinaudes, two pieces bear traces compatible with use in percussive butchery: an unmodified semi-cortical flake with a low edge angle (26°), and a biface (perhaps two) with a natural base and a transverse distal edge with a cutting angle of 42° (Claud *in* Chadelle *et al.*, in prep.).

At the Middle Palaeolithic site of Romentères, choppers (n=11) were used in the percussion of medium-hard to hard or hard organic materials (Claud *in* Lelouvier *et al.*, 2012). On certain pieces, the numerous and large scars, could be the result of use in fracturing bones (sternum, ribs, for example). This hypothesis is further supported by the morphological characteristics of the pieces, namely their considerable weight (752 and 1037 g) and broad angles (75° and 67°).

At Bayonne Jupiter, in assemblage PM1, one or two flint bifaces with distal cutting-edges and natural bases could have served in percussion on a hard organic material (Cologne *et al.*, 2017b). The intensity of the use-wear traces corresponds either to disarticulation or defleshing.

Finally, at Badaran, P. Utrilla and C. Mazo (1996) note a possible flake cleaver in flint that bears polish from butchery and whose supposed mode of use was percussion.

Thus, the pieces that could have served in butchery by percussion are relatively rare in terms of the sites concerned and, if one excludes Romentères, infrequent in our study assemblages. Their typological diversity is considerable: flake cleavers, bifaces with transverse cutting edge, flakes, side scrapers – sometimes modified with notches – and choppers were used. Flint, ophite (flake cleavers) and quartzite (flake cleavers and choppers) were used (figure 239, table 70). The edges, unmodified or retouched, generally have a moderate angle (around 45°). The active angles of the modified cobbles at Romentères are the highest (67° ± 4°). All of the edges, with the exceptions of the flake cleavers, the preferential-Levallois flakes, and one flake from Bessinaudes, are positioned opposite a comfortable prehension zone that indicates potential use by hand. Hafting is supposed for the flake cleavers, and possible for the preferential-Levallois flakes, as the retouch adjacent to the platform seems insufficient preparation for bare-handed use. Due to reasons of imperfect preservation, potential traces of hafting could not be identified. Two functional groups could be identified amongst the pieces that were used in percussion: those used in forceful defleshing or disarticulation, held in the bare hand and presenting relatively light use-wear (flakes, denticulates, side scrapers, bifaces), and those pieces that were hafted (flake cleavers, perhaps certain preferential flakes) or held in the hand but rather heavy, apparently used in operations requiring greater force, such as fracturing.

The potential use of percussion in butchery activities could be influenced by several factors: the size of prey (percussion allowing for more rapid breakdown of large carcasses), specific nutritional requirements (intensive exploitation, with fracturing of the ribcage, for example), or even specific modes of carcass exploitation linked to the technological traditions of a group. Percussion with a sharp tool is not in fact necessary for disarticulating a carcass or fracturing a bone. It could even be considered less effective than percussion with a heavy, dull cobble in the latter case.

The archaeozoological data is difficult to apply to these questions because the axial skeleton is often underrepresented in Palaeolithic assemblages. Though no trace indicative of percussion has been found in the archaeofauna included in our study, the study sites that have yielded tools that bear traces of percussion also yielded faunal assemblages characterized by the presence of large ungulates (bison and horse). This suggests that the percussive tools could have been used in the segmentation of the axial skeleton. At the same time, the levels at Coudoulous 1, Mauran, and Les Fieux that are dominated by bison have not yielded tools of this type. At primary butchery sites,

it is entirely possible that the axial skeleton was abandoned once defleshed, without segmentation of the vertebral column; patterns in the faunal assemblages at residential sites support this scenario. Amongst the comparative sites that have yielded tools with traces of percussion, few have yielded faunal remains. Though the remains of large animals like horse and mammoth are numerous at Salzgitter Lebenstedt (Gaudzinksi, 1999a) and Sesselfelsgrotte (Rots, 2009), in contrast, US 22 at Chez-Pinaud (Niven *et al.*, 2012) and probably in level D1 at Fond des Blanchards (Bemilli *in* Lhomme *et al.*, 2007), reindeer is the dominant prey species. This suggests that prey size is not, itself, a determining factor. At Salzgitter Lebenstedt, the mammoth remains are primarily rib fragments that were used as tools (Gaudzinski, 1999b). One could speculate that there is a potential connection between the bifacial pieces used in butchery by percussion and the spiral fractures observed on these pieces that might result from the forceful separation of the ribs from the vertebral column (Gaudzinski, 1999b). Numerous traces of percussion observed on other mammoth remains (Gaudzinski, 1999b) could also derive from this mode of action. A detailed study of these traces of impact and fracture might provide some insights.

d - The scraping of bone

The active zones that bear traces of transverse contact with a hard organic material that could be bone (n=41) could be *a priori* related to different activities: removing remaining meat from bones (butchery), preparing the surface of bones for the extraction of marrow by fracturing (butchery), or to prepare a surface for use as a retoucher (fabrication of tools).

Scraping has been identified at Les Fieux, on 21 active zones – half of the active zones attributed to butchery activities at the site – at Mauran, on nine active zones, and at much less frequently at the sites of Chez-Pinaud (four zones), Saint-Césaire (three zones) and Coudoulous (three zones). At this last site, as noted above, 26 active zones show evidence of cutting and scraping of meat (see above) and of these, three show contact with bone.

The tools used in scraping a hard material like bone are made of flint, quartz, and quartzite (Les Fieux, Mauran, and Coudoulous), and are of varied types (table 58, figures 231-232). Unmodified flakes (one backed knife, one core-edge flake, and one pseudo-Levallois point), notched pieces (denticulates, Clactonian notches, one retouched notch) and side scrapers are the most numerous, but some retouched flakes and endscrapers, a biface manufacturing flake and a biface are also included. The morphology in plan view of the active zones is variable, but concave and rectilinear forms are frequent. The edge angles are equally varied, and in some cases (the retouched notch at Mauran, for example) the natural cutting edge of the piece has been modified by semi-abrupt or abrupt retouch. Nonetheless, most of the active zones, unmodified or modified with a shallow retouch (or a tranchet-blow in the case of the biface at Chez-Pinaud), probably presented a rather low cutting angle prior to use. The initial edge angles, though, are difficult to quantify because they have been clearly modified by edge damage, rendering the edge more abrupt.

Seven pieces, from Bayonne le Prissé PM2 (scraper), Chez-Pinaud (unmodified flake), Mauran (unmodified flake, backed core-edge flake, pseudo-Levallois point), Saint-Césaire (unmodified semi-cortical flake, backed core-edge flake) could also be included in this category, as they were used to scrape a medium-hard to hard material that could have been very hard wood or bone (figures 233-234).

With the exception of Fonseigner, the faunal assemblages at the sites concerned allow for some further discussion of the activities that generated the use-wear observed. Amongst the four assemblages, only Les Fieux yielded a fragment of equine (*E. hydruntinus*) tibia that had been scraped, but the poor preservation of the osseous surfaces could introduce certain bias to the study. Aside from Coudoulous 1, none of the sites produced a bone retoucher. If we accept that these pieces

Chez-Pinaud
(photographs: EC; drawing: J. Airvaux)
a - CPN D18 86, Turonian flint
b - CPN03 D17s 47s, flint
use: scraping a hard organic material

Les Fieux
(photographs: CT)
a - K 30808, quartzite (denticulate)
b - K 19 VI 35562, quartzite (denticulate)
c - K 32011, flint (pseudo-Levallois point)
d - K 30228, quartzite (notched piece)
e - K 34280, flint (denticulate)
use: scraping a hard material

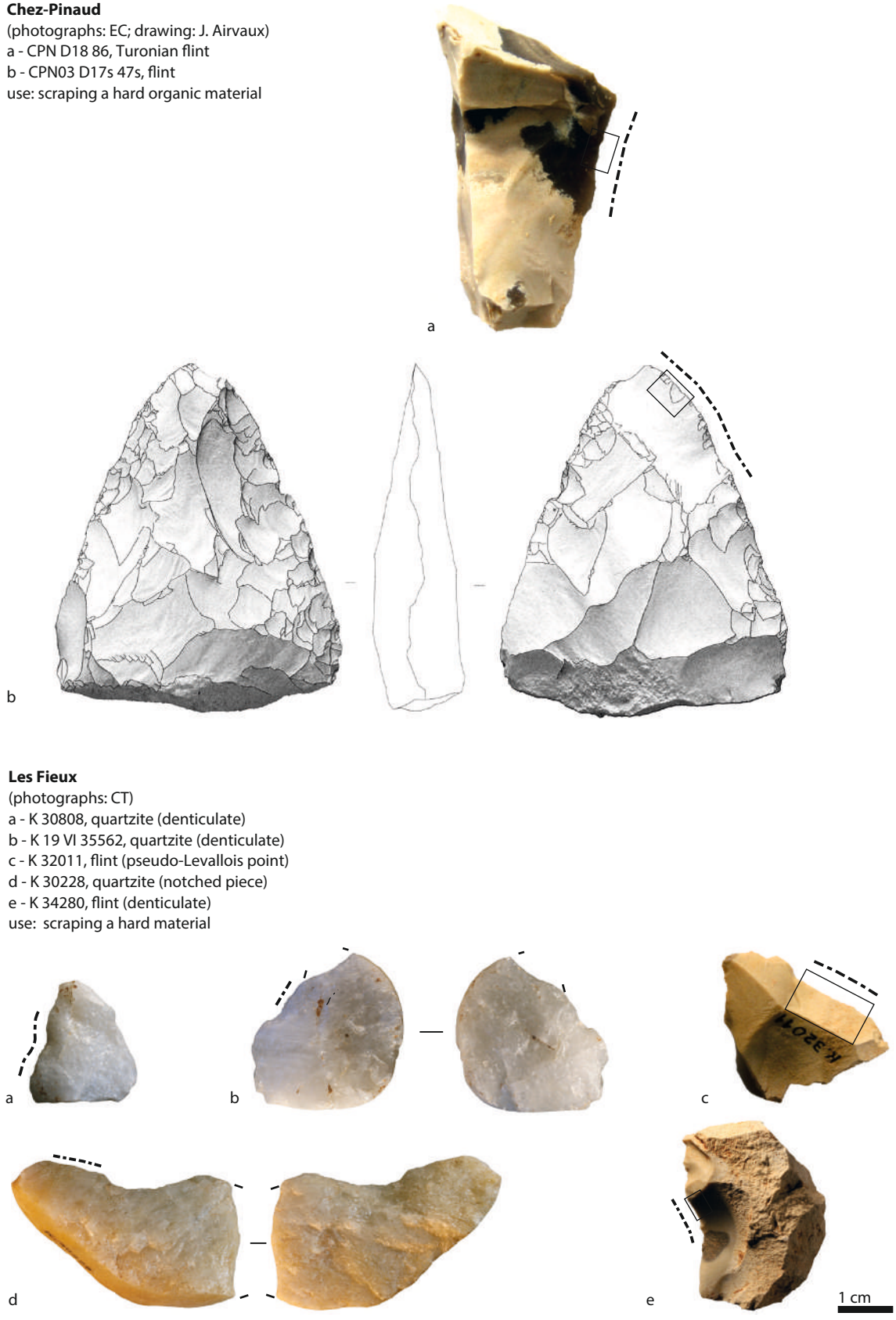
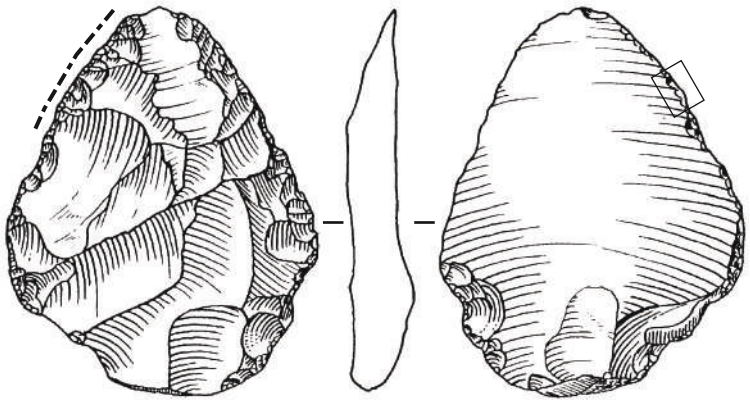


Figure 231 - Unmodified flakes, biface and retouched tools from the sites of Chez-Pinaud and Les Fieux bearing traces from scraping an organic hard material of bony type. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figures 178[b,e] and 179[c] (CAD: É. Claud and M. Coutureau).

Fonseigner
(drawings: J.-M. Geneste)
Fons 77.Z3.Dsup.03 28, flint
use: scraping of a hard organic material



Mauran
(photographs: CT)
1 - M75 II E13 29, flint (notched piece)
2 - M77 E12 83, flint (side scraper)
3 - M781 2007, flint (notched piece)
use: scraping a hard material
4 - M74 II H12 134, quartzite
use: scraping a medium-hard to hard material

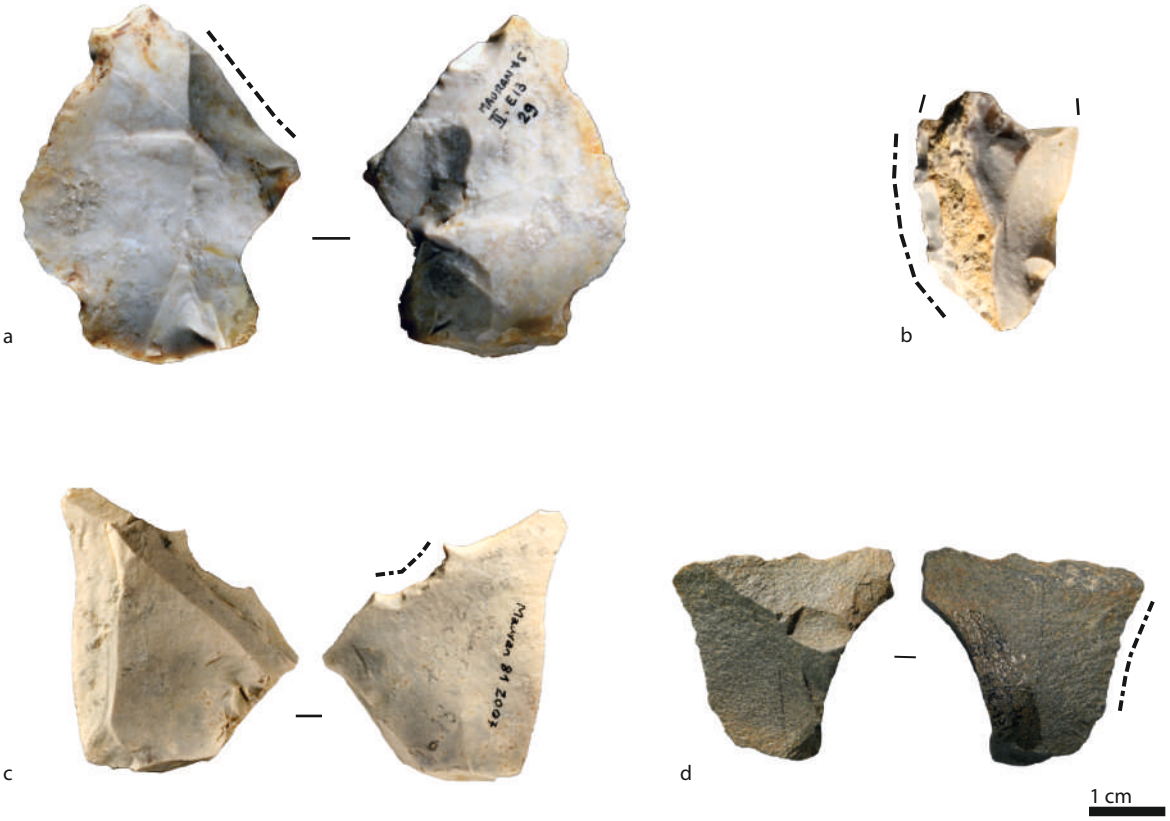


Figure 232 - Unmodified flakes and retouched tools from the sites of Fonseigner bearing traces from scraping an organic hard material of bony type. The black rectangle indicates the location of the photograph of the use-wear traces presented in figure 178[f] (CAD: É. Claud and M. Coutureau).

Bayonne le Prissé
(photographs: EC)
PM2 30010, flint
use: scraping of a medium-hard to hard organic material

Grotte du Noisetier
(photographs: EC)
a - NS07 D12 c1 208, quartzite
b - 65NS 18 D 1 79, schist
c - NS65 D17 c1 160, quartzite
use: possible scraping of a medium-hard to hard material

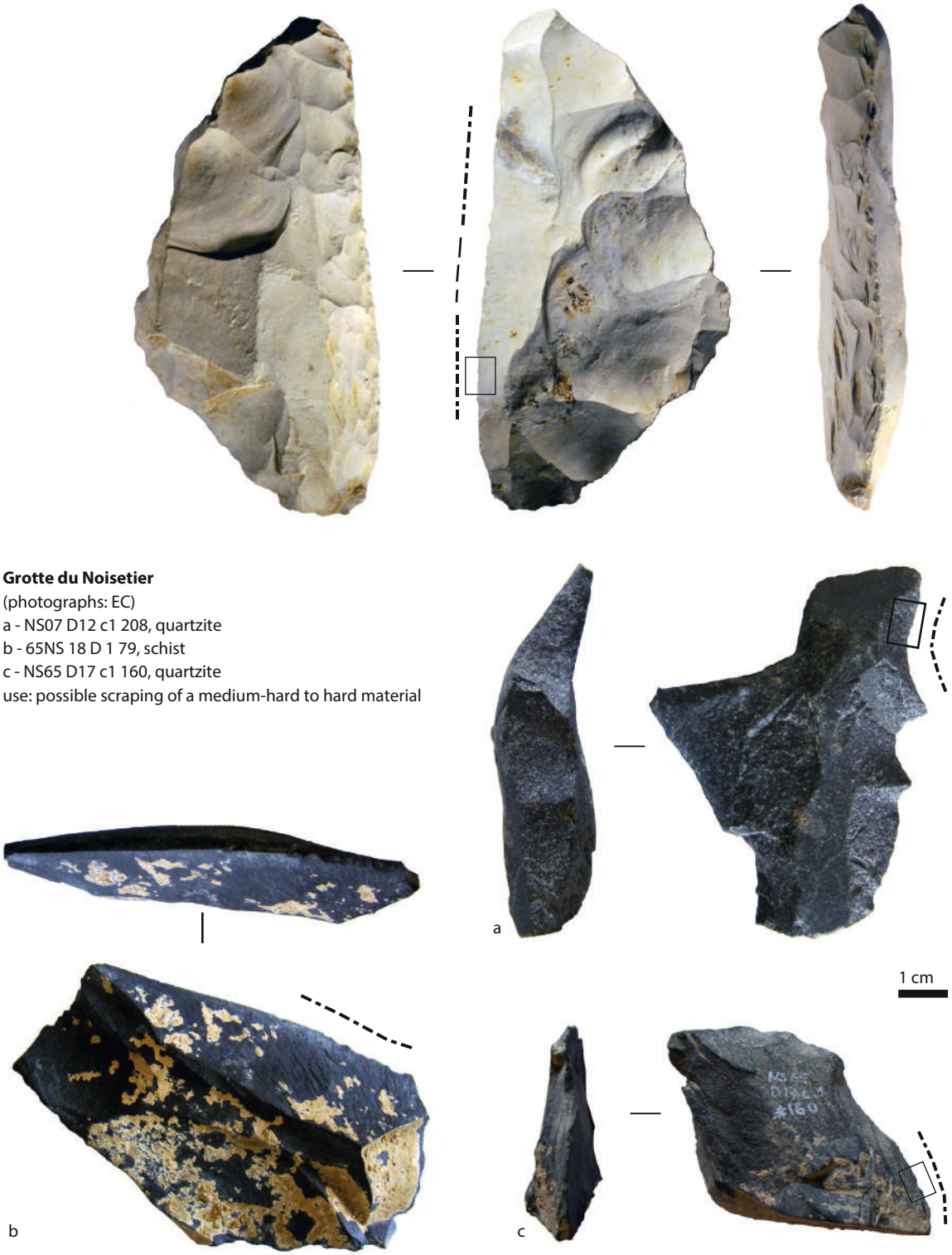
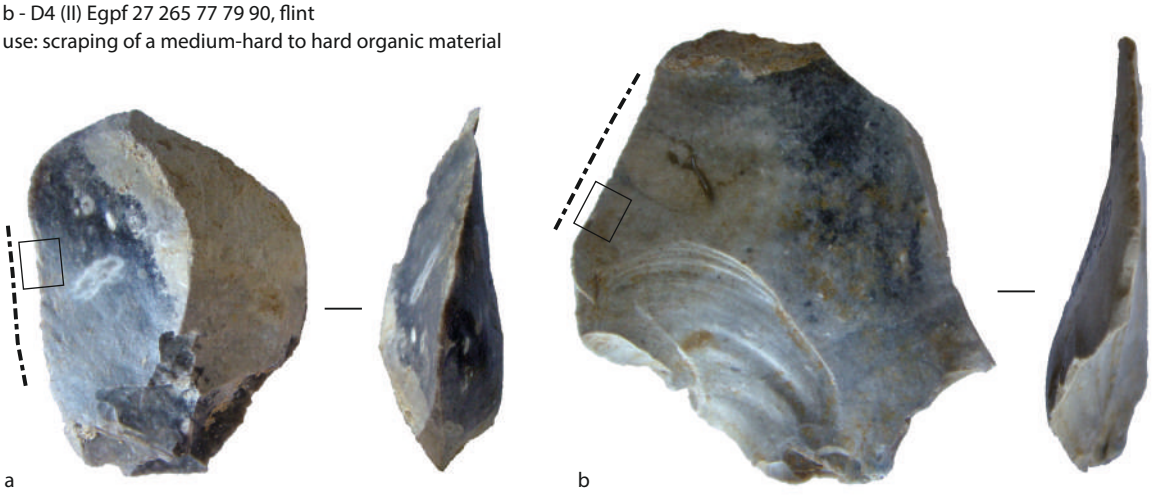


Figure 233 - Unmodified flakes and retouched tools from the sites of Bayonne le Prissé (PM2) and Grotte du Noisetier bearing traces of scraping hard or medium-hard materials that could be related to butchery activities. The functional (rather than natural) origin of these traces at Grotte du Noisetier, and at Bayonne Le Prissé, the precise activity (butchery, working of hardwood?) could not be determined with certainty. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figures 178[a] and 179[a-b] (CAD: É. Claud and M. Coutureau).

Saint-Césaire
(photographs: EC)
a - H6 (IV) Egpf 29, flint
b - D4 (II) Egpf 27 265 77 79 90, flint
use: scraping of a medium-hard to hard organic material



Chez-Pinaud
(photograph: EC)
CPN D19 1422, flint
use: scraping of a medium-hard to hard organic material

Figure 234 - Unmodified flakes from the sites of Saint-Césaire and Chez-Pinaud bearing traces from scraping hard or medium-hard materials that could be related to butchery activities. The activity (butchery? working of hardwood?) could not be determined with certainty. The black rectangles indicate the locations of the photographs of the use-wear traces presented in figures 178[c] and 179[e-f] (CAD: É. Claud and M. Coutureau).

were used in scraping bone, scraping activities at the other sites (Mauran, Les Fieux, Saint-Césaire, Chez-Pinaud) could have been related to butchery. In this case, scraping could have served two functions: the extraction of slivers of meat still attached to bone, or the preparation of bone surfaces for the recuperation of marrow by fracturing. The latter practice, experimentally conducted on bovine tibia and femur under the auspices of the PCR, show that preparation by removal of the periosteum allows for better propagation of the waves of percussion that fracture the bones. According to these experiments, scraping is not necessary for the fracturing of the femur, but is essential for the fracturing of the tibia (Gerbe *et al. in* Thiébaut *et al.*, 2008). At Mauran and Les Fieux, given the quantity of meat recovered and the number of fractured long bones, it is probably that the scraping of bones was undertaken as a phase of marrow exploitation from long bones. Without observable traces on the bones, it is not possible to exclude the scraping of other materials, such as very hard or heat-treated wood, for the fabrication or maintenance of spears, for example (see above). At Grotte du Noisetier, the surface of a retoucher shows traces of scraping, indicating surface preparation prior to use as a retoucher. At this site, dubious use-wear traces of scraping observed on certain lithic pieces (not counted in the 41 active zones tallied, but nonetheless illustrated in part in figure 233[a-c]) could be linked to this sort of activity. Similarly, at Les Pradelles, traces of bone-scraping in the preparation of the surfaces of certain retouchers have been identified (Costamagno *et al.*, 2017) and prove that scraping is not strictly limited to butchery activities.

Amongst the published use-wear analyses, scraping on a hard organic material has been identified in a relatively limited number of assemblages (n=30, table 67) and, with the exception of Grotta Breuil, on a limited number of artefacts (generally fewer than five per site). Some assemblages have yielded tools that were used to scrape a medium-hard to hard organic material, and the possibility that material was wood cannot be excluded. The relevant objects are rarely described in detail, but the use of unmodified edges is frequently mentioned, whether on ordinary flakes (Havrincourt sector 2, La Combette, Abric Romaní, Grotta Breuil, El Salt), core-edge flakes (Corbehem), recycling flakes (Chez-Pinaud US 22), pseudo-Levallois points (Beauvais), Levallois point (Abric Romaní level 0), bladelets (Champ-Grand) or flakes produced by secondary debitage (Le Pucheuil). Retouched tools, comparatively rare, include side scrapers, some used on the retouched edge (Combe-Grenal, Fumane, Grotta Breuil, Ciota Ciara Cave, El Esquilleu) and others used on the unretouched edge (Saint-Amand-les-Eaux, Chez-Pinaud US 22), denticulates (Abric Romaní), and *limaces* (Champ-Grand). At Grotta Breuil, the tools that functioned in scraping for butchery purposes have been interpreted as defleshing tools, with the exception of two pieces from layer 6 that show polish characteristic of scaling fish. At the site of El Salt, the cortical flake mentioned could have served to scrape meat from a bone.

Amongst these studies, few examples provide evidence, notably on the fauna, that could be used to evaluate the interpretation of the lithic analyses. At ten of the sites no faunal assemblages were preserved, and at three of them the surfaces of the bones were poorly preserved (Havrincourt, sectors 1 and 2; Le Fond des Blanchards). At other sites, either no archaeozoological study has been published (Spy, Semal *et al.*, 2009), Combe-Grenal (Guadelli, 1987), Abri du Musée (Bourguignon, 1992), or the published studies are not detailed (El Esquilleu, Yravedra *et al.*, 2014; Sesselfesgrotte Rots, 2014; Santa Croce, Boscato, Crezzini, 2006). At two sites (La Combette, Texier *et al.*, 2003; Ciota Ciara, Buccheri *et al.*, 2016), no traces were identified on the bone surfaces. At Grotta Breuil, the presence of scraping traces in layer 3 indicates the removal of scraps of flesh, potentially indicative of dietary stress (Alhaique, Lemorini, 1996). In level 6, rare traces of scraping were also observed. For the assemblage from US 22 at Chez-Pinaud, the tools presenting traces of scraping on bone could have resulted from butchery, or from surface preparation for use as retouchers, as indicated by the traces of scraping observed on retouchers from this layer (Mallye *et al. in* Jaubert *et al.*, 2008). Some pieces from Sesslfelsgrotte, whose techno-typological characteristics are not described, served in scraping a hard material like bone or antler. They were not directly involved in butchery activities, but in the transformation of animal materials, as tools for the perforation of hard materials have also been identified (Rots, 2009). At Fumane, the traces of scraping described could be related to the removal of periosteum before the fracturing of bones (Romandini *et al.*, 2014a). Nonetheless, because of the presence of retouchers in the Quina level, it is difficult to determine the precise nature of the activities that left use-wear traces associated with scraping. Some pieces with such traces are also noted at El Salt (levels 4e and 4.1) but in figure 7e (*in* Machado, Perez, 2016), the cutmarkss identified as scraping marks on a rib appear more similar to cutmarks from cutting than scraping. Finally, at Abric Romaní, bones bearing this sort of trace are indicated in layers H, Ja, M, and O (Cáceres, 2002; Fernándex Laso, 2010; Gabucio *et al.*, 2014a).

On the basis of the available data, scraping could have served in a variety of butchery activities (meat extraction or bone preparation for fracturing) as well as the preparation of osseous materials for utilitarian purposes (retouchers), and it is difficult to distinguish between them. With the exception of certain assemblages (Mauran, Les Fieux, Grotta Breuil), these traces are not widely distributed. The tools are of variable morphology, but appear preferentially on unmodified blanks, notched pieces, and side scrapers (figure 239, table 70). Levallois points, Mousterian points, and bifaces are rare or even absent from this functional group.

	Site	Scraping hard material	Sacraping bone / meat on bone (micro-polishes)	Tool types
Belgium	Spy	**x?**		Mousterian point
Germany	Neumark-Nord	**x?**		unretouched flakes
	Sesselfelsgrotte	**x**		undetermined
North France	Beauvais "La Justice"	**x**		pseudo-Levallois points
	Corbehem		**x**	core edge flakes from Levallois debitage
	Havrincourt "Les Bosquets" (sector 2)	**x?**		unretouched flake
	Havrincourt "Les Bosquets" (sector 1)	**x**		preferential Levallois flake (used by cutting and maybe by percussion, and possibly by scraping too)
	Le Pucheuil		**x**	"Le Pucheuil" flakes
	Rémicourt	**x?**		undetermined
	Saint-Amand-les-Eaux	**x**		retouched flake (retouches on lower face)
North Center France	Le Fond des Blanchards	**x?**		scrapers
South West France	Cantalouette II	**x**		undetermined
	Combe-Grenal (layers 21-24)		**x**	Quina scraper
	Chez-Pinaud (US 22)	**x**		unmodified flakes, including a scraper recycling flake and a retouched flake (traces on the unretouched edge)
	Abri du Musée	**x**		undetermined
	Les Bessinaudes	**x?**		unretouched flake, scraper (traces on the unretouched edge)
South East France	Champ-Grand	**x**		*limaces*, bladelets
	La Combette		**x**	unmodified flake + undetermined
Italy	Grotta Breuil (layer 3)		**x**	flakes (with biplanar or plano-convex section and straight or concave profile)
	Grotta Breuil (layer 6)		**x**	flakes + others? (with rectilinear and convex delineation)
	Grotta Breuil (layer XX)		**x**	mainly scrapers and flakes with concave profile
	Fumane	**x**		Quina scrapers
	Ciota Ciara cave	**x**		quartz scraper
	Santa Croce	**x?**		retouched flakes?
Iberian Peninsula	Abric Romaní (levels H, I, Ja)		**x**	unretouched flakes, denticulates
	Abric Romaní (level 0)	**x**		Levallois point
	Abric Romaní (level M)		**x**	unretouched flake
	El Esquilleu		**x**	Quina scraper
	El Salt		**x**	cortical flake
	Ribeira Ponte da Pedra / Atalaia	**x?**		flakes

Table 67 - Published data on Middle Palaeolithic assemblages in Western Europe that have yielded traces related to scraping bone, meat, and a hard to semi-hard material (butchery activity?) and the types of pieces that present such traces. The cross with a question mark indicates that the pieces were used to scrape a semi-hard to hard material, from which wood cannot be excluded, and interpretations must be cautious. See Annex 1 for the literature references.

e - Butchery activities as revealed by faunal analysis

Given the sheer abundance of available archaeozoological studies, it was not possible to complete an exhaustive synthesis of evidence for butchery of the kind that was completed with regard to use-wear studies of lithic assemblages. In addition to the systematic study of the literature on the sites included in the use-wear studies (see above), we have chosen to focus in this chapter on studies that provide detailed information on the placement and orientation of cutmarks, with emphasis on activities that are relatively underrepresented in the literature, such as skinning and the removal of tendons. Only evidence relevant to large mammals were retained: layers 4 and 9 from Roc de Marsal (Hodgkins, 2012; Castel *et al.*, 2017), Pech de l'Azé IV (Hodgkins, 2012), Abri du Maras, Baume Flandin, Balazuc, layers Fa and Fc-d at Payre, layers g and h at Saint-Marcel, Baume des Peyrards (Daujeard, 2008), Biache-Saint-Vaast (Auguste, 1995), the Discoid Mousterian level and levels A5/A6 at Fumane (Peresani *et al.*, 2011b; Romandini *et al.*, 2014a) and Ciota Ciara (Buccheri *et al.*, 2016).

At Mousterian sites subjected to archaeozoological analysis, the systematic observation of cutmarks from defleshing and traces of percussion related to the exploitation of marrow indicates the importance of meat and fat to Neanderthal groups. At some sites, the underrepresentation of the epiphyseal ends of long bones has been interpreted as evidence for the exploitation of the grease contained in spongious tissue for purposes that may have been dietary, technological, or combustible (Boscato, Crimini, 2006; Costamagno, 2013; Costamagno, Rigaud, 2014; Yravedra *et al.*, 2014; Castel *et al.*, 2017).

With regard to the disarticulation of carcasses, the underrepresentation of epiphyses at a number of sites has limited the reconstruction of operational sequences. Such is the case at Les Pradelles and Grotte du Noisetier. At Roc de Marsal, no trace of disarticulation has been documented in the assemblages 4 and 9 due to the near total absence of epiphyseal extremities. At Biache-Saint-Vaast, cutmarks present on the femoral head (*Fp-a*) and distal condyles (*Fd-d*, *Fd-g'*) provide solid evidence for the dismemberment of the hindquarters and disarticulation of the knee. At the sites studied by C. Daujeard (2008), several cutmarks also indicate this phase of butchery. The cutmarks illustrated are primarily located on the lower bones of the foot. The disarticulation of the ankle is evidenced at Payre on horse bones in layer Fc-d (*Gcf-a*, photo 115 *in* Daujeard, 2008), on bovid bones (*Tal-c*, *Tal-c'*, photo 112, idem) and red deer bones (*Cbn-a*, photo 115, idem) in layer Fa, at La Baume des Peyrards on red deer bones (*Tal-d*, photo 97, idem) and, potentially, on roe deer bones in layer g at Saint-Marcel and ibex bones at Balazuc (*cal-a*, photos 108-118, idem). The traces present on the external malleoli of two ibex tibia, not documented in our study samples, also attest to the disarticulation of the ankle. Finally, the different types of cutmarks identified on the distal extremity of a red deer humerus from layer Fa at Payre indicate the disarticulation of the elbow (*Hd-d*, *Hd-d'*, *Hd-e*, photo 109, idem). In contrast, the cutmarks observed on the neck of an ibex scapula from la Baume de Peyrards and interpreted as the result of disarticulation (Daujeard, 2008) are in fact related to defleshing (*Sc-b*, photo 96, idem), as are the cutmarks observed on the proximal end of a red deer radius from Balazuc (*Rp-f*, photo 116, idem).

Traces of skinning are noted at numerous sites on both ungulates and carnivores. This skinning is most often accompanied by defleshing, even in the case of carnivores: for example, at Biache-Saint-Vaast, Hohle Fels, Ciota Ciara, the Discoid level at Fumane, level M at Abric Romaní (Auguste, 1995; Münzel, Conard, 2002; Romandini *et al.*, 2014a; Gabucio *et al.*, 2014a; Buccheri *et al.*, 2016). On the ungulates and at the sites included in our synthesis, some traces present on fragments of mandible (*Man-c*) indicate skinning of the head: Baume Flandin (photo 119, idem) and Abri du Maras (photo 120, idem), Fumane (red deer and roe deer), Roc de Marsal 9 and 12, Pech de l'Azé IV I2 and YZ (figure B7, *in* Hodgkins, 2012). Regarding the lower legs and feet, the three types of cutmark described in our study sample are present at the sites included in our broader discussion. Circular

incisions are documented at Baume des Peyrards on the distal diaphysis of a horse metapodial (*Mts-c˝* or *Msc-c˝*, photo 99, idem) and a second phalanx of an ibex (photo 102, idem). At Fumane, this type of cutmark is visible on the middle shaft of a red deer metacarpal (*Mcs-b˝*), the first phalanx of a red deer (*Phl-a*) and the distal metatarsal of a roe deer (*Mts-b˝*). At Roc de Marsal and at Pech de l'Azé, no such cutmark is noted, even though traces related to the removal of skin are numerous (*Mcs-a*: Roc de Marsal 4, *Mcs-b*: Roc de Marsal 4 and 9, Pech IV YZ, *Mts-a*: Roc de Marsal 4 and 9, Pech IV 12 and YZ, *Mts-b*: Roc de Marsal 4, *Td-c*, *Td-a˝*: Roc de Marsal 4). They co-occur with cutmarks related to the longitudinal incision of the hide. Aside from longitudinal cutmarks observed on a distal shaft-fragment of a tibia from layer 4 of Roc de Marsal (*Td-a'*), they are also present on the lateral surfaces of metapodials (*Mcs-b´* and *Mts-b´*: Roc de Marsal 4). These two sites, for which documentation is complete, allow us to postulate certain modes for the cutting and removal of skins. At both sites, the absence of circular incisions on the metapodials and phalanges could indicate that the starting incisions were made closer to the hooves. The fact that longitudinal cutmarks are present on the lateral faces of these elements in layer 4 at Roc de Marsal and absent in the other three layers – which could indicate that incisions were made on the posterior[4] or anterior surfaces – suggests that the skinning of the trunk and the legs were distinct operations, in keeping with starting the incisions closer to the hoof. A re-examination of the faunal assemblage would be necessary to confirm this hypothesis, but it is worth noting that at Les Pradelles and Roc du Marsal, which share many features (Quina Mousterian, intense specialisation on reindeer, intensive exploitation of resources down to the grease in the spongious tissue), skinning traces document different methods: skin from the feet taken at Roc de Marsal, little attention to this part of the hide at Les Pradelles (see above). The factors underlying these disparities (different groups, different seasons of occupation, the intended use of the hides) are difficult to determine based on the evidence at hand, but this example underscores the importance of the detailed study of butchery cutmarks. Paired with use-wear analyses of lithic tools, such approaches could shed new light on the behaviour of Neanderthal groups.

Cutmarks associated with the extraction of tendons are often interpreted as skinning cutmarks due to the lack of experimental references for the former activity. They are present in layer g at Grotte Saint-Marcel on a red deer metacarpal (*Mcs-c*, photo 103 *in* Daujeard, 2008)). At Fumane in level 9, the cutmarks depicted in figure 7d (*in* Romandini *et al.*, 2014a) and interpreted as cutmarks from skinning are clearly the result of tendon removal on the anterior surface of a red deer metatarsal (*Mts-c*). In levels A5/A6, the removal of the posterior tendon is attested on at least one red deer metatarsal (*Mts-f*) and of the anterior tendon of a roe deer (*Mcs-c*). At Roc de Marsal layer 4, on the metacarpals, only the removal of posterior tendons (*Mcs-f*, *Mcs-f˝*) is attested (longitudinal or transverse gestures) while on the metatarsals, it is exclusively the anterior tendons (*Mts-c*, *Mts-c'*). In layer 9, not a single cutmark indicates this activity. At Pech de l'Azé IV, it is the anterior tendons of the metacarpals (*Mcp-b˝*, *Mcs-c*) and the posterior tendons of the metatarsals (*Mts-f*, *Mts-f'*) that were removed. Without a precise count of the anatomical zones identified in different sites, it is difficult to infer a preference for any particular tendon, but this type of analysis once more offers new perspectives on the practices of Neanderthals related to the use of certain tendons. These preferences could have been dictated by their intended use (as bindings, glue, or a food-source) or by the time allotted to processing. In the case of immediate needs for bindings, the anterior tendons of the metacarpal, which are thinner and dry more quickly, may have been preferred. At this time, traces related to the removal of tendons are exclusively documented on cervid bones. The question of species preference related to the intrinsic characteristics of tendons (length, strength, ...) remains to be examined.

4. Longitudinal striations (*Mts-c'*) present on either side of the malleolar groove and not inside it could evidence this gesture rather than the removal of tendons.

f - Hide working

Thirty-four active zones, only 7 % of the identified active zones, served to cut (21 zones), scrape (10 zones), and, to a lesser extent, perforate (2 zones) skins (tables 51, 68, figure 211). One piece served in both cutting and scraping (Fonseigner).

Cutting was identified at Chez-Pinaud (14 active zones), Fonseigner (7) and Coudoulous (1); scraping at Fonseigner (7), Coudoulous (2), Grotte du Noisettier (1) and Mauran (1), while perforation is probable (absence of micro-polish) at Les Fieux (1) and at Mauran (1).

Even if the exact state of the hide is difficult to determine with precision and certainty (see Part II, chapter 2.2.C), it seems that hides in different states are represented: dry hide at Grotte du Noisetier, dry and semi-dry hide at Coudoulous and fresh or moist hide and dry hide at Fonseigner. Tools in flint, quartz, and quartzite were used.

In these assemblages, the number of tools that were used to work hide is low (2 to 8 %, table 68), with the exception of Fonseigner. At this site, the activity is actually well represented, with 13 active zones of 46, or a frequency of 28 %. The state of the cut hides is intermediate, which is to say they were moist and supple. This state and the mode of action could correspond to the hide-defleshing phase, or to the cutting of hide already prepared to be used in the manufacture of objects, such as thongs, clothing, or sacs. Nonetheless, it is easier to achieve a neat and precise cut on a completely dry hide than on a hide that is still fresh, and it is therefore more probable that the cutting of moist hide corresponds to a phase of cleaning. The general morphology of the tools that bear traces of hide-cutting also point to this phase of processing, as the active zones are convex in plan (rectilinear in one case) and rectilinear in profile, with no irregularities on the edge that could accidentally puncture the skin during the cleaning process (figure 237). The cutting angles are low to moderate (31° to 51°). The active zones are localised on four side scrapers (amongst which one, elongated, was used on its unmodified edge) and a Mousterian point. The use of the latter for the defleshing of hide would nonetheless be surprising given the convergent morphology of the active zone and the presence of traces that could indicate hafting on the proximal end. If this piece was truly hafted in a distal fashion, its use in hide-defleshing is improbable because the handle would be more of an impediment than an aid given that the required gesture is very tangential and requires a controlled pressure that is distributed over a wider cutting edge (and not a pointed zone that risks puncturing the hide). It is therefore possible that this piece was used in some other phase of hide working, for example the initial incision of the hide or skinning; contact with bone is not indicated. One of the side scrapers appears to have been resharpened (reduced blank with semi-abrupt retouch).

	Number of active zones with cutting traces	Number of active zones with scraping traces	Number of active zones with piercing traces	Number of active zones with cutting and scraping traces	Total number of active zones	Frequency of hide working (%)
Chez-Pinaud (US 06/07)	14				170	**8**
Coudoulous (layer 4)	1	2			64	**5**
Fonseigner (D sup)	6	6		1	46	**28**
Grotte du Noisetier		1			21	**5**
Les Fieux (layer K)			1		52	**2**
Mauran		1	1		57	**4**
Total	**21**	**10**	**2**	**1**	**492**	

Table 68 - Number of active zones interpreted as having been used in hide-working activities and the frequency of this activity according to the assemblages studied.