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BLADE UTILIZATION STRATEGIES AT GÖNNERSDORF AND BOIS LAITERIE: FROM THE LATE TO FINAL MAGDALENIAN

Abstract

At the Magdalenian site of Gönnersdorf (dated to ca. 15,800 cal BP) a large number of flint tools made on long blades were unearthed. These blades are comparably long and curved in profile, which is characteristic for the Late Magdalenian. In contrast, at the slightly younger cave site of Bois Laiterie in Belgium (dated at ca. 15,100 cal BP), the typical Late Magdalenian long blades were found, as well as shorter, straight blades, which prevail throughout the succeeding Late Palaeolithic. To better understand the differences in blade utilization strategies between Gönnersdorf and Bois Laiterie, the results of use-wear analysis of flint tools from the two sites are compared and discussed. While the blade tools from Gönnersdorf were exhaustively used, none of them shows traces that resulted from hunting activities. Instead, backed bladelets were predominantly used as hunting armatures. This is due to the fact that while the extremely long Late Magdalenian blades are ideal for repeated use and long reduction sequences on the one hand, the great length and curved profile make them unsuitable for use as a projectile. In contrast, at Bois Laiterie a considerable number of backed points were made on shorter, straight blades, many of which show impact fractures. The change of blade utilization strategies would have been the first sign of the gradual techno-functional transformations underlying transition from the Late Magdalenian to the Late Palaeolithic in North-western Europe.

Keywords

Use-wear analysis, hunting weapons, Late Pleniglacial, Late Glacial Interstadial, North-western Europe

INTRODUCTION

Few archaeological sites that date into the Last Glacial Maximum (LGM) are known in North-western and Central Europe. Due to the extremely cold climatic conditions of the LGM, large portions of the hunter-gatherer population abandoned North-western and Central Europe, and survived in the Mediterranean region (Gamble, 1986; Bosinski, 1995; Housley et al., 1997). Although the climate gradually recovered and the ice sheets of Northern Europe retreated further north, North-western and Central Europe remained uninhabited until 16,500 years ago – except for a couple of Middle Magdalenian sites in southern Germany and southern Poland (Jöris and Street, 2014). Nevertheless, between 16,500 and 15,000 years ago, Late Magdalenian hunter-gatherers probably followed the Pleistocene fauna that migrated from South-western Europe to the north. These hunter-gatherers eventually re-colonized North-western and Central Europe (Jöris et al., 2011; Jöris and Street, 2014).

The Late Magdalenian of North-western and Central Europe shows functional variability across different geographic areas (Sano, 2012a, 2012b). The vast amounts of finds, comprising lithic artefacts, faunal remains, figurative art, and architectural remains, at the sites of Gönnersdorf and Andernach-Martinsberg in the Neuwied Basin of the Central Rhineland (**Fig. 1**), suggest that these had been used as base camps (Bosinski, 1981, 1987, 2007). The Neuwied Basin was probably an optimal location, where Magdalenian people were able to hunt a wide variety of prey animals (Street et al., 2012). The abundant and diverse faunal remains preserved at Gönnersdorf indicate that this locality has been repeatedly occupied over multiple seasons

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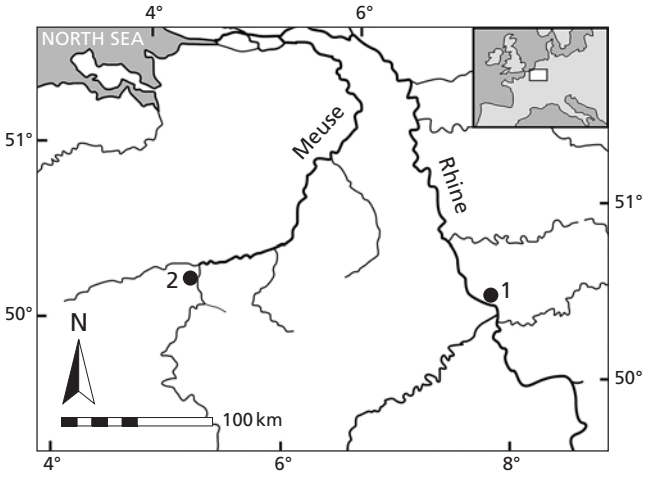

Fig. 1 Map showing the locations of Gönnersdorf (**1**) and the cave of Bois Laiterie (**2**).

(Jöris et al., 2011; Street and Turner, 2013). Another distinctive feature of the sites of Gönnersdorf and Andernach-Martinsberg is the variety of lithic raw materials, which were imported from different regions. Three different types of high-quality exogenous lithic raw materials were transported to the sites. These include chalcedony from south-eastern sources, located at distances of around 80 to 120 km, and two Upper Cretaceous flint types, i. e., Baltic Flint and Meuse Flint, which originated from sources at a distance of more than 100 km (Floss, 1994; Jöris et al., 2011). The former came from the northern glacier-pushed tills, the latter from the chalk formation in the Meuse catchment area.

At Gönnersdorf, concentration II (K-II) yielded numerous Meuse flint artefacts. Their surfaces show little to no patination, compared with other flints. Use-wear analysis was undertaken for K-II Meuse flint artefacts. The results indicated that a series of activities, including hunting, butchery, processing of carcass remains, and stone-working had been performed at the site (Sano, 2012a, 2012b).

Meuse flint is also often found at the Late/Final Magdalenian cave sites in the Ardennes Massif in Belgium (Straus and Orphal, 1997), demonstrating that the Magdalenian hunter-gatherers moved with this type of raw material to the cave-rich area along the Meuse River (Straus and Otte, 1998). While huge amounts of debitage and laminar blanks were recovered at Magdalenian open-air sites in the Meuse flint provenance area (Rensink, 1993), cortical debitage and blade cores are almost absent at the cave sites in the Ardennes Massif (Straus and Orphal, 1997). On the other hand, backed bladelets are abundant at the caves, such as Chaleux and Bois Laiterie (**Fig. 1**). In addition to numerous backed bladelets, several lithic and antler points were also found at Bois Laiterie. Due to the limited habitation area and the northward-facing entrance, the Bois Laiterie cave is unsuitable as a residential locality. Conversely, it is highly suitable for more specific activities such as hunting (Straus and Otte, 1998). A use-wear analysis undertaken on flint artefacts from Bois Laiterie demonstrated the validity of the hypothesis (Sano, 2009; Sano et al., 2011).

A series of radiocarbon dates from Magdalenian sites in Germany and Belgium has been accumulated over the last few decades. In particular, samples of anthropogenically-modified remains of horses and reindeer – the dominant species at the site of Gönnersdorf (Street and Turner, 2013) – were submitted for AMS radiocarbon age determination. The dating of megafauna, including mammoths and woolly rhinoceros, yielded older results than those from horses and reindeer. Such findings suggest that Magdalenians collected sub-fossil mammoth and woolly rhinoceros bones and teeth for use as constructional elements or art (Street and Terberger, 2004). A sample of elk bone from the south-western area of the Gönnersdorf site (SW) shows that this area was also occupied at a later period, which had already been inferred based on the remains of faunal elements adopted to (boreal) forested environments, such as red deer (Street et al., 2006),

and a lithic assemblage that includes backed points (Buschkämper, 1993). The most reliable AMS radiocarbon dates (ca. 13,270-12,990 ^{14}C BP) (Stevens et al., 2009; cf. Housley et al., 1997; Street and Terberger, 2004;), excluding dates from the large mammal fauna in Gönnersdorf SW, indicate that the main period of occupation at Gönnersdorf took place at around 15,800 cal BP (Street et al., 2012) – corresponding to the second half of the Greenland Stadial (GS) 2a cold phase.

Radiocarbon dates from Magdalenian cave sites in the Belgian Ardennes Massif fall within a tight chronological frame, ranging from ca. 13,000 to 12,500 ^{14}C BP (Charles, 1993, 1994, 1996), although there are some exceptions. Based on the radiocarbon dates from Bois Laiterie the Magdalenian occupation of the cave is dated to ~ 15,100 cal BP (ca. 12,650 ^{14}C BP) (Sano et al., 2011), and seems to have been occupied during a phase that is slightly younger than the western German Late Magdalenian, slightly predating the Late Glacial Interstadial. A techno-morphological analysis of the Bois Laiterie assemblage indicates that the site should not be assigned to a specific archaeological culture. Rather, it falls into a transitional period that forms the substrate from which the Final Magdalenian, the Hamburgian and the Creswellian affiliate as techno-typological affinities indicate (Sano et al., 2011). For instance, the presence of backed points made of blades is a striking distinction in the Bois Laiterie assemblage, which differs from the Gönnersdorf material. Hence, the blade utilization strategies may have changed from the Late Magdalenian to the subsequent chronological phase.

In the following research, the differences in blade utilization strategies between Gönnersdorf and Bois Laiterie are shown, with the significance of this change discussed in the context of the cultural evolution from the Late Pleniglacial to the Late Glacial Interstadial (cf. Grimm, 2019). The details of the use-wear analysis have been published elsewhere (Sano, 2009, 2012a, 2012b; Sano et al., 2011). Here, the author focuses on typical Magdalenian blade tools, such as end-scrapers and burins, blades, backed bladelets, and backed points. The use-wear analysis was undertaken based on the Low-Power Approach (LPA) (Tringham et al., 1974; Odell and Odell-Vereecken, 1980; Odell, 1981; Akoshima, 1987) and the High-Power Approach (HPA) (Keeley, 1980; Plisson, 1985; Vaughan, 1985a; Gijn, 1990). Use-wear traces were analyzed using a metallographic microscope Leitz Metallux II, at magnifications ranging from 100× to 400×. A stereomicroscope Leica M420 at magnifications ranging from 6.3× to 32× was likewise used. The microphotography was carried out with a Canon EOS 40D SLR digital camera attached to the microscopes.

	bBLL	BL	BU	BUsp	ES	PE	PE/BU	ES/BU	BU_{sp}	ES_{sp}	SP	Total
Hard		2		1		11					11	25
Hard/hard-medium	1				5				2			8
Stone	1	3	1	1	9	2	1	1	1	1	1	22
Shell or tooth		2				1						3
Antler, bone, or ivory		4	6	4	6			1	5	6	8	40
Hide	1	5	5	3	14			3	1	4	1	37
Butchery		1	3		2							6
Projectile	27											27
No usewear	2	4	4	5	2	1						18
Uncertain	35	6	2	7	3	6						59
Total*	**67**	**27**	**21**	**21**	**41**	**21**	**1**	**5**	**9**	**11**	**21**	**245**

Tab. 1 Results of the use-wear analysis of flint artefacts from Gönnersdorf K-II. – *Several artefacts show more than one worked material. bBLL backed bladelet; BL blade; BU burin; BUsp burin spall; ES endscraper; PE perforator; PE/BU perforator-burin combination tool; ES/BU endscraper-burin combination tool; BU_{sp} splintered burin; ES_{sp} splintered endscraper; SP splintered piece.

LATE MAGDALENIAN LITHIC UTILIZATION STRATEGY AT GÖNNERSDORF

To reveal the spectrum of use of the Upper Cretaceous Meuse flints, all the Meuse flints artefacts excavated from Gönnersdorf K-II were scanned. Among them, unpatinated or less patinated specimens were selected for use-wear analysis. A total of 203 flint artefacts were microscopically analyzed, with a large number of them showing discernible use-wear traces. While 18 pieces showed no clear use-wear traces and 56 exhibit uncertain traces, 134 items bear use-wear traces (**Tab. 1**).

Interestingly, a large number of unretouched or marginally retouched blades show clear use-wear traces that indicate a series of activities, such as butchery, hide-processing, antler-, bone-, or ivory (ABI) processing, shell- or tooth-processing, and stone-processing (**Tab. 2**). Although some blades were employed for tasks using the distal end, most blades were used with their lateral edges involved in longitudinal motions, including cutting and sawing motions. A typical Magdalenian long blade with a curved profile retains very fresh surfaces and exhibits multiple use-wear traces (**Fig. 2**). The right lateral edge of the distal portion of the blade presents unifacial micro-flaking on the dorsal face (**Fig. 2: a**), and polish from hide-working on the ventral face. Such features demonstrate that this edge was used for hide-scraping. The left lateral edge of the proximal part shows alternate edge damage and polish that formed bifacially and that results from ABI processing on both sides (**Fig. 2: b**). These traces indicate its use for sawing of hard organic materials.

High power approach									
	Bu	Hi-TM	Hi-LM	Hi-Wo	ABI-LM	ST-LM	St-LM	St-TM	St-Gr
distal end				1				1	3
broken end								1	
lateral sides	2	4	4		4	2	1		
Low power approach									
	HM-LM	HM-TM	unc.-TM						
lateral sides	1	1	1						
Total number of IUZs									**26**

Tab. 2 Functions by the independent use zone (IUZ) of blades (n = 24) from Gönnersdorf K-II. – Bu butchering; Hi hide; ABI antler, bone, or ivory; ST shell or tooth; St stone; HM hard material; unc. uncertain; TM transverse motion; LM longitudinal motion; Gr grooving; Wo motion is uncertain.

High power approach								
	Bu	Hi-TM	Hi-LM	ABI-LM	ABI-TM	St-Wo	St-TM	St-We
end-scraper edge		16			3		6	1
proximal end						1		
proximal/distal ends					1			
lateral sides	2	2	5	7			2	
Low power approach								
	H/MM-LM							
lateral sides	6							
Total number of IUZs								**52**

Tab. 3 Functions by the independent use zone (IUZ) of endscrapers (n = 24) from Gönnersdorf K-II. – Bu butchering; Hi hide; ABI antler, bone, or ivory; St stone; H/MM hard or medium hard material; TM transverse motion; LM longitudinal motion; We wedging; Wo motion is uncertain.

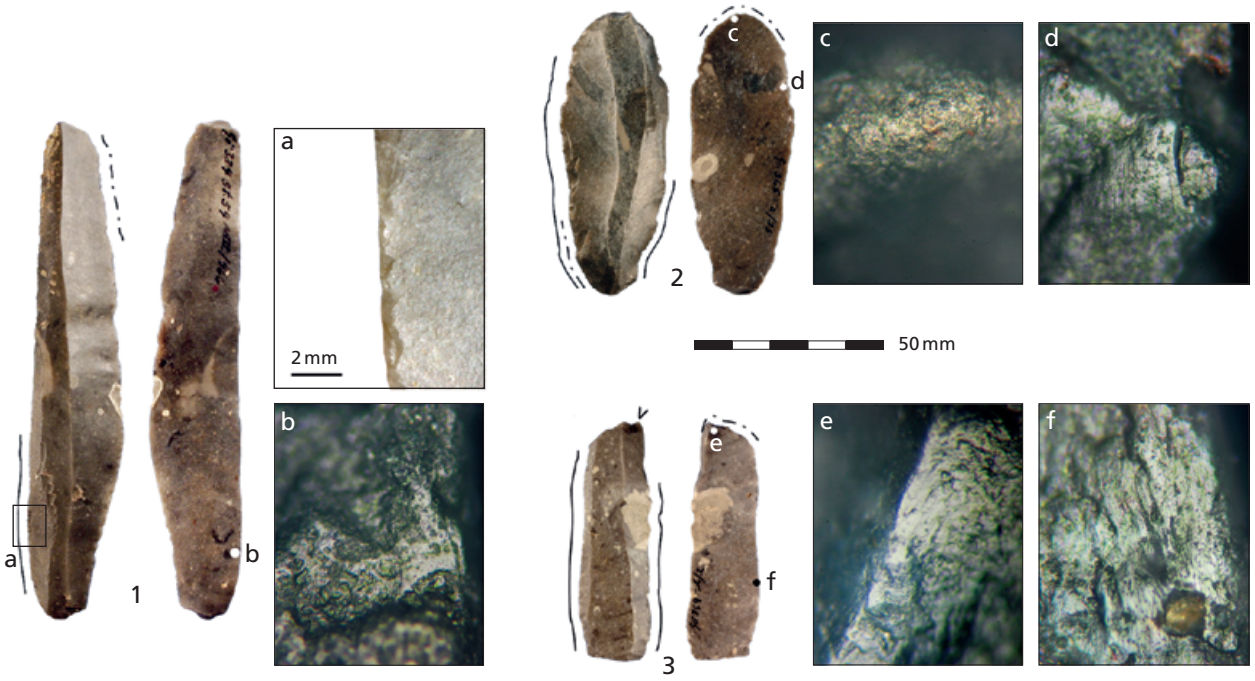

Fig. 2 Blade tools from Gönnersdorf showing use-wear traces. **1** blade; **2** end-scraper; **3** burin. **a** edge damage; **b** polish from ABI-sawing; **c** polish from hide-scraping; **d** polish and striation from ABI-sawing; **e** polish from ABI-grooving; **f** polish from hide-cutting. – b-f magnifications are at 200 ×. Solid lines show edges worked with longitudinal actions, dashed lines show edges worked with transverse actions, and v shows traces of grooving.

Most of the end-scrapers from Gönnersdorf show traces linked to hide-working, as is typical for end-scrapers from other Late Magdalenian sites (Audouze et al., 1981; Moss, 1983; Vaughan, 1985b, 2002; Plisson and Vaughan, 2002; Gosselin, 2005). In particular, distal scraper edges were used primarily for hide-scraping (**Fig. 2: c**; **Tab. 3**). Out of 29 scraper edges, 16 edges were used for hide-scraping, six edges for stone-scraping, and three edges for ABI-scraping. On the other hand, their lateral edges were used for diverse purposes, including butchery, hide-working, ABI-sawing (**Fig. 2: d**), and stone-processing.

While more than 70 % of the scraper edges show clear use-wear traces, burins exhibit a low frequency of utilization of their "working" edges, such as burin bits (23.8 %) and burin facets (14.3 %) (**Tab. 4**). Despite the low frequency of use, burin bits provide evidence for ABI-grooving (**Fig. 2: e**), as the pointed tip is

High power approach								
	Bu	Hi-TM	Hi-LM	Hi-Wo	ABI-LM	ABI-TM	ABI-Gr	St-TM
burin bit				1			4	
burin facet				2		1		1
truncation edge		3				1		
broken edge								1
lateral sides	3		3		3			
Total number of IUZs								23

Tab. 4 Functions by the independent use zone (IUZ) of burins (n = 16) from Gönnersdorf. – Bu butchering; Hi hide; ABI antler, bone, or ivory; St stone; TM transverse motion; LM longitudinal motion; Gr grooving; Wo motion is uncertain.

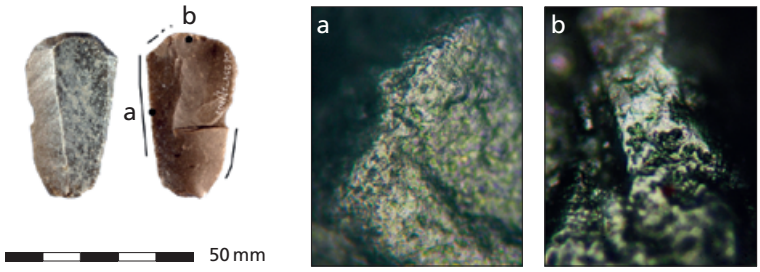

Fig. 3 A splintered endscraper from Gönnersdorf showing use-wear traces. **a** polish from hide-cutting; **b** polish from ABI-working. – a-b magnifications are at 200×. Solid lines show edges worked with longitudinal actions, dashed line shows edges worked with transverse actions, and arrow shows the direction of wedging.

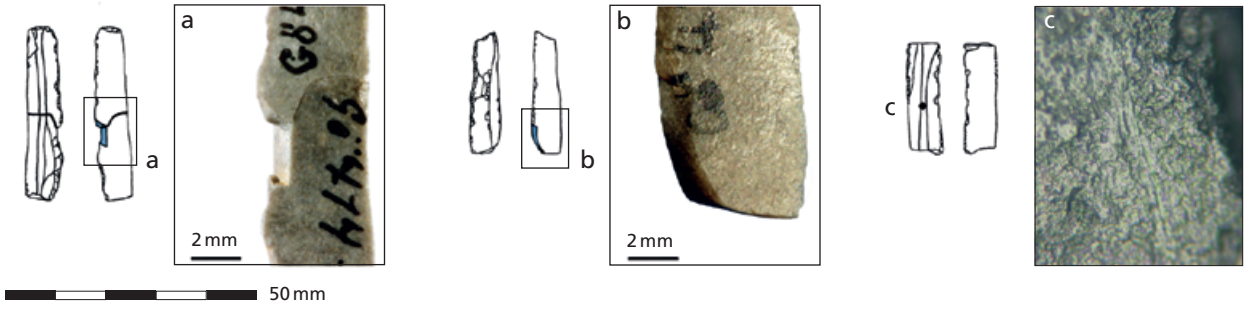

Fig. 4 Backed bladelets from Gönnersdorf showing evidence of hunting. **a-b** impact fractures (burin-like fractures); **c** microscopic linear impact traces (200×).

assumed to be effective for the grooving of hard material. In contrast to our expectations, the lateral edges of the burins were used more frequently (**Fig. 2: f**). The functions of the lateral edges of burins match more or less those of blades and end-scrapers. Multiple utilization of the lateral edges of burins was confirmed at other Late Magdalenian sites (Vaughan, 1985b, 1985c, 2002; Plisson and Vaughan, 2002). As use-wear traces are more often found on adjacent edges to burin facets compared to on burin facets or burin bits themselves, it is suggested that the burin-blow was a technique not only for the preparation of a working edge, but also for the production of bladelets, the rejuvenation of worn edges, and preparation for hafting (Vaughan, 1985c; Barton et al., 1996; Tomášková, 2005).

At Gönnersdorf, a substantial number of end-scrapers and burins demonstrate massive splintering on both ends. The lateral edges of these tools also show diverse functions (**Fig. 3: a**; **Tabs. 5-6**). Experiments have demonstrated that large splintered scars seen on pieces from Gönnersdorf could only have formed if these items were used as wedges against hard materials, such as antlers, bones, or stones (Sano, 2012b). As this wedging induces fracturing of the working edges during use, microwear traces are hardly retained. Nevertheless, some splintered end-scrapers and burins show polish from ABI-working on the ridges between flake scars (**Fig. 3: b**), demonstrating that the pieces were used for wedging against ABI-materials.

Backed points made on blades are absent at Gönnersdorf, except for the younger occupation remains at Gönnersdorf SW. No flint artefacts made on blades were used for hunting (**Tab. 2**). In contrast, numerous backed bladelets show evidence that they were used for hunting (**Tab. 4**). Of the 67 backed bladelets analyzed, 27 specimen bear diagnostic impact fractures (DIFs) (**Fig. 4: a-b**) and four pieces exhibit microscopic linear impact traces (MLITs) (**Fig. 4: c**). In contrast, only three backed bladelets yield other use-wear traces, such as hide-scraping, stone-grooving, and cutting/sawing of hard or medium-hard materials. The high

Splintered end-scrapers								
High power approach								
	Hi-TM	Hi-LM	ABI-LM	ABI-We	St-LM	St-TM	St-TM	St-Gr
proximal and distal ends				6			1	3
end-scraper edge	4					1	1	
lateral sides	1	2	3		1			
Total number of IUZs								18

Tab. 5 Functions by the independent use zone (IUZ) of splintered end-scrapers (n = 6) from Gönnersdorf. – Hi hide; ABI antler, bone, or ivory; St stone; H/MM hard or medium hard material; TM transverse motion; LM longitudinal motion; Gr grooving; We wedging.

Splintered burins			
High power approach			
	Hi-TM	ABI-We	St-Gr
proximal and distal ends		5	
distal end	1		
burin bit			1
Low power approach			
	H/MM-LM		
lateral sides	3		
Total number of IUZs			10

Tab. 6 Functions by the independent use zone (IUZ) and splintered burins (n = 5) from Gönnersdorf. – Hi hide; ABI antler, bone, or ivory; St stone; H/MM hard or medium hard material; TM transverse motion; LM longitudinal motion; Gr grooving; We wedging.

ratio of burin-like fractures to other types of impact fractures suggest that these backed bladelets were laterally hafted, as is evidenced at the cave of Lascaux and the site of Pincevent in France, where backed bladelets were found laterally attached to an osseous point (Leroi-Gourhan and Allain, 1979; Pétillon et al., 2011).

LATE / FINAL MAGDALENIAN LITHIC UTILIZATION STRATEGY AT BOIS LAITERIE

All of the excavated lithic artefacts from Bois Laiterie cave, excluding collections for the permanent exhibition and micro-debitage, were scanned. A total of 256 samples were selected for use-wear analysis. Unfortunately, the microscopic analysis on most of the materials from the Bois Laiterie cave is hindered by the heavy patination of flints. Therefore, it was impossible to identify a polish type on most artefacts based on HPA; those pieces were analyzed based on LPA only (**Tab. 7**).

Similar to the Gönnersdorf assemblage, many burins and several end-scrapers from Bois Laiterie show use-wear traces on their lateral edges (**Tabs. 8-9**). The lateral edges exhibit alternate micro-flaking on the dorsal and ventral faces, indicating that these edges were used for longitudinal motions, such as cutting or sawing. The contact material for these tools is still uncertain. An end-scraper made on a typical Magdalenian long blade retains relatively fresh surfaces, allowing the identification of micro-wear traces. A developed polish band from hide-scraping was observed along the scraper edge (**Fig. 5: a**). Both lateral edges bear alternate micro-flaking and complex micro-wear traces, consisting of generic weak polish, hide-polish, and partially

	bBLL	FR	FL	BL	BP	BU	BUsp	ES*[1]	PE	TR	SP+ NO+ DE	Total
Hard			1	4		5		3	2			15
Hard/hard-medium			2	9		6						17
Stone						1						1
Shell or tooth												0
Antler, bone or ivory				1				1				2
Hide								1		1		2
Butchery								1				1
Projectile	24	3		10	13							50
No usewear				2								2
Uncertain	52	34	4	40	10	3	5	6	10	3	3	170
Total*[2]	**76**	**37**	**7**	**66**	**23**	**15**	**5**	**12**	**12**	**4**	**3**	**260**

Tab. 7 Results of the use-wear analysis of flint artefacts from Bois Laiterie. – *[1] Two endscrapers have splintering and both the splitered endscrapes show traces from hard material working; *[2] Several artefacts show more than one worked material. – bBLL backed bladelet; FR fragment; FL flake; BL blade; BP backed point; BU burin; BUsp burin spall; ES endscraper; PE perforator; TR truncation; SP+NO+DE includes one splintered piece, one notch, and one denticulate.

High power approach			
	Bu	Hi-TM	ABI-LM
end-scraper edge		1	
lateral sides	2		1
Low power approach			
	HM-We	HM-LM	
end-scraper edge	2		
lateral sides		3	
Total number of IUZs			**9**

Tab. 8 Functions by the independent use zone (IUZ) of endscrapers (n = 10) from Bois Laiterie. – Bu butchering; Hi hide; ABI antler, bone, or ivory; HM hard material; TM transverse motion; LM longitudinal motion; We wedging.

High power approach				
	St-TM	St-Gr		
burin bit		1		
burin facet	1			
Low power approach				
	HM-TM	HM-Gr	HM-LM	H/MM-LM
burin bit		5		
burin facet	1			
lateral sides			4	6
Total number of IUZs				**18**

Tab. 9 Functions by the independent use zone (IUZ) of burins (n = 13) from Bois Laiterie. – St stone; HM hard material; H/MM hard or medium hard material; TM transverse motion; LM longitudinal motion; Gr grooving.

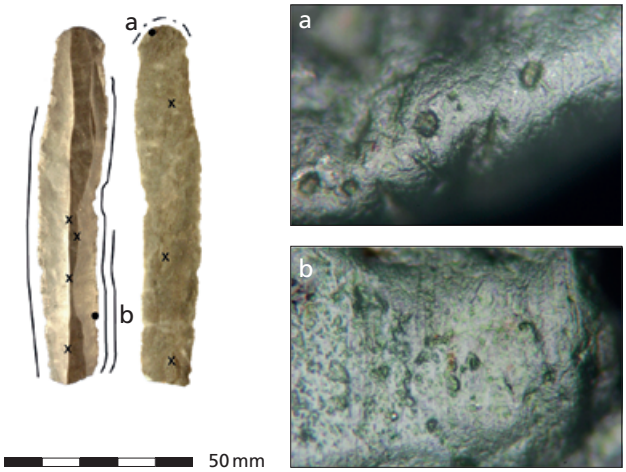

Fig. 5 An end-scraper from the Bois Laiterie cave showing use-wear traces. **a** polish from hide-scraping; **b** polish from ABI-sawing. a-b: magnifications are at 200×. Solid lines show edges worked for longitudinal actions, dashed lines show edges worked for transverse actions, and x shows traces of hafting.

formed linear ABI-polish. The combination of these traces suggests that both edges were used for butchery. The proximal half of the right edge was probably also used for ABI-sawing as this zone shows well-developed ABI-polish, which is an uncharacteristic feature for butchery (**Fig. 5: b**).

Backed bladelets were abundant at Bois Laiterie, and a high ratio of the backed bladelets show DIFs (**Fig. 6: a-b**). No other use-wear traces were observed on the backed bladelets. Due to heavy patination none of them allowed the analysis of micro-wear traces. Nevertheless, the highly-frequent occurrence of impact scars on backed bladelets demonstrates that they were basically used as hunting armatures. In contrast to Gönnersdorf, a considerable number of backed points were found at Bois Laiterie (Sano et al., 2011). Out of 23 backed points, 13 backed points show evidence for projectile usage (**Tab. 7**). Moreover, no other use-wear traces were observed on backed points. The large dimension of the impact fractures (**Fig. 6: c-e**) suggests that they were delivered with high impact velocity.

The backed points from Bois Laiterie were made on blades. However, the blade production technique differs from that documented at Gönnersdorf. The typical Magdalenian long and curved blades are knapped by use of an organic hammer after a specific preparation of the core's striking platform(s), referred to as *en éperon* preparation (Weiner, 1989). The *en éperon* preparation is also present in blades from Bois Laiterie. However, this technique is practiced much less frequently (< 10 %) at this cave than at other typical Late Magdalenian sites (Sano et al., 2011). At Bois Laiterie, blade tools show approximately straight profiles, with curved blades rather rare. Using a soft stone hammer is favorable when seeking to obtain straight profiled blades (Pelegrin, 2000). Technological scars for the use of soft stone hammers (Pelegrin, 2000), comprising a marked striking impact scar, an *en esquillment du bulbe*, and a platform remnant that is ≤ 5 mm^2, were often observed on blade tools from Bois Laiterie (~ 40 %). Although the striking platform of backed points is missing due to retouch, their straight profile implies that the blanks were detached using a soft stone hammer, in order to obtain a preferential straight profile that is ideal for use as a projectile tip.

DISCUSSION AND CONCLUSIONS

The high frequency of impact scars on backed bladelets has also been observed at other Magdalenian sites in Western Europe, including Pincevent (Moss, 1983) and Étiolles (Christensen and Valentin, 2004) in the Paris Basin, and Champréveyres (Plisson and Vaughan, 2002) at Lake Neuchâtel. Although other use traces

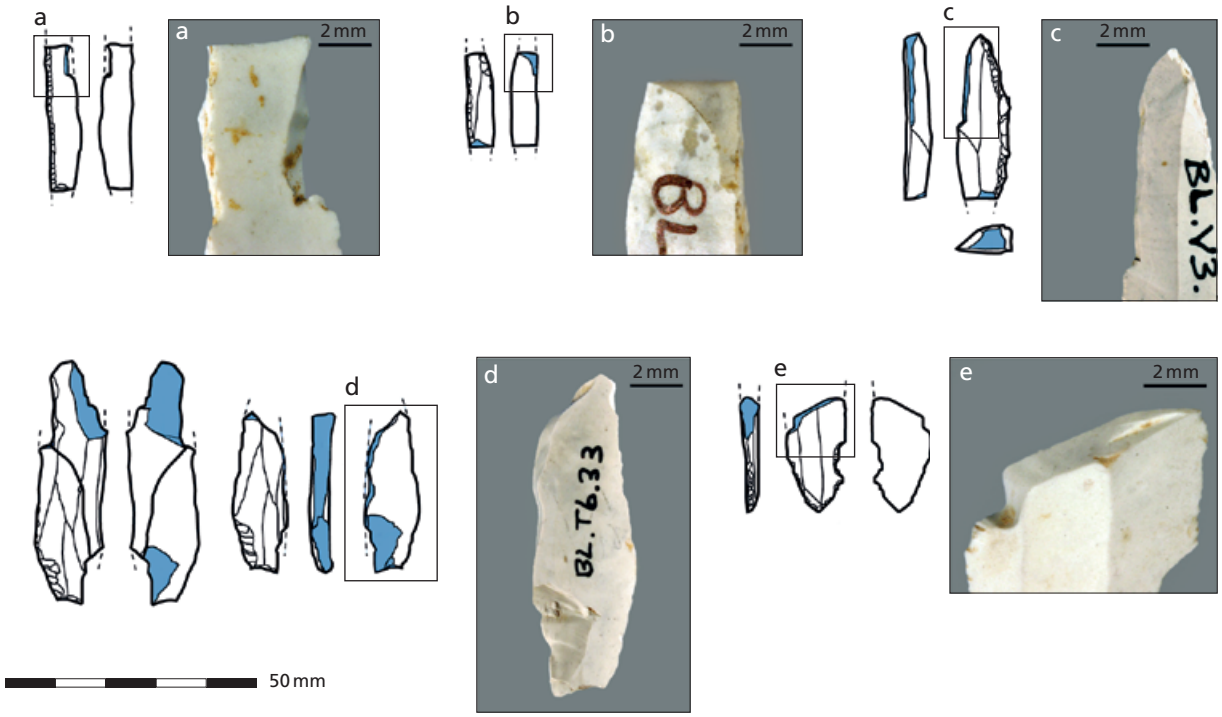

Fig. 6 Backed bladelets and backed points from the Bois Laiterie cave showing impact fractures. **a-c** burin-like fractures; **d** burin-like (s-shaped) and flute-like fractures; **e** burin-like (s-shaped) fracture.

were also found on backed bladelets from these sites, their otherwise low frequency suggests that the utilization of these artefacts for other purposes was rather opportunistic. Consequently, we may conclude that Magdalenian backed bladelets were produced specifically as hunting weapons (**Fig. 6**).

While scraper edges and burin bits were used for a relatively specific task with transverse motions, the lateral edges of end-scrapers and burins were employed for multiple tasks, with mostly longitudinal motions. The temporal relationship between the distal ends and lateral edges is challenging to elucidate. However, while hafting traces on the Gönnersdorf flints were ambiguous due to the overlap of developed use-wear traces and possible hafting traces, Magdalenian end-scrapers were probably hafted for their use (Rots, 2005). The lateral edges of end-scrapers and burins were not usable during the task using the distal end. Hence, the functional disconnection between the distal ends and lateral edges suggests reduction sequences from blades to end-scrapers and burins.

The lateral edges of typical long, standardized Late Magdalenian blades from Gönnersdorf were used for multiple tasks (**Fig. 7**). Some of them were even given scraper edges and were used for hide-scraping. Some were continuously utilized, and worn edges were rejuvenated by retouch or burin-blows. They are then used again after repair. Several blades may have obtained burin-blows, particularly in order to use the burin bits for grooving of hard materials. Moreover, burin-blows were probably performed to attain bladelets. However, the process was also performed in the course of modification for hafting as well. Considerable numbers of end-scrapers and burins show massive splintering on both ends, suggesting that many blade tools were also used as wedges after repeated use, and they have finally finished their "life-cycle" when discarded.

While blades from Gönnersdorf were exhaustively used, none of them were used as a hunting weapon. This is not surprising, since the curved longitudinal profile and the great length of the typical Magdalenian

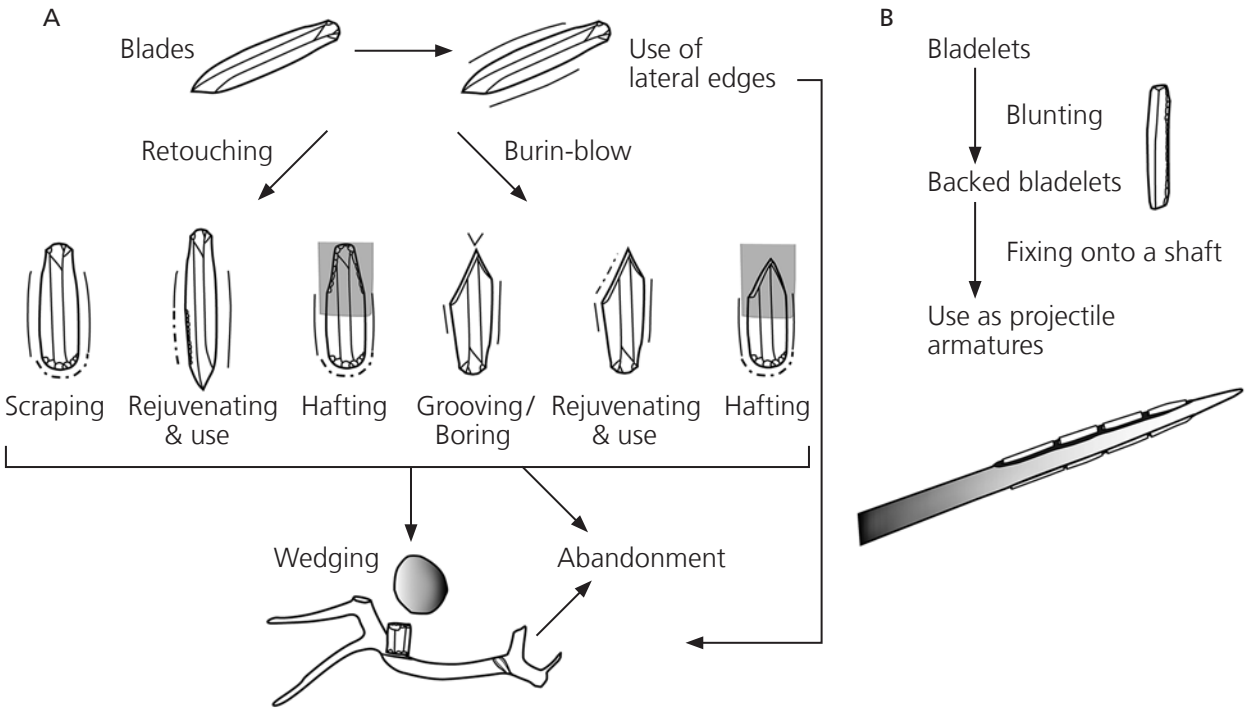

Fig. 7 Utilization sequences for Magdalenian blades (**A**) and bladelets (**B**). Solid lines show edges worked for longitudinal actions, dashed lines show edges worked for transverse actions, and v shows traces of grooving.

blades render it unsuitable as a projectile point. The extremely long Magdalenian blades are optimal for repeated use. Reduction by retouch or burin-blows allowed Magdalenian people to rejuvenate their blades. Therefore, the great length of the blades is especially well-suited for longer utilization.

We can therefore consider that while, on the one hand, Magdalenian blades became longer to maximize durable blade utilization, on the other hand, this would have made them unsuitable as a projectile tip. Instead, backed bladelets are used as projectile tips for hunting. The more significant number of backed bladelets in Magdalenian assemblages compared to in preceeding European Upper Palaeolithic technocomplexes, including the Solutrean and the Gravettian, in which lithic points are also abundant, may reflect the more critical role of Magdalenian backed bladelets as hunting weaponry.

The straight, short blades at Bois Laiterie, probably detached using a soft stone hammer, might stem from the somewhat younger Magdalenian phase of this site (ca. 15,100 cal BP, compared to the age of Gönnersdorf at ca. 15,800 cal BP). The production method for such straight, short blades is more frequently attested in Final Magdalenian and Azilian assemblages (Valentin, 2006; Weber, 2006; Grimm, 2019). A typological comparison of backed points recovered from Bois Laiterie with those found in the succeeding Late Glacial assemblages indicate a similarity with the angle-backed points of the Creswellian, as well as the curve-backed points found in Azilian and *Federmessergruppen* contexts (Sano et al., 2011). The radiocarbon dates of the Bois Laiterie cave slightly predate the Late Glacial assemblages, and partially overlap temporally with the earliest chronological phase of the classic Hamburgian on the North European Plain (Weber and Grimm, 2009). While the Hamburgian shares a long, curved blade production method with Late Magdalenian, using *en éperon* preparation, new technological trends also appear within the former (Weber, 2006, 2012). The coexistence of Magdalenian and Late Glacial technologies is also seen in the Creswellian, which chronologically coincides with the Hamburgian, but is distributed through the Benelux and the south British Isles

(Barton et al., 2003). The change of blade utilization strategy from Gönnersdorf to Bois Laiterie indicates the first step of the gradual techno-functional transformation from the Late Magdalenian to the Late Palaeolithic in North-western Europe.

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