Less simple than expected. New technological and functional insights on the Late Azilian site of Le Closeau (France)

Weniger einfach als erwartet. Neue technologische und funktionale Erkenntnisse über die spät-federmesserzeitliche Fundstelle von Le Closeau (Frankreich)

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Abstract - Already perceived through certain characteristics of the site, notably via the scarcity of retouched elements, the absence of hearths, and the localization of the site a few hundred metres from an exploited flint outcrop, the trend towards functional specialization seen in the late Azilian loci of Le Closeau seems to be equally confirmed by the results of the first techno-functional studies. The study of locus 36 indicates that flint production was very wasteful and predominantly oriented towards obtaining small blades, blanks that are compatible with the requirements for hunting implements, i.e., points. The backed points found were broken during the manufacture process and demonstrate that these were produced on site. Along with traces indicating the working of rigid plants with small cross-sections, they provide the only significant evidence of transformation activities. The results from other loci suggest that this functional orientation is not an exception but rather a shared pattern across the late Azilian loci at Le Closeau. It is therefore proposed that this large site was generated primarily by the accumulation of isolated specialized uses, and furthermore, said accumulation could even contribute to the internal formation of the loci themselves given the observed autonomy of some of the flint concentrations that constitute locus 36. Both the site operation and site formation at Le Closeau seem quite original and underline the various modes of occupation that contribute to the many large Azilian open-air sites. Although these large sites of the Allerød appear, at least at first glance, not to be particularly variable they actually seem to correspond to very distinct occupational situations, ranging from large campsites organized into complementary loci (the Rekem site in Belgium: De Bie & Caspar 2000), to successions of small-scale residential camps (the scenario proposed for the Chaloignes site: Marchand et al. 2009), or even to accumulations of specialized visits. It would seem that certain characteristics of Azilian occupation strategies, such as repeated site use and discrete habitation structures, do not favour a clear comprehension of site status. In such a context, it is imperative that interdisciplinary approaches combining petrographic, technological, refit, and functional analyses become standard practice. It is quite likely that the development of an integrated and interdisciplinary techno-functional approach will profoundly transform our collective interpretations of Azilian economics.

Zusammenfassung - *Die Tendenz zur funktionalen Spezialisierung, wie sie an der spät-federmesserzeitlichen Fundstelle Le Closeau beobachtet werden konnte, insbesondere am Mangel an retuschierten Elementen, am Fehlen von Feuerstellen und an der Lage der Fundstelle nur wenige hundert Meter von einem genutzten Feuersteinaufschluss entfernt, scheint sich auch durch die Ergebnisse der ersten techno-funktionalen Studien zu bestätigen. Die Untersuchung der Stelle 36 zeigt, dass die Bearbeitung von Feuerstein sehr verschwenderisch und überwiegend darauf ausgerichtet war schmale Klingen zu gewinnen, Grundformen, die mit den Anforderungen für Jagdwerkzeuge, d.h. Spitzen, kompatibel sind. Die hier gefundenen rückengestumpften Spitzen waren während des Herstellungsprozesses zerbrochen und zeigen, dass sie vor Ort hergestellt wurden. Zusammen mit Spuren, die auf die Bearbeitung fester Pflanzen mit kleinem Querschnitt hindeuten, sind sie der einzige signifikante Hinweis auf Aktivitäten vor Ort. Die Ergebnisse von anderen Stellen deuten darauf hin, dass diese funktionale Ausrichtung keine Ausnahme ist, sondern ein gemeinsames Muster für die spät-federmesserzeitliche Fundstelle Le Closeau darstellt. Es wird vorgeschlagen, dass diese große Fundstelle in erster Linie durch die Anhäufung isolierter spezialisierter Aktivitäten entstanden ist. Darüber hinaus könnte diese Anhäufung sogar zur internen Strukturierung der Stellen selbst beitragen, wenn man die beobachtete Autonomie einiger der Feuersteinkonzentrationen bedenkt, die Stelle 36 ausmachen. Sowohl die Organisation als auch die Entstehung der Fundstelle Le Closeau scheinen einzigartig zu sein und unterstreichen die verschiedenen Nutzungsformen, die zu den vielen großen federmesserzeitlichen Freilandfundstellen beitragen. Obwohl diese großen allerødzeitlichen Fundstellen zumindest auf den ersten Blick nicht besonders variabel erscheinen, dürften sie in Wirklichkeit sehr unterschiedlichen Siedlungsmustern zu entsprechen, die von*

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großen, in komplementären Einheiten organisierten Lagerplätzen (vgl. Rekem, De Bie & Caspar 2000) bis hin zu Abfolgen von kleinen Basislagern (vgl. Chaloignes, Marchand et al. 2009) oder sogar zu Ansammlungen von spezialisierten Aktivitäten reichen. Es hat den Anschein, dass bestimmte Merkmale der federmesserzeitlichen Siedlungsstrategien, wie z. B. die wiederholte Nutzung einer Stelle und diskrete Siedlungsstrukturen, ein klares Verständnis der Funktion einer Stelle erschweren. In diesem Zusammenhang ist es unerlässlich, dass interdisziplinäre Ansätze, die petrographische, technologische, Ausstattungs- und Funktionsanalysen kombinieren, zum Standard werden. Es ist sehr wahrscheinlich, dass die Entwicklung eines integrierten und interdisziplinären techno-funktionalen Ansatzes unsere kollektiven Interpretationen der federmesserzeitlichen Wirtschaftsweise verändern wird.

Keywords - Azilian, Allerød, techno-functional approach, site function, economic organization
Azilian, Allerød, techno-funktionaler Ansatz, Funktionen der Fundstelle, wirtschaftliche Organisation

Introduction

Like the sites of Rekem (Belgium, De Bie & Caspar 2000, 2006), Niederbieber (Germany, Bolus 1992; Street et al. 2006 ; Gelhausen 2011; Mevel & Grimm 2019), or Les Chaloignes (France, Marchand et al. 2009) Le Closeau (Rueil-Malmaison, Hauts-de-Seine, Bodu 1998; Bodu 2000a, 2000b; Bodu et al. 2006; Bodu & Mevel 2008; Mevel & Bodu 2018) is among the few Azilian/Federmessergruppen open-air sites (Fig. 1) that were extensively excavated throughout the 1990s. Excavated over a 29,000 m^2 surface and being composed of 59 individualized loci, Le Closeau is one of the largest Late Glacial sites excavated in Europe (Fig. 2). Having been occupied at different moments during the Azilian between the end of GI-1e and the beginning of GS-1, it has quickly become a reference site, in particular to discuss internal variations in the Azilian and scenarios of rupture with preceding Magdalenian traditions (Bodu & Valentin 1997; Bodu 2000; Bignon-Lau 2020).

The upper level, upon which we focus in this article, is attributable to the Late Azilian, which is widely known across Europe under several names – the Federmesser or the Curved Backed Point industries – and is generally associated with the GI-1c/b, and sometimes even as late as GS-1 (see, for example, Grimm 2019). At Le Closeau the radiocarbon measures conducted confirm this chronological association even though the charcoal fragments that were dated are, for the most part, considered to be the result of phases of natural wildfire occurring after human occupation of the site (Cary 1998). These dates do, however, provide two *termini post quem* for the occupations after to the Early Azilian: roughly 10,700 and 10,500 calBC (Fig. 3). The most recent dates, in particular those obtained for locus 25, even suggest the presence of occupations contemporary with the Younger Dryas (Bodu 2000). These radiocarbon dates as well as the presence of Malaurie points could link this locus to the Laborian culture (see Langlais et al. 2020 for a recent synthesis on the subject).

The archaeological materials of the upper level, which are for the most part lithics, are distributed among 50 loci of heterogeneous size and density (from 1 to 70 kg of knapped flint) whose limits are not always easily discernable. The separation of the loci as presented in the map (see figure 2) is an arbitrary division partly inherited from the progression of excavations. The question of the archaeological reality of these boundaries remains open. The majority of the loci for the Late Azilian at Le Closeau are situated on the southern side of an east-west oriented paleochannel of the Seine. In opposition to the lower level, situated on the northern side and attributed to the early phase of the Azilian (Bodu 2000), no stone lined structures were identified. These weakly structured activity or habitation units appear to be a shared feature across all of the Allerød Azilian sites. While neither ^{14}C dates nor sufficient stratigraphic resolution have allowed for the discrimination of different chronological groupings within the loci of the upper level, a chronological phasing of Late Azilian has been proposed using between-locus flint production technical variations (Bodu 1998; Bodu & Valentin 1997; Bodu 2000; Mevel & Bodu 2018). The concept of Azilianization, then under construction and supporting a gradual vision of the transformations between Magdalenian, Early Azilian and Late Azilian/Federmesser (Bodu & Valentin 1997 ; Bodu 2000), deeply conditioned the way of interpreting these variations. According to the idea of a gradual abandonment of Magdalenian standards, loci showing the simplest production sequences were grouped into an "upper" phase (Fig. 2) while those demonstrating the most regular blade productions were grouped into an "intermediary" phase (i.e. between the early Azilian of the lower archaeological level and the upper phase of the upper level, Fig. 2). Numerous loci were placed within an "indeterminate" phase, as the technical attribution did not allow them to be placed into the two other phases with sufficient confidence.

Given the lack of structures, the extreme rarity and mediocre conservation of faunal remains, and the lack of use-wear data for the upper level, discussions regarding the functional attribution of its loci were essentially based on the typological composition of the lithic industry. The overwhelming predominance of backed points relative to the rarity of end scraper or burin types favoured the interpretation of the majority of these loci as hunting stands that may have been functionally complementary with the rare loci that provided a broader typological diversity (see

Fig. 1. Map of Azilian and FMG sites cited in the article (Map: M. Sauvage, USR 3225 CNRS, modified).

Abb. 1. *Karte der im Artikel zitierten Standorte von Azilian und FMG (Karte: M. Sauvage, USR 3225 CNRS, modifiziert).*

Bodu et al. 2011). Given the difficulty encountered when attempting to conduct inter locus refits on a site of this size, the question of complementarity between the different loci remains, for the time being, an open question.

In order to better understand the status of the different loci of Le Closeau, to make progress on the question of possible inter-locus complementarities, and to better characterize the differences between the loci attributed to the intermediate, upper and indeterminate phases of the upper level, a techno-functional approach of the lithic industry has been initiated. In this article we will present the initial results of this study which, to date, concerns three neighbouring loci. This paper will particularly focus on locus 36, which has been subjected to the most in-depth techno-functional study, completed with essential and complementary analyses of the spatial distribution as well as intensive refitting sessions. Use-wear analyses were also recently conducted on loci 20 and 26, but given that the technological analysis remains incomplete these results will only be mentioned in passing in order to begin discussing between-locus variability. In the near future techno-functional analyses will be extended to loci 1/11 and 14, respectively attributed to the "upper" and "intermediary" phases and both constituting some of the richest loci in terms of typological richness and diversity.

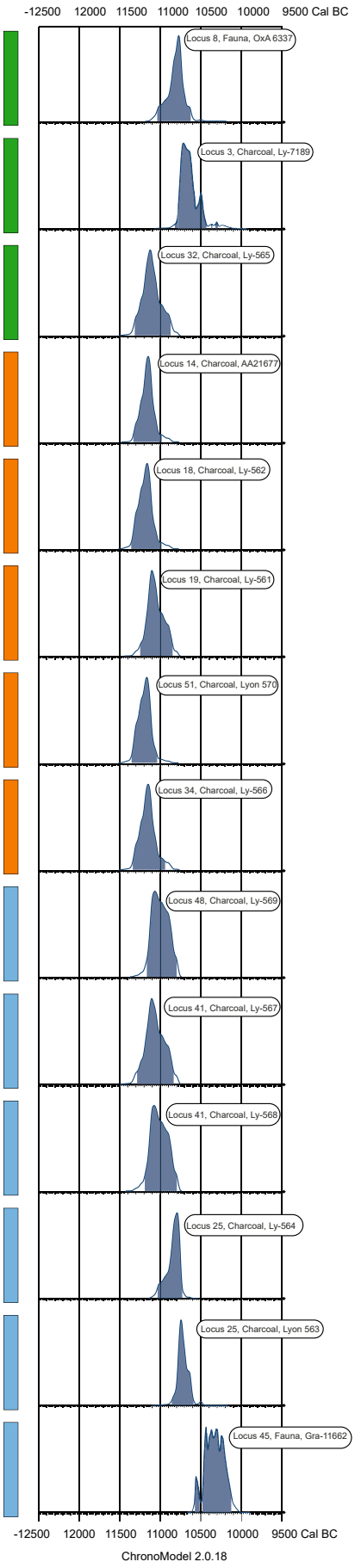
Materials and methods

The first part of this study concerns loci 20, 26 and 36, attributed variably to the "intermediate", "upper", and "indeterminate" phases (Fig. 2). These loci are fairly representative of the general trend at Le Closeau in that, apart from locus 20, these different loci lack typological diversity (Tab. 1). The typologically defined tools are dominated by backed points, with a few end scrapers, some rare burins, and a few retouched blanks whose interpretation is not provided without some reserve

Fig. 2. Le Closeau site plan (CAD: N. Gomes, I. Pasquier).
Abb. 2. *Lageplan von Le Closeau (CAD: N. Gomes, I. Pasquier).*

(pieces show short series of removals that may have been unintentionally generated). In this respect, locus 20 is distinct from the other three and original at the site level, with the presence of 17 becs all concentrated within a few square metres. Beyond the typological composition, these loci are characterized by a lack of faunal remains, a high quantity of flint production (represented by between 20 and 58 kg of flint pieces), globally simplified operational chains, and a poorly standardized target product, i.e., bladelike flakes, used in the production of a specific type of armature.

As explained above, this article will focus on locus 36. This locus was attributed to the "indeterminate" phase, indicating that the production observed was intermediary between the structured blade and the more simplified examples seen in the upper level. Excavated over a 133 m^2 surface, 2,473 flint artefacts were discovered in locus 36, amounting to a total of about 42 kg of flint



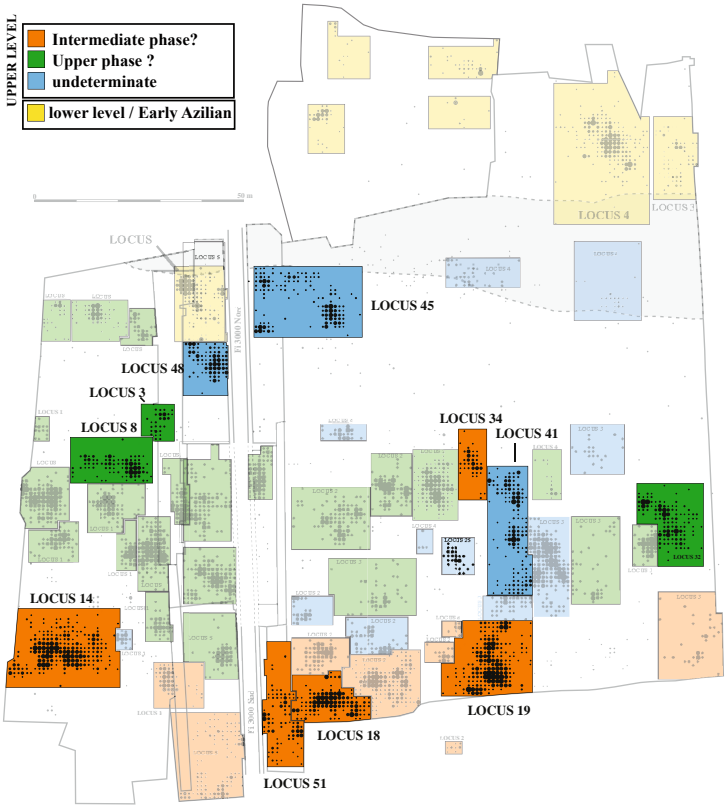


Fig. 3. Dates of the loci in Le Closeau's upper level (calibrated with Chronomodel 2.0, Lanos & Dufresnes 2019).
Abb. 3. *Datierung der Loci in der oberen Ebene von Le Closeau (kalibriert mit Chronomodel 2.0, Lanos & Dufresnes 2019).*

Locus	Excavated surfaces	Weight secondary flint (local)	Weight tertiary flint (local)	All lithics (n=)	Retouched tools (n=)	Unretouched tools (n=)	Cores (n=)	Backed points (n=)	Backed bladelets (n=)
36	133	41.97	0.05	2,336	5	16	40	12	0
20	134	55.31	0.41	4,340	18	11	54	43	3
26	107	57.48	0	3,070	4	13	68	17	23

Tab. 1. Details from the locus 20,26 and 36 (excavated surface and lithic inventory).

Tab. 1. *Details aus den Fundstellen 20,26 und 36 (ausgegrabene Oberfläche und lithisches Inventar).*

(Fig. 4). The flint artefacts in this locus were intensively refitted in order to understand the goals of production (via a chaîne opératoire analysis) and the organization of production within the studied area, ideally shedding light on certain aspects of the flint economy (segmentation of operational chains, circulation of products, etc.). The use-wear study was conducted in parallel in order to explore the economy of products (sensu Perles 1991) as well all the overall functional orientation of the locus. To ensure that the results were representative, and also to guarantee a productive comparison across our techno-economic, spatial, and functional datasets, the sample selected for use-wear analysis needed to be as large as possible. Although the entire assemblage of locus 36 (N = 2,336) was not studied in depth via microscopic analysis, all of the retouched implements (23, of which 12 are either backed points or bladelets) and the unmodified blanks of over 10 millimetres in length were observed using a stereomicroscope (x1 to x90 magnification) in order to rapidly detect patterns of wear, as explained in Van Gijn (2014). This first macroscopic phase of observation allowed for the identification of potential tools, their different active zones, and even possible residues. This phase was completed by occasional observations under a reflected light microscope (x100, x200, and x500 magnification) when necessary, in particular when macroscopic analysis did not allow us to distinguish without a doubt between the origin of traces or damage, which can be functional, technical, or taphonomic in nature. The functional analysis of the identified tools was then performed at low and high magnifications with the same optical equipment in order to describe the traces and reconstruct how each tool was used. The same protocol was used to study loci 20 and 26. A camera mounted on the trinocular head of the optical instruments used for analysis made it possible to acquire microphotographic images as well as most of the macrophotographic images. Some macroscopic traces, specifically those requiring a wider field of view, were recorded using a digital camera equipped with a macro lens.

Results of the technological analysis and spatial approach to the production economy

While locus 36 itself is a large horizontal spread of artefacts, it can be subdivided into six distinct sectors: three dense concentrations that are limited in their horizontal distribution, evoking lithic production heaps, a surface of low-density artefact distribution, and two small concentrations interspersed between the large examples (Fig. 4). Here we will present the techno-economic results per sector, and for each we will discuss the technical intentions as well as the ways and means prehistoric knappers used to materialize said intentions. Refits will be highlighted in particular; while these are by no means exhaustive, they shine the spotlight on the circulation of products within the locus and allow us to discuss the possible export of single products, production sequences (series of blades, bladelets, or flakes) or still exploitable cores. A total of 395 lithic artefacts were refitted or conjoined (roughly 17 % of the locus 36 assemblage), consisting of 87 groups containing between 2 and 33 elements.

The raw materials exploited all correspond to varieties of secondary and tertiary flints that are available close to the site, at roughly 200 m from locus 36. No clear extra-regional flints have been identified within the assemblage.

Concentration n°1: heap RST 71-74

Concentration n°1 corresponds to a heap located in the south-east of the locus. It is composed of 583 artefacts, or roughly 25 % of the materials from locus 36. Flakes dominate the blank categories (N = 384), while blades and bladelike flakes are in the minority (N = 128) (Tab. 2). There are eleven cores in the sector. One hundred and one artefacts were refitted here, and these fit into 20 distinct sequences. None of these sequences integrate materials from the other concentrations of locus 36. One sequence, consisting of two refitted blanks (a flake that refits onto a tool identified via the use-wear analysis: (Fig. 5), is, however, from a nodule that was not worked within the locus. Its cortical surface, which is in fact neocortical, underlining the collection of this secondary flint from an alluvial context, does not correspond with the materials present in the concentration, or with any of the other concentrations of locus 36. This demonstrates the import of at least a few already knapped blanks into locus 36. Attempts to find refits between locus 36 and its nearest neighbour, locus 41, have not been successful.

Besides the refitted tool, this concentration contains only one other tool that was also identified via use-wear analysis. This highlights that the production

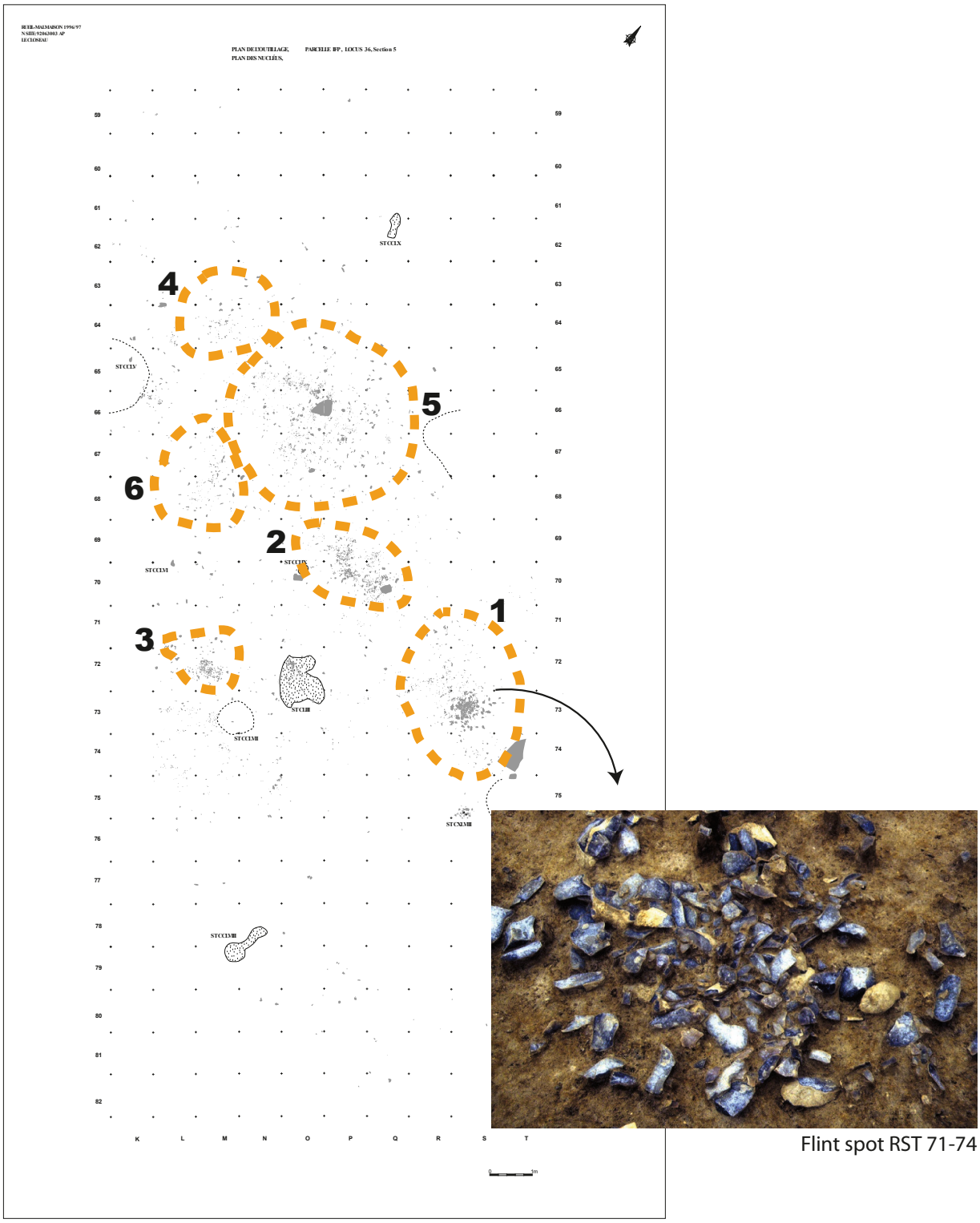


Fig. 4. Organization of locus 36 and photo of lithic heap RST 71-72 (CAD: N. Gomes, I. Pasquier; Picture: P. Bodu).
Abb. 4. *Organisation der Fundstelle 36 und Foto des cluster RST 71-72 (CAD: N. Gomes, I. Pasquier; Foto: P. Bodu).*

sequences that created this lithic heap were not oriented towards the manufacture of products to be used on this spot. This hypothesis is further corroborated by the presence of several refitted sequences that demonstrate the export of a certain number of products. The most significant examples concern two sequences that demonstrate the production of a series of quite regular blades that are no longer present in the locus (Fig. 6). Among the tools identified via use-wear only one blade, used without being retouched, has the morphological and morphometric characters of the aforementioned exported sequences (Fig. 6). Other sequences demonstrating the exploitation of nodules that were then abandoned within the heap, are

		Inventory	Cores	Unretouched tools	Typological tools	Backed points
Concentration 1 RST 71-74	Flakes	384	6	1	-	-
	Blade like flakes	55	-	1	-	-
	Bladelets like flakes	3	-	-	-	-
	Debris	9	-	-	-	-
	Blades	83	-	1	1	9
	Bladelets	45	-	-	-	-
	Nodules	4	4	-	-	-
	Total	583	10	3	1	9
Concentration 2 OPQ 69-70	Flakes	283	1	-	-	-
	Blade like flakes	46	-	-	-	-
	Bladelets like flakes	6	-	-	-	-
	Debris	6	-	-	-	-
	Blades	15	-	1	-	-
	Bladelets	34	-	-	-	-
	Nodules	1	1	-	-	-
	Total	391	2	1	-	-
Concentration 3 LM 70-72	Flakes	124	1	-	-	-
	Blade like flakes	37	-	-	-	-
	Bladelets like flakes	10	-	-	-	-
	Debris	6	1	-	-	-
	Blades	12	-	1	1	-
	Bladelets	8	-	-	-	-
	Nodules	2	2	-	-	-
	Total	199	4	1	1	-
Concentration 4 M63-64	Flakes	30	-	-	-	-
	Blade like flakes	6	-	-	-	-
	Bladelets like flakes	1	-	-	-	-
	Debris		-	-	-	-
	Blades	6	-	-	-	-
	Bladelets		-	-	-	-
	Nodules	1	1	-	-	-
	Total	44	1	-	-	-
Concentration 5 NOPQ 64-68	Flakes	350	2	2	-	-
	Blade like flakes	97	-	-	-	-
	Bladelets like flakes	11	-	-	-	-
	Debris	60	-	-	-	-
	Blades	45	-	1	-	-
	Bladelets	30	-	-	-	-
	Nodules	8	7	-	-	-
	Total	601	9	3	-	-
Concentration 6 LM 66-68	Flakes	56	-	-	-	-
	Blade like flakes	25	-	-	-	-
	Bladelets like flakes	4	-	-	-	-
	Debris		-	-	-	-
	Blades	21	-	1	-	-
	Bladelets	6	-	-	-	-
	Nodules	1	1	-	-	-
	Total	113	1	1	-	-
Outside main concentrations	Flakes	259	6	2	2	-
	Blade like flakes	54	-	3	1	-
	Bladelets like flakes	8	-	-	-	-
	Debris	10	-	-	-	-
	Blades	52	-	2	-	3
	Bladelets	15	-	-	-	-
	Nodules	7	7	-	-	-
	Total	405	13	7	3	3
Total	Total	2,336	40	16	5	12

Tab. 2. Details of the lithic inventory for the different concentrations from the locus 36.

Tab. 2. *Details des lithischen Inventars für die verschiedenen Konzentrationen aus der Fundstelle 36.*

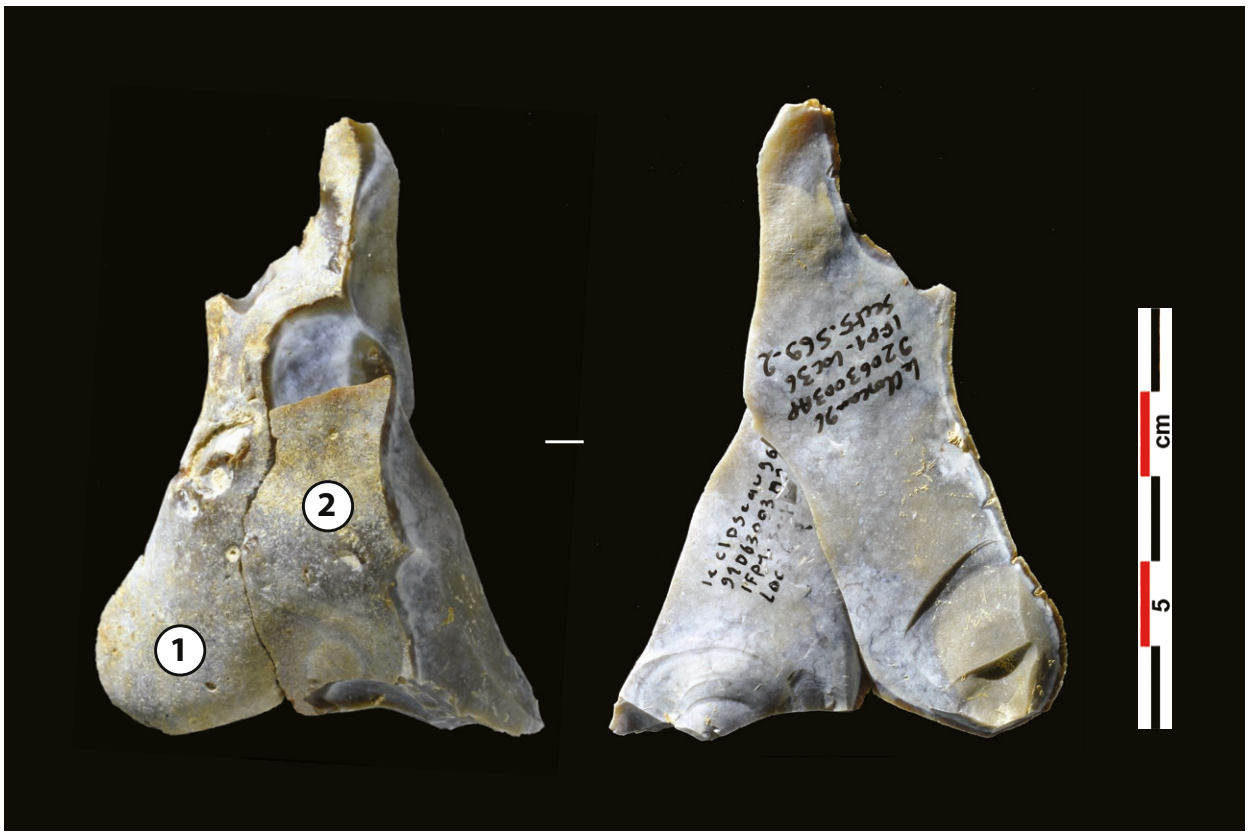


Fig. 5. Tool used without being retouched that refit with a flake; this sequence is not integrated to any of the production sequences in locus 36 (Pictures: J. Jacquier).

Abb. 5. *Unretuschiertes Werkzeug, welches mit einem Abschlag zusammengesetzt werden konnte; diese Sequenz ist in keine der Produktionssequenzen in Fundstelle 36 integriert (Bilder: J. Jacquier).*

incomplete and also underline the export of products from the locus (Fig. 7). These sequences document the production of more modest sized blanks, and the most complete refit groups sometimes show that only one or two blanks were exported (Fig. 7). The variation observed in the production goals (blades of variable size and regularity) as well as that observed in regard to economic behaviours (export of entire sequences or export of single blanks), all within a coherent spatial unit, contrasts significantly with the homogeneity observed in the operational chains themselves: beyond the opening of one or two striking platforms, nodules are not prepared, and a stone hammer, with no platform preparation, appears to be used for all operations.

As we cannot track the movement of these products within the site, the ultimate functional destination of the blanks exported outside of locus 36 remains a mystery. While refits allow us to evaluate the approximate morphology and size of the exported blanks, the flexible nature of the Azilian technical package does not allow us to draw precise conclusions. As a matter of fact, with our current state of understanding of the Azilian, the selection of blanks for transformation into tools is approached with a certain elasticity. This behaviour has been underlined in regard to armatures for projectiles, whereby the act of armature "calibration" is done with variable degrees of retouching, ultimately relaxing constraints when it comes to the selection of the initial blanks (Bodu 1998; Valentin1995, 2008; Naudinot 2010; Naudinot et al. 2019; Fat-Cheung et al. 2013; Mevel et al. 2014; Mevel 2017). Despite this flexibility, there is a general tendency towards the use of blanks that are straighter and narrower for the production of points versus those blanks used for the rest of the toolkit. This observation was identified quite precisely at Rekem via the study of blank dimensions of different tool classes having been reconstituted by refits (De Bie & Caspar 2000:110). This preference for narrow blanks for backed point production is certainly visible at the majority of Late Azilian sites (Valentin 2005; Mevel 2017), and it appears to be the case as well for the fragments of backed points discovered around this lithic heap. These fragments are too few in number, too fragmented, and too transformed by retouch to allow for a precise characterization of initial blank morphology (Fig. 8), but we can underline that these were generally thin and narrow blades, whose maximum thickness did not exceed 5 mm (Fig. 8). By coupling these observations with working hypotheses derived for the analysis of refits and the other materials in this lithic heap, it would appear that the production of said thin and narrow blade blanks

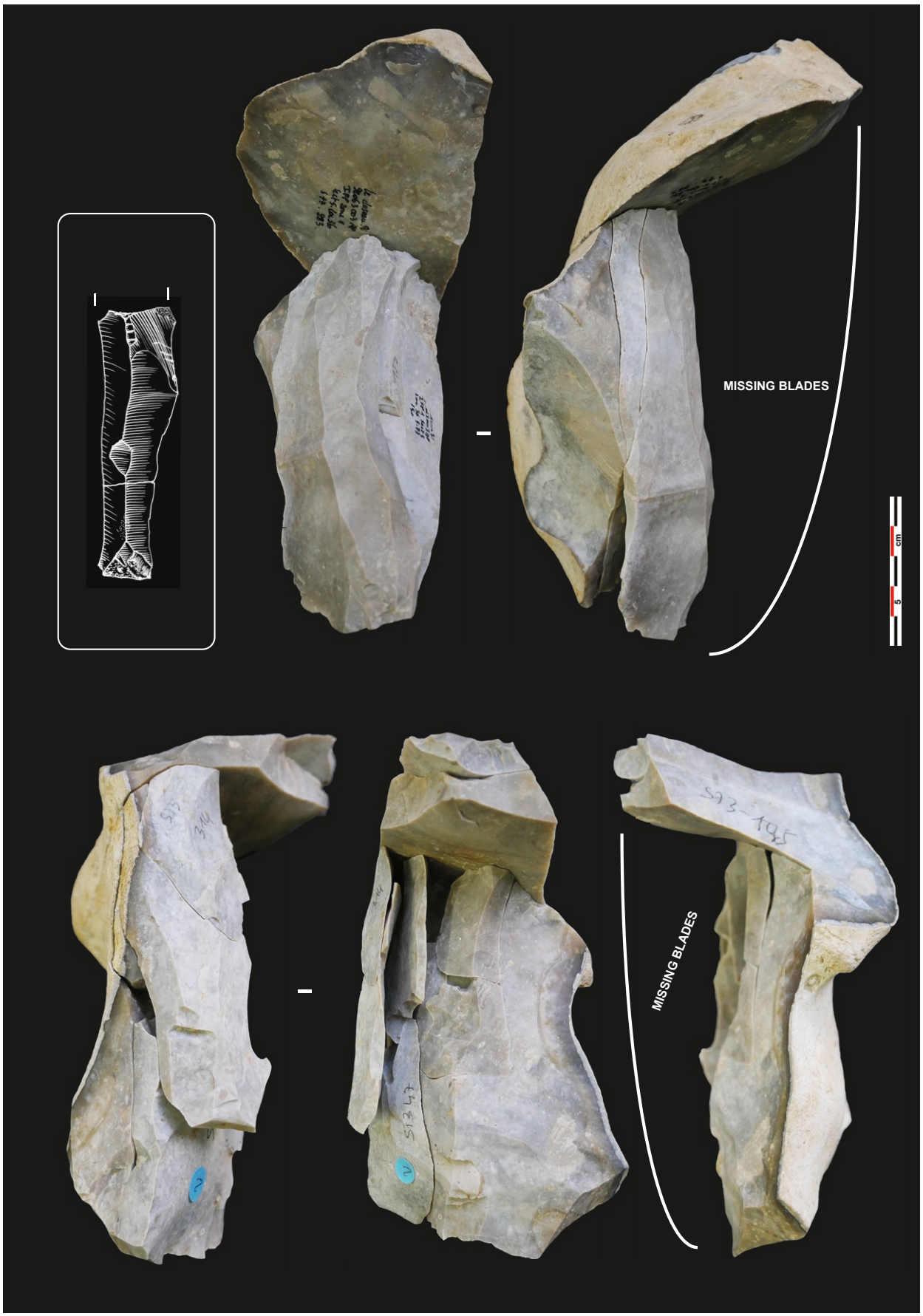


Fig. 6. Refits of two sequences of blades production and corresponding blade tool (Pictures and CAD / L. Mevel ; drawing: M. Reduron).

Abb. 6. *Zusammensetzung von zwei Sequenzen der Klingenproduktion und entsprechendes Klingenwerkzeug (Bilder und CAD / L. Mevel ; Zeichnung: M. Reduron).*

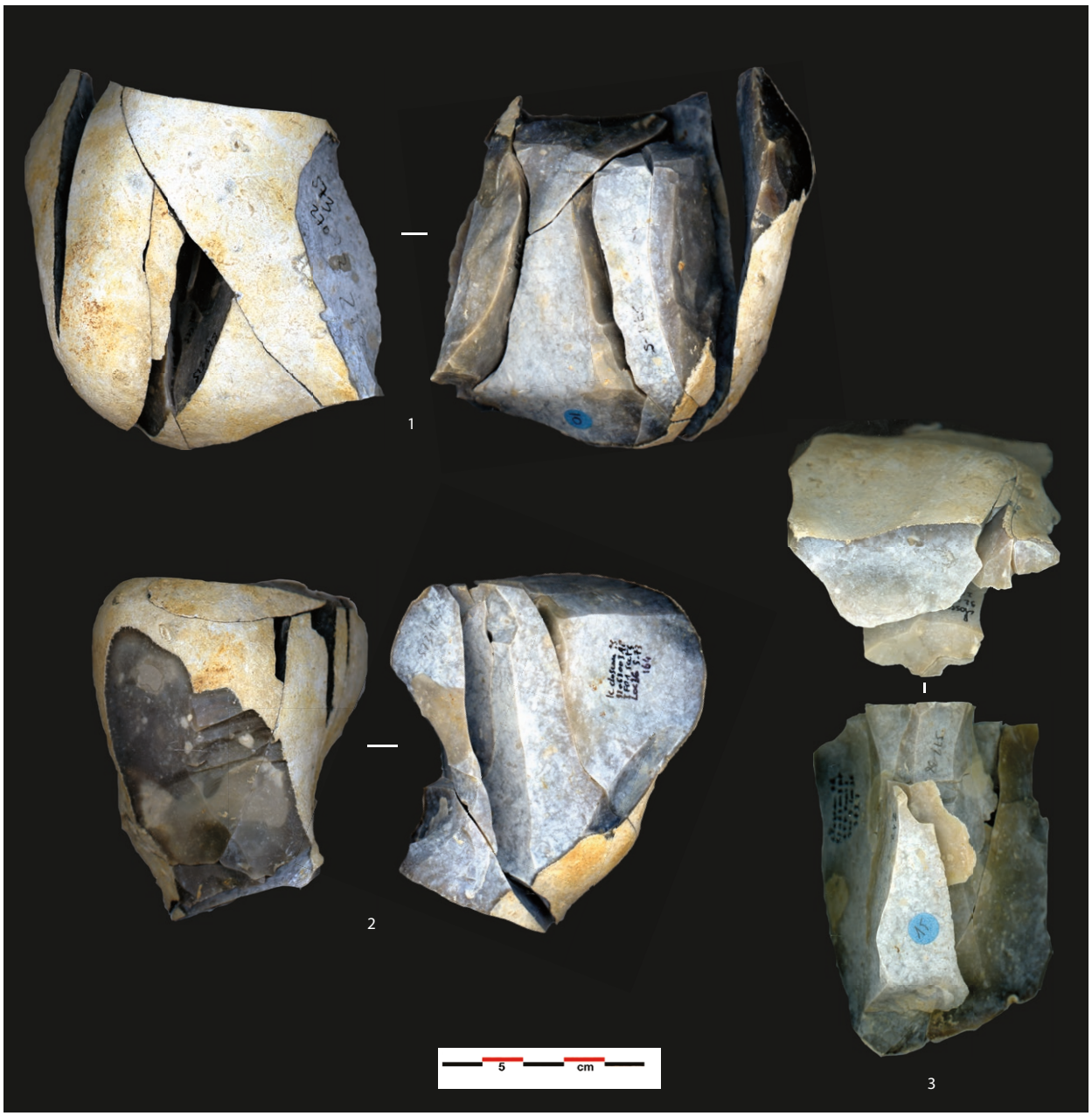


Fig. 7. Three illustrated refit sequences from heap 1 (Pictures and CAD: L. Mevel).
Abb. 7. *Drei illustrierte Zusammensetzungs-Sequenzen aus Cluster 1 (Bilder und CAD: L. Mevel).*

was among the primary goal of production. It is also notable that the majority of point fragments on locus 36 (13/15) are found around this particular lithic heap. These fragments belong to ten backed points, of which at least five were abandoned during production (interpretation supported by the presence of hertzian fractures initiated by an internal percussion during the backing of points and an absence of use-wear, see below). Given this evidence, it seems highly probable that a portion of the blanks produced here were exported as backed points.

Concentration n°2: heap OPQ 69-70

The second concentration is located roughly three metres to the north-west of the first (RST 71-74). This concentration has fewer remains (N = 391), has three tools that have been identified through use-wear analysis, has no armatures, and has a single core (Tab. 2). Twenty-four refitted sequences integrate at least one artefact from this heap, but in opposition to heap RST 71-74, this concentration can be linked to other sectors of locus 36, in particular those in the north-west (concentrations 4 and 5).

A particular raw material, a black and glassy flint, demonstrates the rare circulation of artefacts within the locus. Several nodules of this material were exploited in order to produce small and narrow blades, which were likely privileged for the production of backed points, and slightly larger blade blanks were also produced, likely for other uses (Fig. 9). One of the tools identified

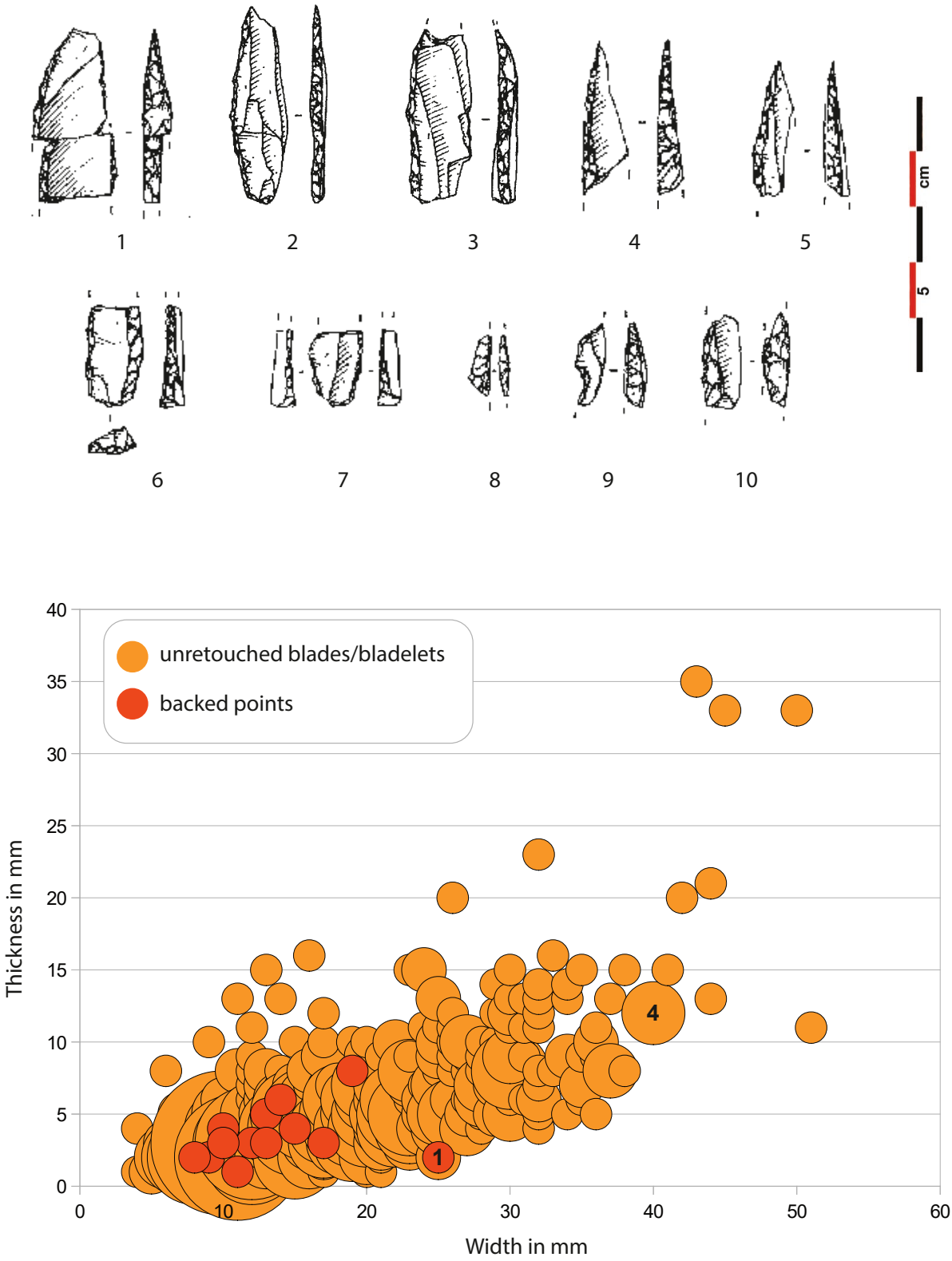


Fig. 8. Backed point fragment morphometrics.
Abb. 8. *Rückenmesser fragment-Morphometrien.*

through use-wear refits onto a nodule of this flint, where as several blanks of the same calibre seem to have been produced in the same sequence, yet were not recovered. This core then went on to produce shorter blades with morphologies comparable with those privileged for backed point production (Fig. 9).

While this volume of flint was knapped in its entirety in this sector, the used blade was found at the margins of locus 36, to the north-west of concentration n°4. Another blade that refits into a sequence produced on a nodule of the same type of flint was abandoned in concentration n°4 itself (Fig. 9), though no use-wear has been identified on this piece.

As was the case with concentration n°1, several refitted sequences in this concentration are incomplete, which underlines the circulation of a proportion of the products outside of locus 36 (Fig. 9). As already noted, there is a relative deficit of cores in this concentration, which likely indicates that certain operations that were started here were continued elsewhere.

Besides operations conducted in this glassy black flint, eleven distinct sequences belong to this concentration. As already highlighted, a single core was discovered in this concentration, which happened to be nearly completely refitted. Only one blank appears to be missing, which is a blade removed from one of the core's cortical flanks and would appear to have been too thick to be an ideal blank for a backed point production (Fig. 10: 1). The other refits are incomplete sequences and are notably dominated by phases common to the first stages of core exploitation. Given the morphology of the volumes, it can be proposed that they were largely oriented towards the production of armature blanks (Fig. 10: 2), but at any rate the fact that the last sequences of production and cores are absent indicates that these final phases were conducted elsewhere, most likely outside of locus 36.

While no refits or conjoins were made between concentrations 1 and 2, we can highlight the similarity in both the target products (short blades) and the means of obtaining them. It is also of note that these target products were exported outside of this area of lithic heaps. Furthermore, the incomplete sequences do not only indicate the exportation of target products, but of cores as well, as their absence indicates that they still had productive potential. And even though no refits were found between concentrations 1 and 2, the latter does have refit/conjoin links with both other concentrations and areas of lower density, which are probable complementary activity areas.

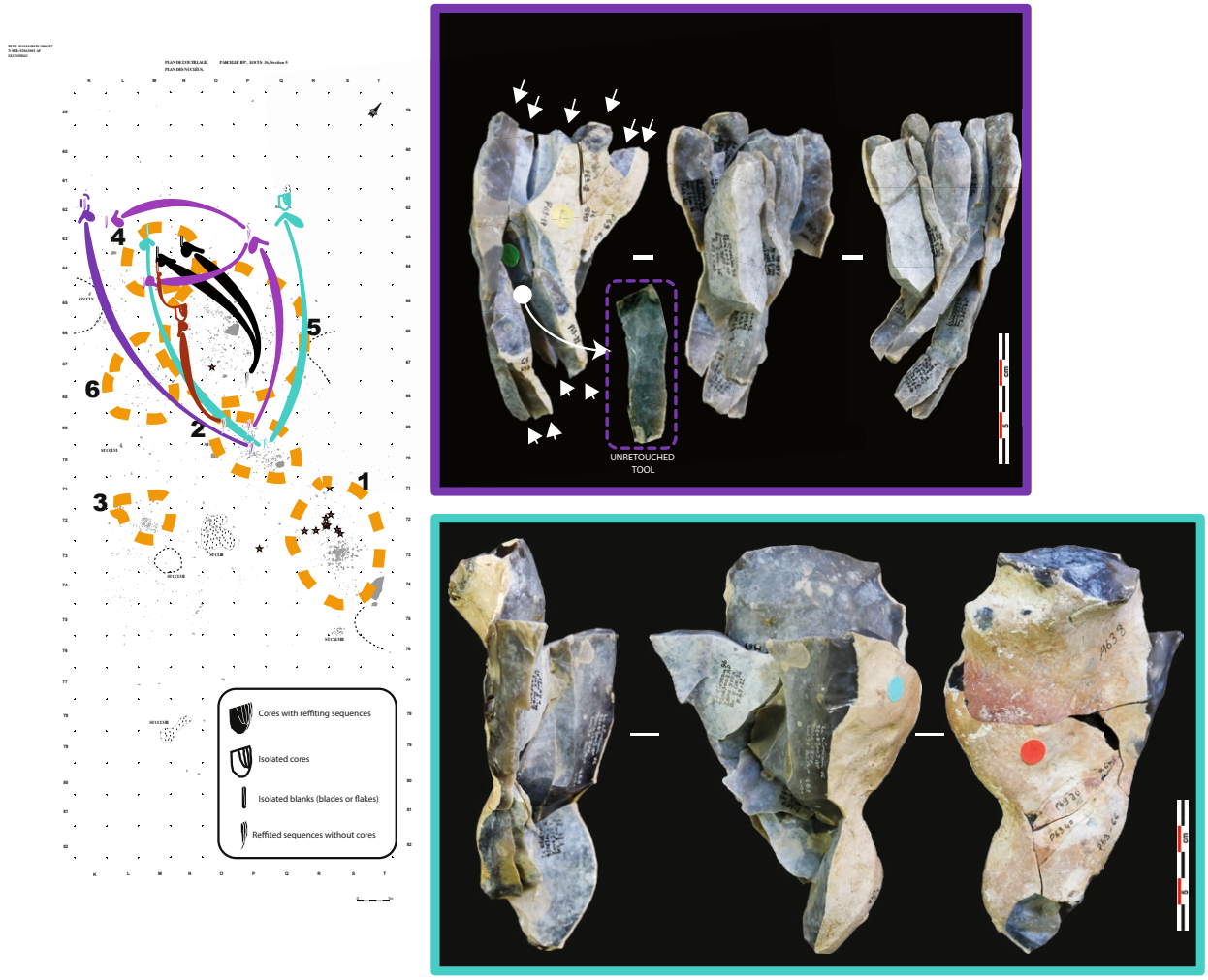


Fig. 9. Refits and circulation of glassy black flint elements (Pictures and CAD: L. Mevel).

Abb. 9. *Zusammensetzung und Umlauf von glasig-schwarzen Feuersteinelementen (Bilder und CAD: L. Mevel).*

Fig. 10. Examples of refits from heap 2 (Pictures and CAD: L. Mevel).
Abb. 10. *Beispiele für Zusammensetzungen aus Cluster2 (Bilder und CAD: L. Mevel).*

Concentration n°3: heap LM 71-72
This third concentration is located in the western portion of the locus. This concentration contains no typologically defined tools, but one unretouched tool was identified by use-wear analysis (Tab. 2). The six refitted sequences all underline the production of short blades from either small nodules or from large flakes as burin cores (Fig. 11). All signs point again to this concentration being primarily oriented towards the production of blanks for backed points, and as was the case with concentration n°1 this heap is not connected to the rest of the locus by refits or conjoins.

Concentration n°4: M63-64
The fourth concentration is located in the north-west corner of the locus, and consists of a low-density collection of 44 objects. As already shown, this area of the site is connected to concentration n° 2, and is, furthermore, characterized by the introduction of blanks knapped elsewhere in the locus (Fig. 12). Given the location of the corresponding refitted sequences within concentrations 2, 5, and 6, which correspond, moreover, to production waste, we have little doubt that it is the blanks that circulated and not the cores themselves. While the sequences are not numerous (N = 8), they do clearly link this concentration with those mentioned above (concentrations 2, 5, and 6, Fig. 12).

Concentration n°5: sector NOPQ 64-68
This area is, in fact, not particularly dense, as it corresponds to numerous objects (N = 601, i.e., 25 % of the objects from the entire locus) dispersed over a roughly 20 m^2 surface. Only a single tool was identified by use-wear (Tab. 2), and no true lithic heap can be defined within this space. A significant proportion of the knapped flints in this area seem to have been heated by fire (N = 228), though no fireplaces have been formally identified in the area. A combustion area was discovered, but was considered the result of a natural wildfire, as is the case for the majority of combustion areas in the upper level at Le Closeau (Cary 1998).

The refitted sequences (N = 19) show intentions that are quite close to those that already have been described. Four thick flakes were exploited as burin cores in order to produce potential blanks for backed points, while nodules produced larger blanks (Fig. 13). In this sector, the documented operational chains are quite fragmented. With the exception of one example, where the entirety of the operation was conducted in this area (Fig. 13), this sector is characterized by fragmented operational chains that demonstrate the movement of volumes within and beyond the locus itself. The lack of a clearly structured use of space of this area, the dispersion of objects over a large surface, and the large proportion of burned flints all contribute to a significant reduction in our capacity to read and articulate the activities that occurred in this part of the site.

Concentration n°6: Heap LM 66-68
This sixth and final area of locus 36 (LM 66-68) corresponds to a small concentration of materials (N = 163) that all seem to be related to the production of short blades for the manufacture of projectile armatures (Fig. 14). One tool identified via use-wear analysis is also found in this concentration. The analysis of refits has allowed us to link this concentration with concentration 4, as it would appear that movements of artefacts occurred in both directions.

Use-wear results

A limited toolkit
Locus 36 contains only a small quantity of retouched elements. Once we take into account conjoined blank fragments, the assemblage only contains 16 typologically defined tools, or 0.6 % of the assemblage. The collection is composed of eleven backed points or bladelets (Fig. 15), three end scrapers, a fragment of a thick truncated blank, and a backed bladelike flake (Fig. 16). The backed bladelike flake is the only formal tool with traces of possible use (small removals along the cutting edge opposite the back; Fig. 18: a). However, six backed point or bladelet fragments have hertzian fracture surfaces (or cone fractures), underlining breaks during manufacture (Fig. 15: a & b). Given these observations, the collection of points and backed bladelets of locus 36 is interpreted as the waste of armature production, rather than the result of used elements being unhafted after the return of a hunting party.

This small proportion of retouched tools and the relative absence of use-wear on the typologically defined assemblage echoes the results obtained via our analysis of the unmodified blanks. Despite the good preservation of the lithic artefacts, very few unmodified blanks showed clear traces related to use. Only 16 objects (with a total of 21 use zones) were identified as potential tools. These identified traces are, furthermore, particularly subtle, which confirms the impression gleaned from the technological and spatial studies, that of little on site use of the objects produced.

Subtle traces and delicate interpretations
Beyond a few traces that we can confidently attribute to the working of vegetal matter (see below), the tools identified only present macroscopic evidence (lack of microscopic polishes, striations, or edge-rounding). The majority of functional traces consist only of bifacial edge damage, i.e., a series of small bending scars (Fig. 17). While some of these removals are visible to the naked eye, most of them are smaller than 1 mm. Their identification requires careful examination using a stereo microscope. This type of edge damage was identified on 13 products (6 blades, 4 bladelike flakes, and 2 flakes), including the above-mentioned backed knife made on a bladelike flake.

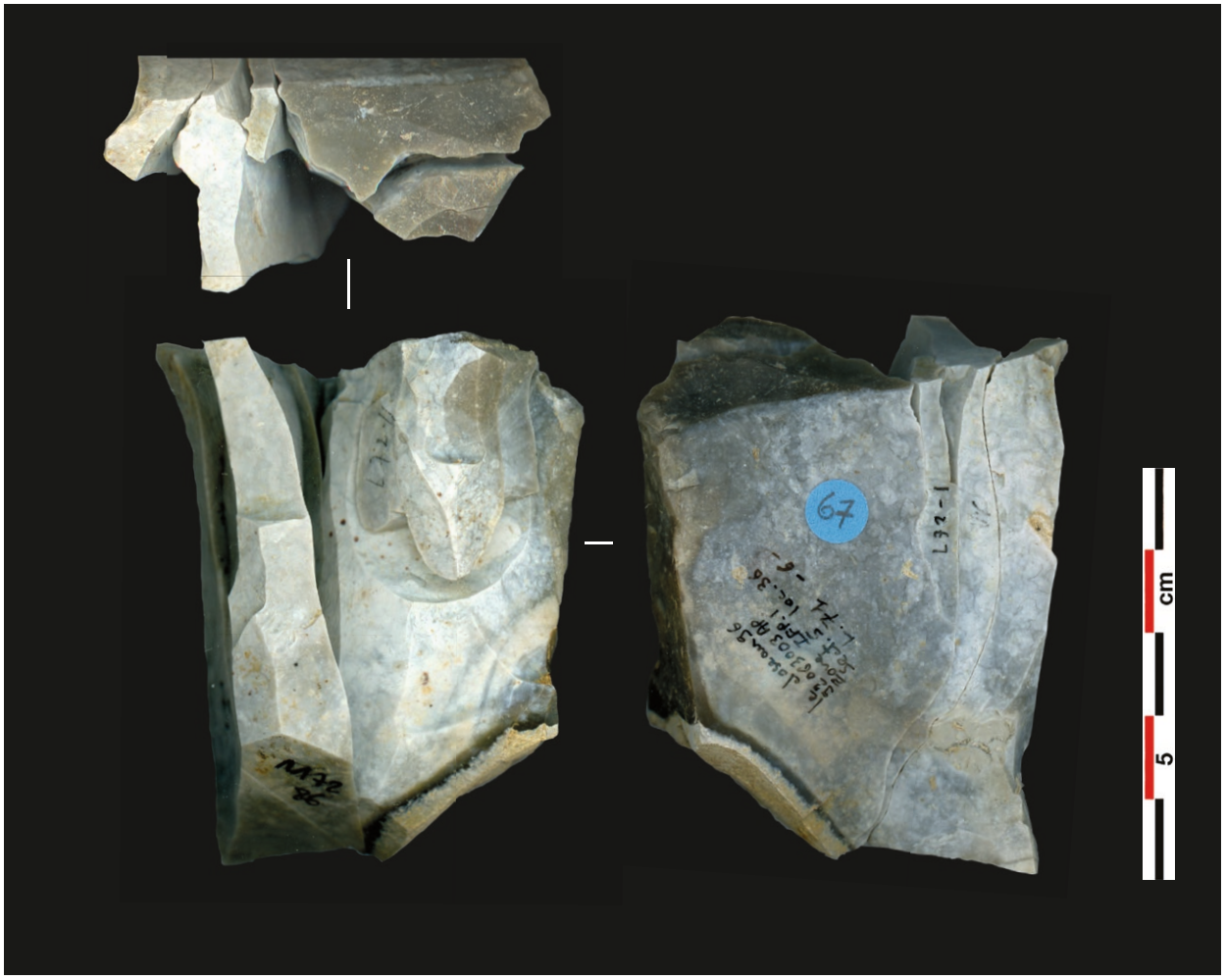


Fig. 11. Example of a refit from heap 3 (Pictures and CAD: L. Mevel).

Abb. 11. *Beispiel für eine Zusammensetzung Refit aus cluster 3 (Bilder und CAD: L. Mevel).*

Two of these tools (Fig. 18: 1 & Fig. 22: 1) were also used to work vegetal matter. These damages refer to uses against soft to medium-hard materials (Fig. 18, Fig. 21: a & Fig. 22: a), and suggest uses as butcher knives or woodworking knives. Unfortunately, the absence of a microtrace makes it impossible to distinguish between these hypotheses. Only two of these tools have discrete microtraces (light rounding of the cutting edge, a rough polish, and striations parallel to the cutting edge) that are coherent with carcass treatment (Fig. 18: a, b1 & b2). The discrete nature of these traces, however, underlines that these interpretations are advanced with a degree of caution.

Among these tools whose functional interpretation remains delicate, one example stands out by the unifacial nature of the edge damage. The sharp cutting edges of this small blade are mesially affected by a series of short, regular, and low-angle removals initiated by flexion. This macroscopic edge damage was generated by the scraping of a medium-hard material that had a small cross-section. In the absence of an associated micropolish the hypothesis of a stick of wood can be advanced, yet this does not preclude a possible case of formal convergence (Fig. 19).

A few tools implicated in the work of vegetal matter

The great majority of interpretable uses, on the basis of both macro- and microscopic criteria, are related to the working of vegetal matter. In locus 36, this integrates at the least (see below) an assemblage of six tools (and six use zones). Among the tools implicated in this sphere, two functional categories can be distinguished.

The quantitatively largest of these categories, consisting of five tools, include those used in transverse cutting at an oblique angle (Fig. 18: 1, Fig. 20: 1-3). While the blanks chosen – blades and generally elongated flakes – have variable sizes and morphologies, their use appears quite homogenous. The use-wear traces are limited to a very short portion of the cutting edge (10 mm on average) and are located mesiodistally or mesioproximally. The active cutting edge has a sharp angle and often a slightly concave delineation. The use-wear is systematically asymmetrical, underling a positive rake angle where the ventral surface of the blank is in direct contact with the material being worked (Fig. 21). This use is macroscopically perceptible via either a light rounding of the cutting edge (that is asymmetrical

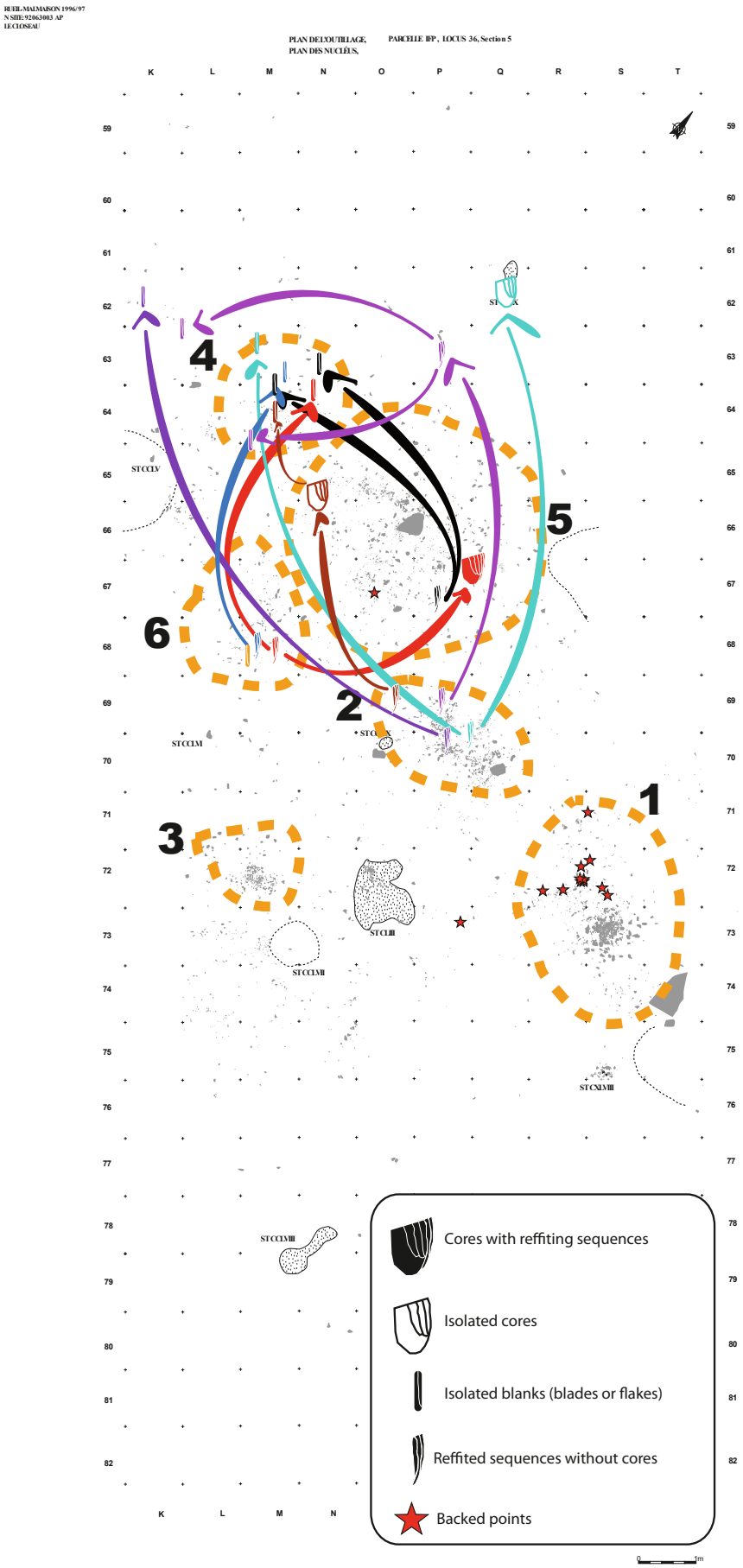


Fig. 12. Circulations of production sequences and blanks between heaps 2, 4, 5, and 6 (Pictures and CAD: L. Mevel).
Abb. 12. *Umlauf von Produktionsabläufen und Grundformen zwischen den cluster 2, 4, 5 und 6 (Bilder und CAD: L. Mevel).*

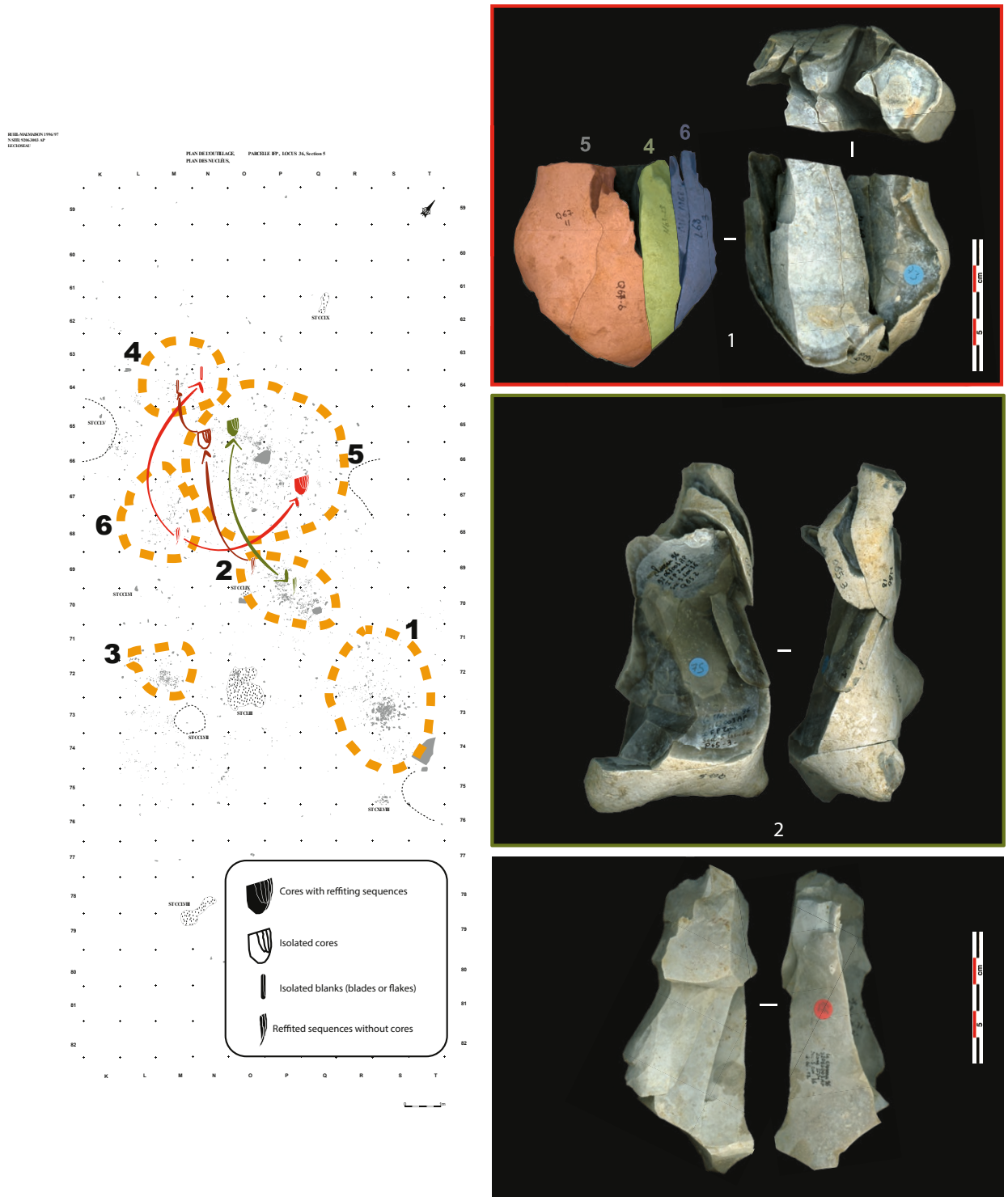


Fig. 13. Examples of refits from heap 5 and plan of movements (Pictures and CAD: L. Mevel).
Abb. 13. *Beispiele für Zusammensetzungen von cluster 5 und Plan der Bewegungen (Bilder und CAD: L. Mevel).*

and skewed towards the ventral surface of the blank) or a marginal lustre. Given that the edges are barely damaged, if at all, these traces of use are exceedingly discrete (Fig. 21: a1 & b1). Microscopic observation allows us to further separate this functional category into two smaller subgroups. One consists of four tools (Fig. 18: 1, Fig. 20: 2 & 3) that have a reflective polish on the contact surface that is skewed at an angle of roughly 45° relative to the parallel axis of the cutting edge (Fig. 21: a2). This polish is sometimes accompanied by a few striations that are oriented along the same oblique angle. The polish on this surface levels the original microtopography to an important degree. Opposite the flank surface (in these examples the ventral surface of the blank), the rake surface (the dorsal surface of the

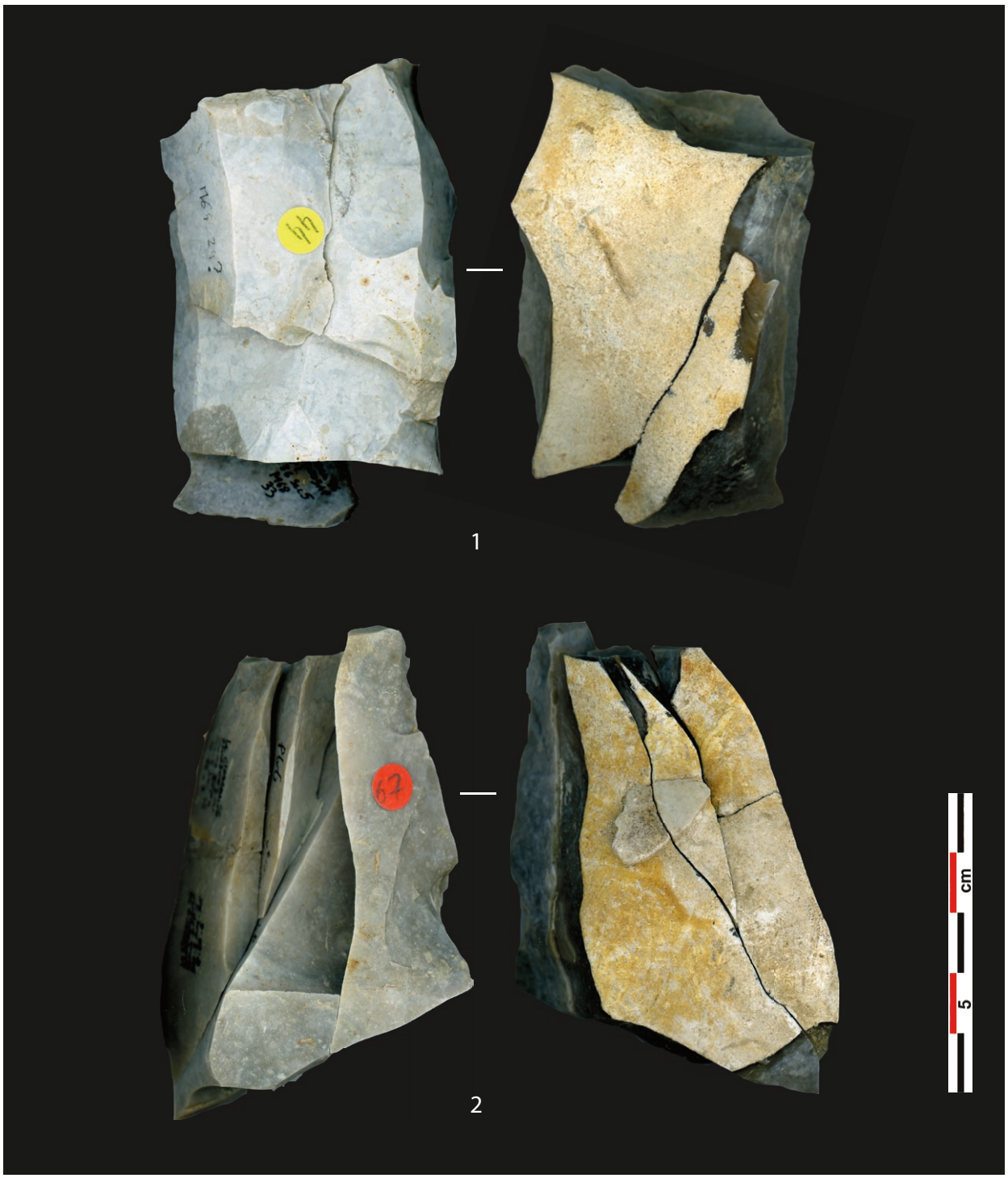


Fig. 14. Examples of refits from heap 6 (Pictures and CAD: L. Mevel).
Abb. 14. *Beispiele für Zusammensetzungen von Cluster 6 (Bilder und CAD: L. Mevel).*

blank in these examples) may present a reflective polish that softens microtopographical high points, and inversely fills low points, all without any skew or striations (Fig. 21: a3). The second sub-group consists of a single object (Fig. 20: 1) and corresponds to a similar tool kinematic, but the trace is restricted to the surface in contact with the material (no polish on the rake face), is matte, and has abundant oblique striations (Fig. 21: b1-b3).

These tools, with their reflective or matte traces of use evoke in certain respects some tools used for working vegetal matter that have been identified at sites attributable to the Mesolithic in a large part of northern Europe (Van Gijn 1989, 2010; Juel Jensen 1994; Beugnier & Crombé 2005; Beugnier 2007; Guéret 2013; Guéret & Jacquier 2019; Little & Van Gijn 2017; Osipowicz 2019), at most sites recently analysed and attributable to the Laborian (GS1-Holocene

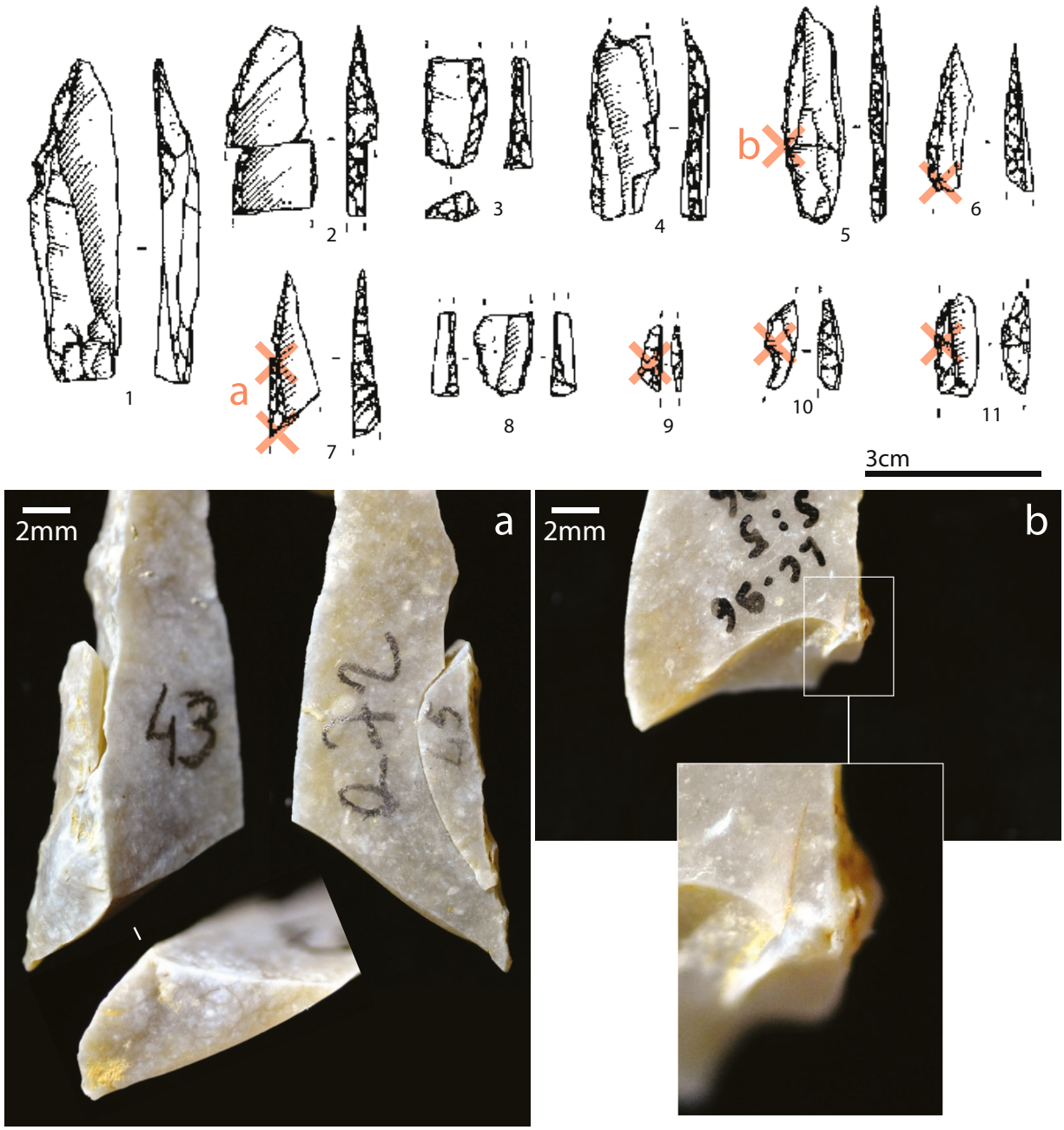


Fig. 15. Bladelets and backed points from locus 36. Red crosses indicate the presence of hertzian fractures, which indicate breaks during the manufacture process. a: refit of a retouch flake onto backed point fragment n°7, the fragment has a hertzian fracture surface; b: hertzian break that split the piece during back manufacture n°5 (Drawings: P. Alix; Pictures and CAD: J. Jacquier).

Abb. 15. *Lamellen und Rückenmesser von Fundstell 36. Rote Kreuze zeigen das Vorhandensein von hertzianischen Brüchen an, die auf Brüche während des Herstellungsprozesses hindeuten. a: Zusammensetzung einer Retuschierabfalls und dem Fragment einer Rückenspitze Nr. 7, das Fragment hat eine Bruchfläche; b: Bruch, der das Stück während der Herstellung des Rückens Nr. 5 spaltete (Zeichnungen: P. Alix; Bilder und CAD: J. Jacquier).*

transition) in western France (Jacquier 2015; Langlais et al. 2015, 2018), and within assemblages attributable to the Federmesser (second half of the Allerød) and the Swiderian (second half of the Younger Dryas) (Sobkowiak-Tabaka & Kufel-Diakowska 2018). These tools have been collectively called "curved knives" by certain authors because on the concave delineation of the majority of the cutting edges used (Juel-Jensen 1994; Guéret 2013a, 2013b; Guéret & Jacquier 2019; Ozipowicz 2019). The current working hypothesis regarding the functional role of these objects, given the shared characteristics of the micropolishes, is that of the working of herbaceous plants rich in silica.

The second tool type linked to the working of vegetal matter is only represented by one instrument in this locus. Furthermore, its use-wear, given the subtlety of the traces, is only understandable when compared with identical tools identified in the other loci (Fig. 22). The tool in question is a bladelike flake that is nearly 10 cm in length. The use-wear is found

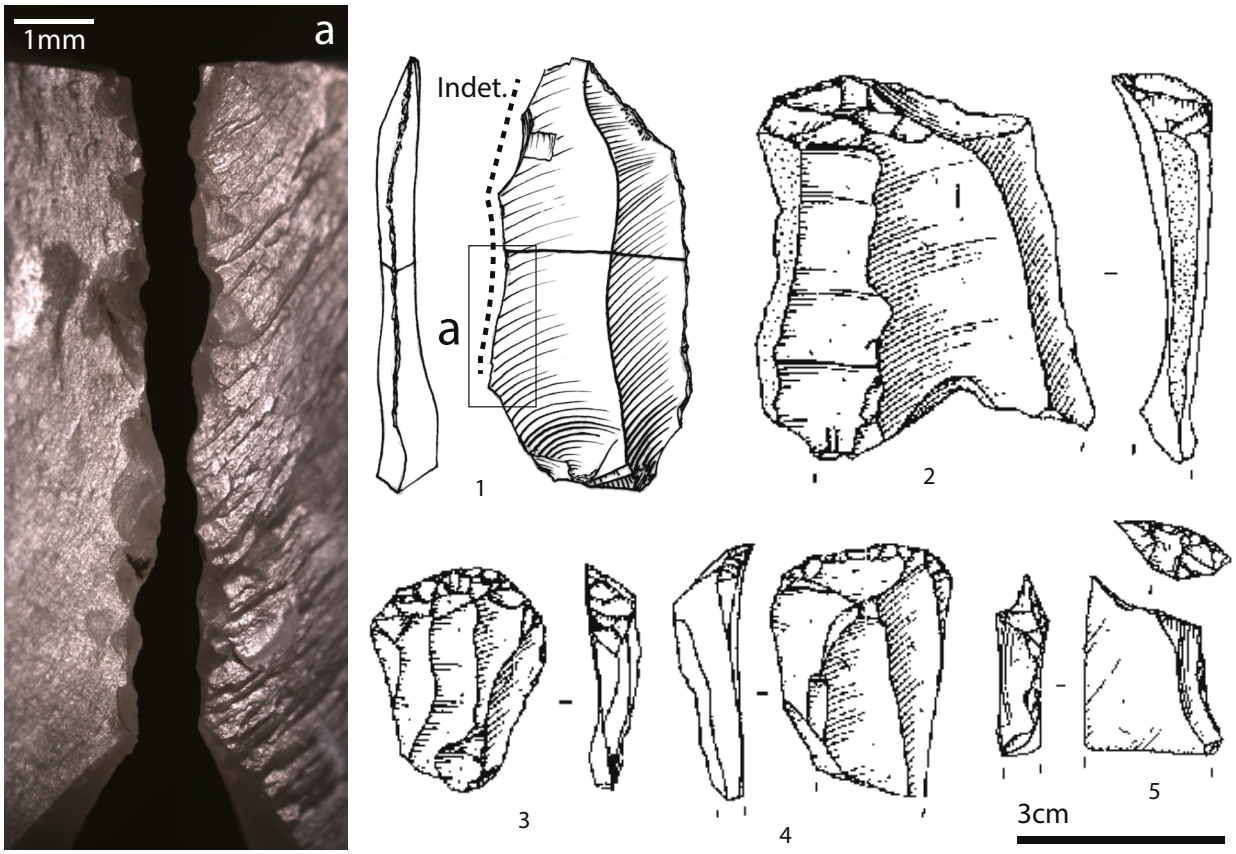


Fig. 16. Retouched toolkit from locus 36 (1: backed knife; 2,3, and 4: end scrapers; 5: truncated blank with lateral retouch). Only the backed knife (n°1) has probable use-wear, having worked a hard or medium-hard material. The few small removals identified (photo a) do not permit us to determine the specific function of this tool. (Drawings: P. Alix and M. Reduron ; Pictures and CAD: J. Jacquier).

Abb. 16. *Retuschierter Werkzeugsatz von Fundstelle 36 (1: Rückenmesser; 2,3, und 4: Kratzer; 5: Endretusche mit seitlicher Retusche). Nur das Rückenmesser (Nr. 1) hat wahrscheinlich Gebrauchsspuren, da es ein hartes oder mittelhartes Material bearbeitet hat. Die wenigen kleinen Abtragungen, die identifiziert wurden (Foto a), erlauben es uns nicht, die spezifische Funktion dieses Werkzeugs zu bestimmen. (Zeichnungen: P. Alix und M. Reduron; Bilder und CAD: J. Jacquier).*

on a sharp cutting edge and extends along a weakly convex portion of the edge for about 30 mm. Some bifacial edge damage, which manifests as small removals initiated by flexion, evokes butchery. A marginal micropolish only affects the contact surface, which happens to be the dorsal surface of the blank in question. This micropolish, that is reflective and domed, is expressed most strongly in the aforementioned small removals. These very likely reflect the transverse cutting of woody material. Given the very regular and coherent organization of this micropolish, it was clearly generated by a regular and repeated action, a kinematic similar to that of a carpenter's drawknife.

Discussion

A workshop above all else

As already suggested, the rarity of retouched tools and the small amount of in situ use of the blanks produced on site would appear to be a defining characteristic of locus 36. This is coherent not only with the small number of pieces that have traces on them, but also with the nature of the traces themselves, whose subtlety underlines generally brief use lives. Given these results, and the recurrent under-representation of target blanks as demonstrated through refits, locus 36 seems to have played the role of a workshop in order to respond to deferred needs at least in space and time.

The technological study demonstrates, unsurprisingly, relatively simplified operational chains. The production of blades and bladelike flakes of different sizes without the necessity for preparation or maintenance operations seems to have been the norm. Moreover, the Azilian occupants use a wide morphological variety of nodules and flakes as cores. As already highlighted, the weak standardization of products coupled with the rarity of retouched or even used pieces does not facilitate the task of clearly defining the production objectives. Nevertheless, the refits underline that the primary objective of the knappers was the production of blanks for backed points, with some of these being further shaped on site (as demonstrated by examples that were broken during back manufacture). Generally, larger and thicker (robust) products were also produced, though we cannot determine the economic role of

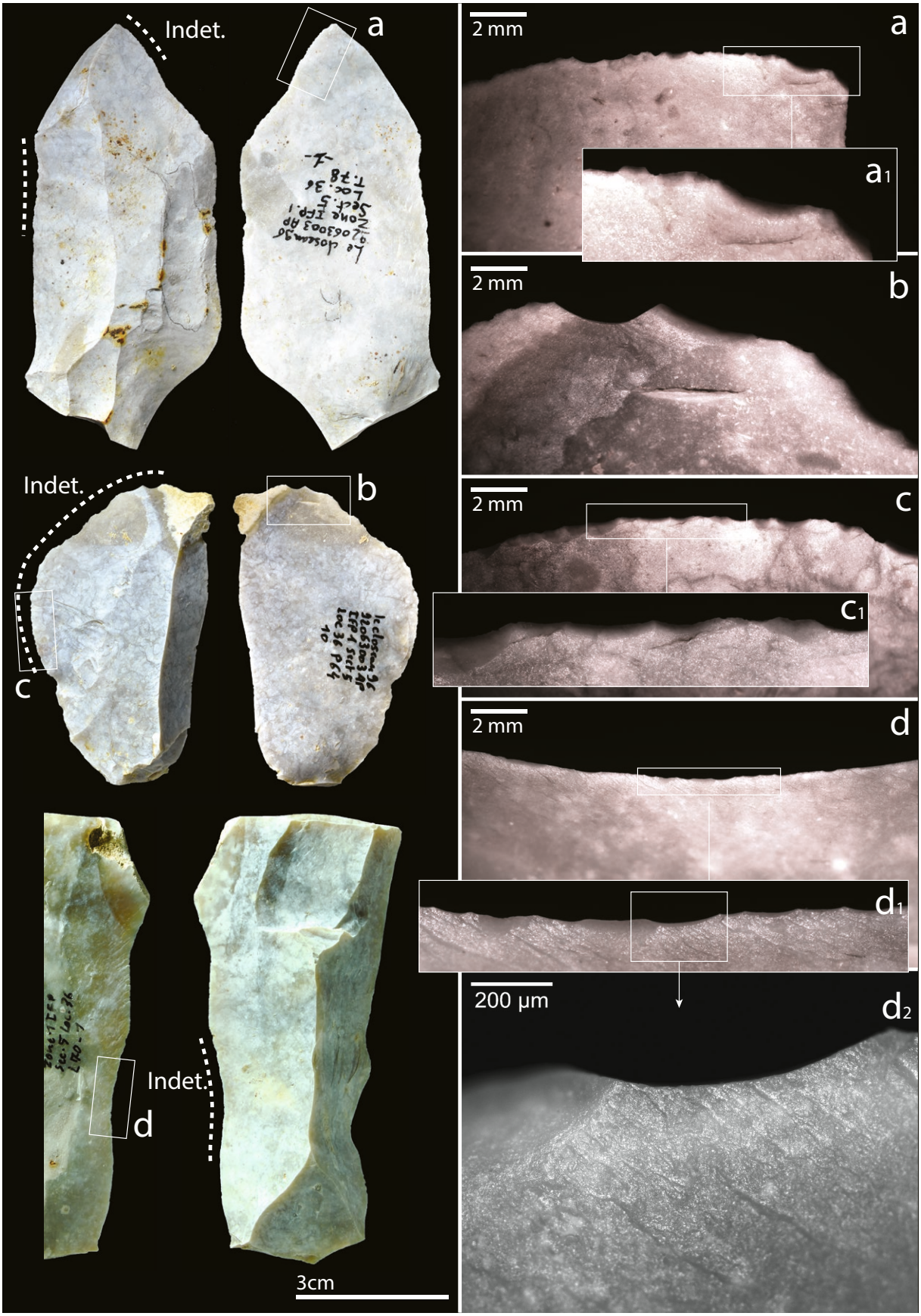


Fig. 17. Overview of the variability of the most common traces (series of removals initiated by flexion) observed on the unretouched equipment of locus 36. The absence of associated micro-wear renders further functional interpretation difficult. (Pictures and CAD: J. Jacquier).

Abb. 17. *Übersicht über die Variabilität der häufigsten Spuren (Serien von Abtragungen, die durch Biegung ausgelöst wurden), die an den nicht retuschierten Geräten von Fundstelle 36 beobachtet wurden. Das Fehlen von zugehörigem Mikroverschleiß erschwert eine weitere funktionelle Interpretation. (Bilder und CAD: J. Jacquier).*

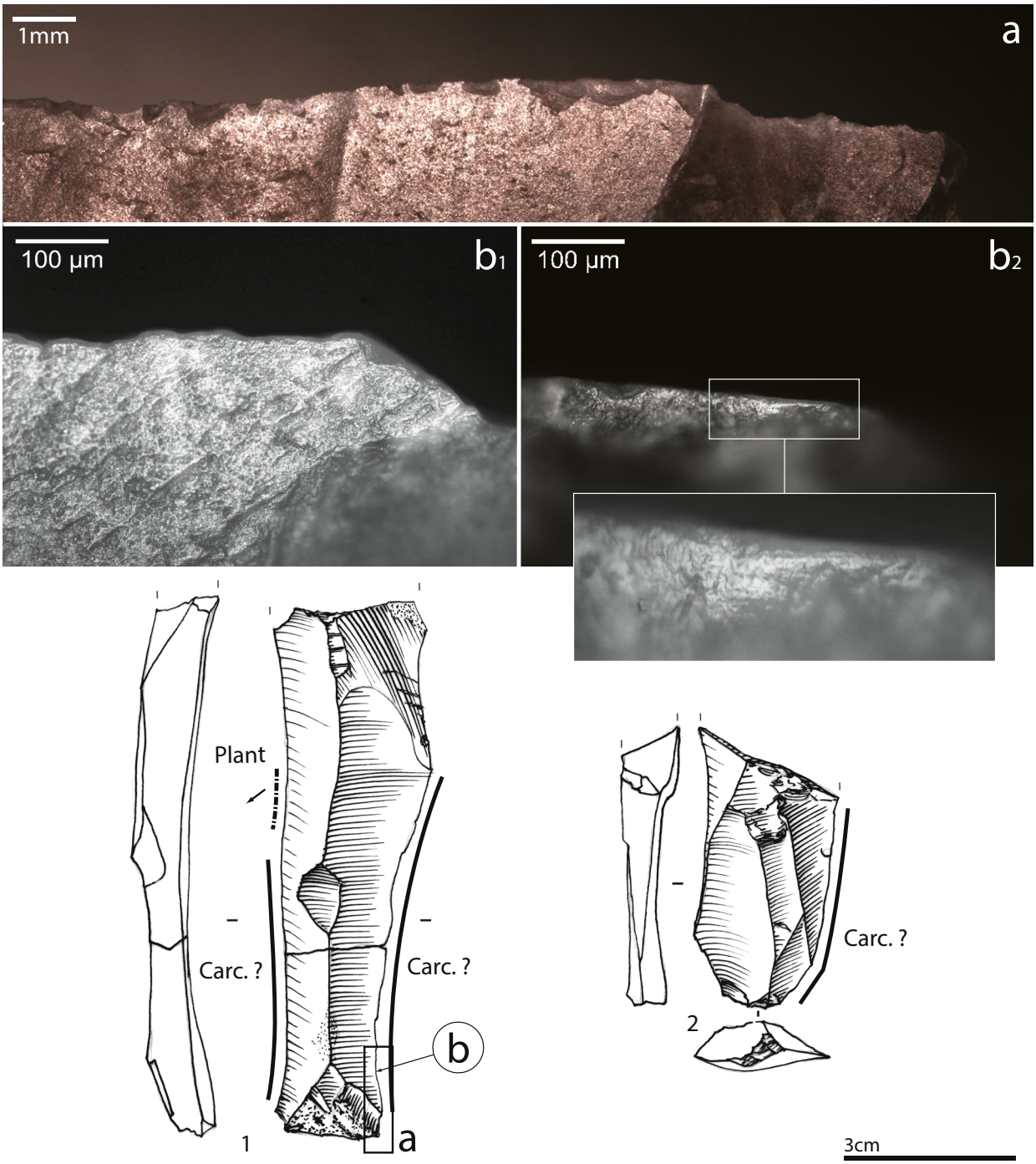


Fig. 18. Tools with macro- and microscopic wear that evokes carcass butchery. a: Submillimetre bifacial removals initiated in flexion; b1 and b2: rough and matte micro-wear, with discreet striations parallel to the edge. These striations are sometimes perceivable along the rounded cutting edge of the piece (b2) (Drawings: M. Reduron; Pictures and CAD: J. Jacquier).

Abb. 18. *Werkzeuge mit makro- und mikroskopischen Abnutzungen, die an eine Kadaverschlachtung erinnern. a: Submillimeter große bifaziale Abtragungen, die durch Flexion initiiert wurden; b1 und b2: raue und matte Mikroabnutzungen, mit diskreten Streifen parallel zur Kante. Diese Streifen sind manchmal entlang der abgerundeten Schneide des Stücks zu erkennen (b2) (Zeichnungen: M. Reduron ; Bilder und CAD: J. Jacquier).*

such elements for the time being. These robust blanks were only rarely used on site, and these showed considerable morphological and morphotechnical variability, including thick cortical pieces, and this is despite a certain functional coherence. The rare used objects consist therefore of the byproducts of backed point production and do not represent an economic goal in and of themselves. These heterogenous blanks would have therefore been chosen after production because of the morphology of their cutting edges (in particular, sharp edges with concave portions used in the processing of plants).

While the refits realized here show a degree of segmentation in the exploitation of the different

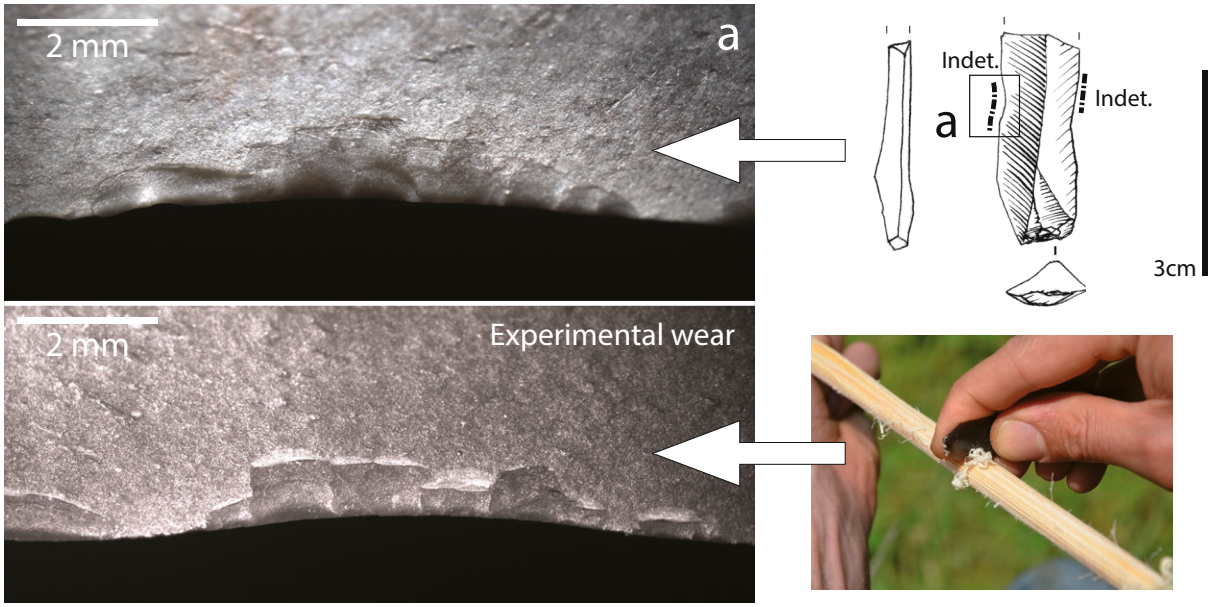


Fig. 19. Narrow blade with a short series of unifacial removals initiated in flexion on both edges. This type of edge damage shows a strong convergence with those generated experimentally while scraping wood with a negative rake angle. (Drawings: M. Reduron ; Pictures and CAD: J. Jacquier).

Abb. 19. *Schmale Klinge mit einer kurzen Serie von einseitigen Abtragungen, die in Flexion an beiden Kanten eingeleitet wurden. Diese Art der Kantenbeschädigung zeigt eine starke Konvergenz mit denen, die experimentell beim Schaben von Holz mit negativem Spanwinkel entstehen. (Zeichnungen: M. Reduron ; Bilder und CAD: J. Jacquier).*

volumes (absence of the beginning or final phases of the operational chain), the majority of the exploited nodules in the locus seem only to have provided one or two used or exported blanks at most. This is the trend visible among the most complete refitted sequences at least. The low productivity of the volumes exploited here would therefore still appear to be a defining characteristic, though this statement should be nuanced by the fact that it is difficult to quantitatively estimate the number of exported backed point blanks that were produced, even with relatively complete refit sequences.

The analysis of refits also underlines that elements rarely moved throughout the locus. Two concentrations seem to have operated individually (n°1 and n°3), and the refits between the other concentrations are rare (9 refit sequences out of 87). These indicate nevertheless that at least one concentration (n°4) seems to have received a non-negligible quantity of blanks (Fig. 12). This would suggest that concentration 4 and its periphery had a particular role as an activity area. However, only one of the seven elements introduced into concentration 4 shows any signs of use. This observation may be linked, moreover, to the short use life of the tools themselves, which makes the identification of unretouched tools particularly difficult, as traces, when present, are not particularly developed. In fact, the nature of the tasks themselves may play a determining role in the rarity of traces. The only activities identified via the functional study of locus 36 were the working of plants and, secondarily via a single-use zone, butchery, and these activities are particularly prone to underestimation during both high- and low-magnification analyses (see notably Van den Dries & Van Gijn 1997).

Besides the backed points abandoned in the periphery of concentration n°1 (see chapter Concentration n°1: heap RST 71-74), whose fractures underline an area of manufacture (see below), and the few blanks introduced into concentration 4 that point towards an activity area, the rare retouched tools and pieces with use-wear traces are scattered across the different concentrations. This would plead in the favour of occasional work sessions, which reinforces the impression of a generally low volume of transformation activities.

What vegetal matter? And for what purpose?

These rare activities highlighted by the use-wear analysis are dominated by plant working. The traces identified all correspond to transverse kinematics, which are coherent with the manufacture of objects rather than proper harvesting. Given the limited extension of the traces along generally concave cutting edges, it would appear that the majority of the activities concerned vegetal elements with small cross-sections (shoots, sticks, splints). The particular species that were worked, however, remains an open question. The piece for which we can push our interpretations the furthest concerns the only tool to have been used along the length of a straight edge, and may also have worked a material with a more considerable cross-section (larger extension of traces along the working edge; Fig. 22). Macroscopically this piece

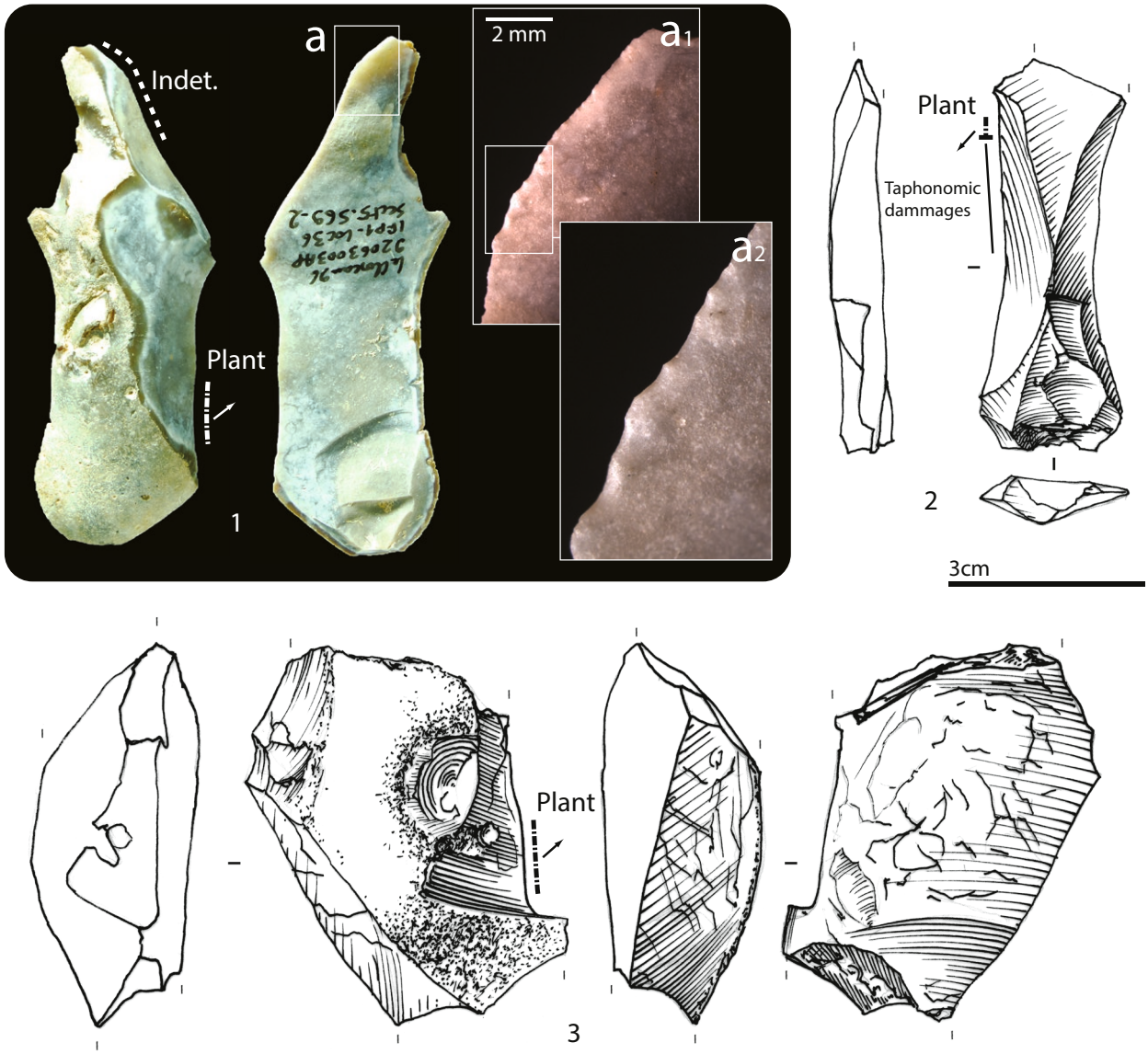


Fig. 20. Illustration of the morphological diversity of the curved knife tool type. a: functional edge damage observed on one of the tools. The interpretation of these removals remains delicate in the absence of any polishes. (Drawings: M. Reduron; Pictures and CAD: J. Jacquier).

Abb. 20. *Veranschaulichung der morphologischen Vielfalt des gekrümmten Messer-Werkzeugtyps. a: funktionelle Kantenschäden, die an einem der Werkzeuge beobachtet wurden. Die Interpretation dieser Abtragungen bleibt in Ermangelung jeglicher Polituren heikel. (Zeichnungen: M. Reduron; Bilder und CAD: J. Jacquier).*

matches equivalent experimental tools that were used to work wood, though the species remains undetermined. The nature of the vegetal matter worked with the other tools is even more of a mystery. To date, use-wear has struggled to identify the species worked in the Late Glacial Interstadial (Sobkowiak-Tabaka & Kufel-Diakowska 2018; Jacquier 2015; Langlais et al. 2015, 2018; Guéret & Jacquier 2019) or Holocene (Van Gijn 1989, 2010; Juel Jensen 1994; Beugnier & Crombé 2005; Beugnier 2007; Guéret 2013; Guéret & Jacquier 2019; Little & Van Gijn 2017; Osipowicz 2019) equivalents of these tools in north-western Europe. While specialists agree that it seems that the plants being worked are silica rich, none of the experiments conducted to date to confirm this in a more precise fashion have been particularly convincing (e.g., Little & Van Gijn 2017; Sobkowiak-Tabaka & Kufel-Diakowska 2018; Osipowicz 2019), and these failures suggest that we should reinvestigate the initial assumption. Perhaps the working of woody plants was too quickly cast aside because of the common and generic image that use-wear analysts tend to have regarding the traces associated with such work (damaged edges, very reflective and domed polishes). On the contrary, wood working does not necessarily generate such stereotypical traces (Fig. 23). Furthermore, the logic of the actual kinematics of these tools, as underlined through our study, seems much more compatible with the working of wood, specifically whittling, rather than that of grassy plants. The sharp edges of these "curved knives" were used with a positive rake angle (Fig. 21), a kinematic that is particularly adapted to

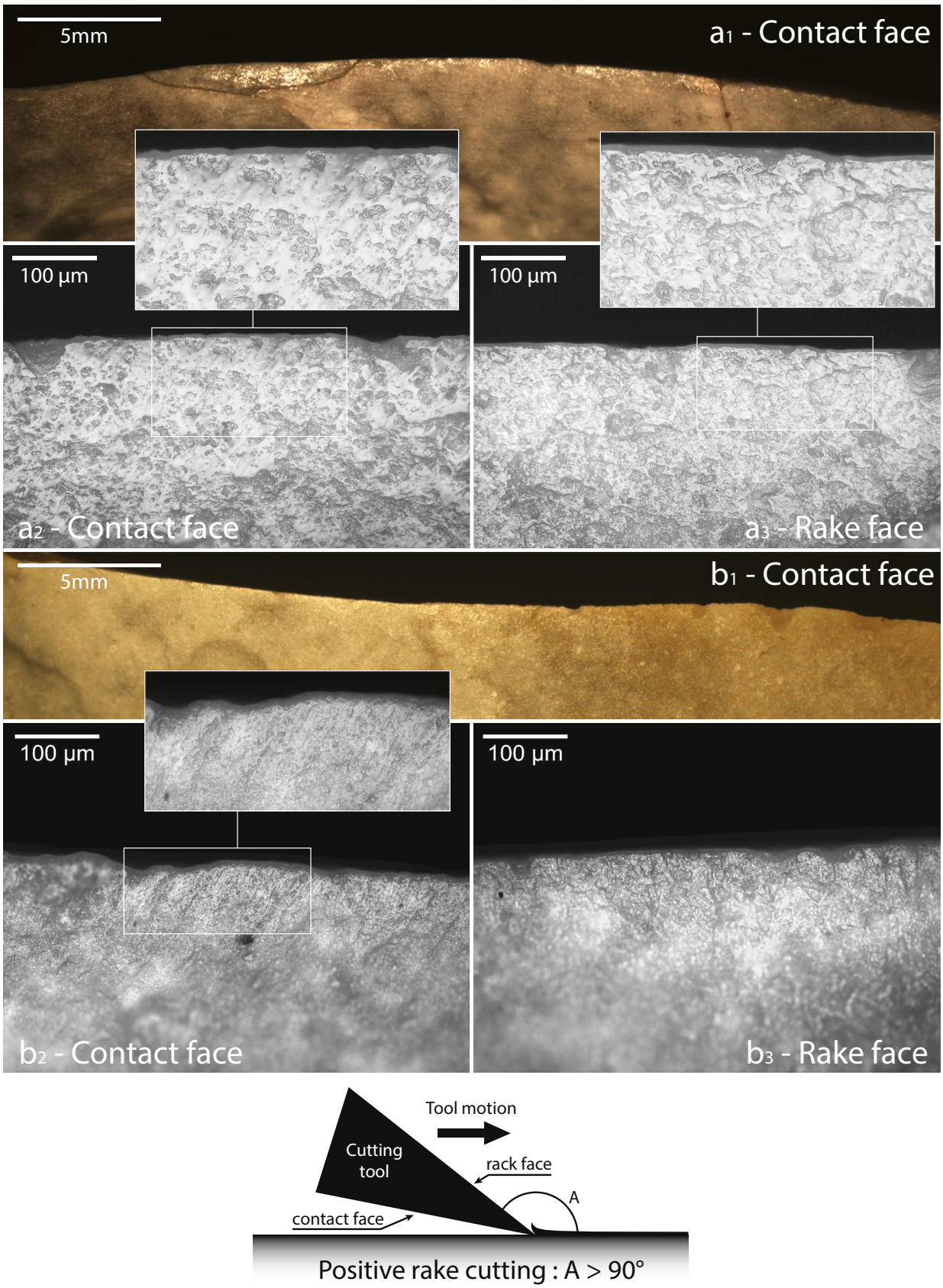


Fig. 21. Traces observed on curved knives. Photos a (1 to 3) and b (1 to 3) are respectively from pieces n°3 and n°1 of figure 20. (Pictures and CAD: J. Jacquier).

Abb. 21. *Beobachtete Spuren an gebogenen Messern. Die Fotos a (1 bis 3) und b (1 bis 3) stammen jeweils von den Stücken Nr. 3 und Nr. 1 aus Abb. 20. (Bilder und CAD: J. Jacquier).*

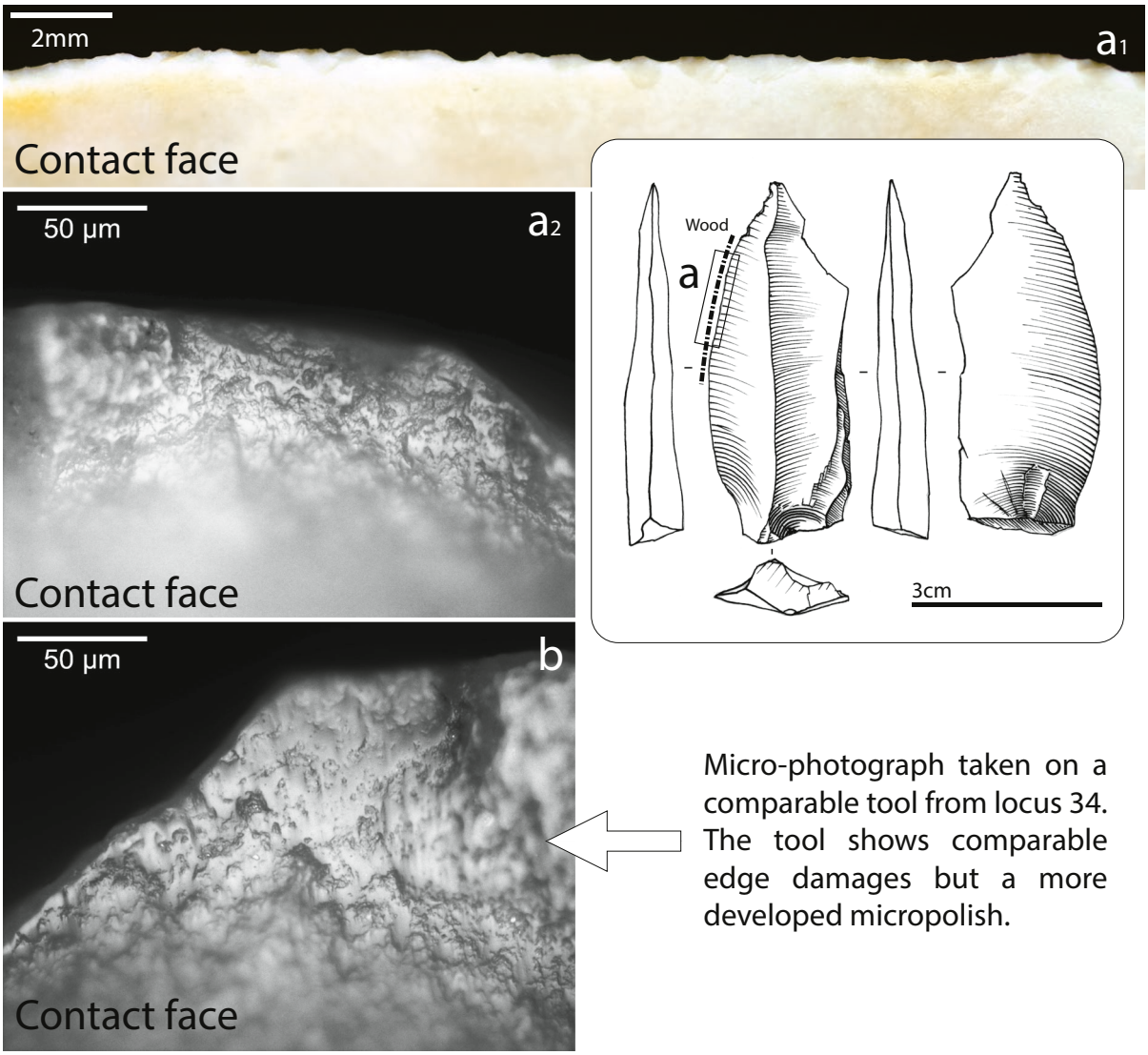


Fig. 22. Second tool type coherent with the working of vegetal matter. In opposition to the curved knives, this type, identified in several loci at Le Closeau, uses blade blanks with long cutting edges. The use-wear develops along several centimetres of the edge, the active edges are damaged by bifacial removals initiated by flexion, and the contact surface of the piece is the dorsal surface of the blank (Drawings: M. Reduron; Pictures and CAD: J. Jacquier).

Abb. 22. *Zweiter Werkzeugtyp, der mit der Bearbeitung von pflanzlichem Material zusammenhängt. Im Gegensatz zu den gebogenen Messern verwendet dieser Typ, der in mehreren Fundorten in Le Closeau identifiziert wurde, Klingenrohlinge mit langen Schneiden. Der Gebrauchsverschleiß entwickelt sich entlang mehrerer Zentimeter der Schneide, die aktiven Kanten werden durch bifaziale Abtragungen beschädigt, die durch Biegung ausgelöst werden, und die Kontaktfläche des Stücks ist die dorsale Oberfläche des Rohlings (Zeichnungen: M. Reduron; Bilder und CAD: J. Jacquier).*

the removal of shavings from rigid materials. Such kinematics are not well adapted to the processing of leaves and stems, which have been the focus of most experiments by use-wear analysts, that is to say bulrush (*Typha* sp.), reeds (*Phragmites*), sedges (*Carex* sp.), nettles (*Urtica* sp.), or horsetail (*Equisetum* sp.). This may in fact explain why the experiments conducted to replicate the traces visible on these enigmatic tools do not always respect the kinematics that can be deduced on the archaeological examples (see Little & Van Gijn 2017, figures 5 and 6 in particular). Furthermore, these plants, when used in traditional wicker and basket work, are little prepared, beyond some possible splitting, drying, or dyeing. The tool kinematics underlined in the present study do not seem to be coherent with the manufacture of rope either, as the tools implicated in scutching (be it of flax, nettles, hemp, or the secondary phloem of wood) are used specifically to separate fibres from the tow (see Caspar et al. 2005), not to cut them, and the latter would certainly happen if one were attempt to transversally work said fibres with a sharp-angled tool and a positive rake angle, i.e., if one were to attempt to whittle them. These reflections push us to seriously reconsider the wood working hypothesis.

While the question regarding the specific nature of the vegetal matter being worked remains in suspense, identifying the activities in which these tools may have participated remains delicate. Reintegrating wood as one of the possible materials being worked, however,

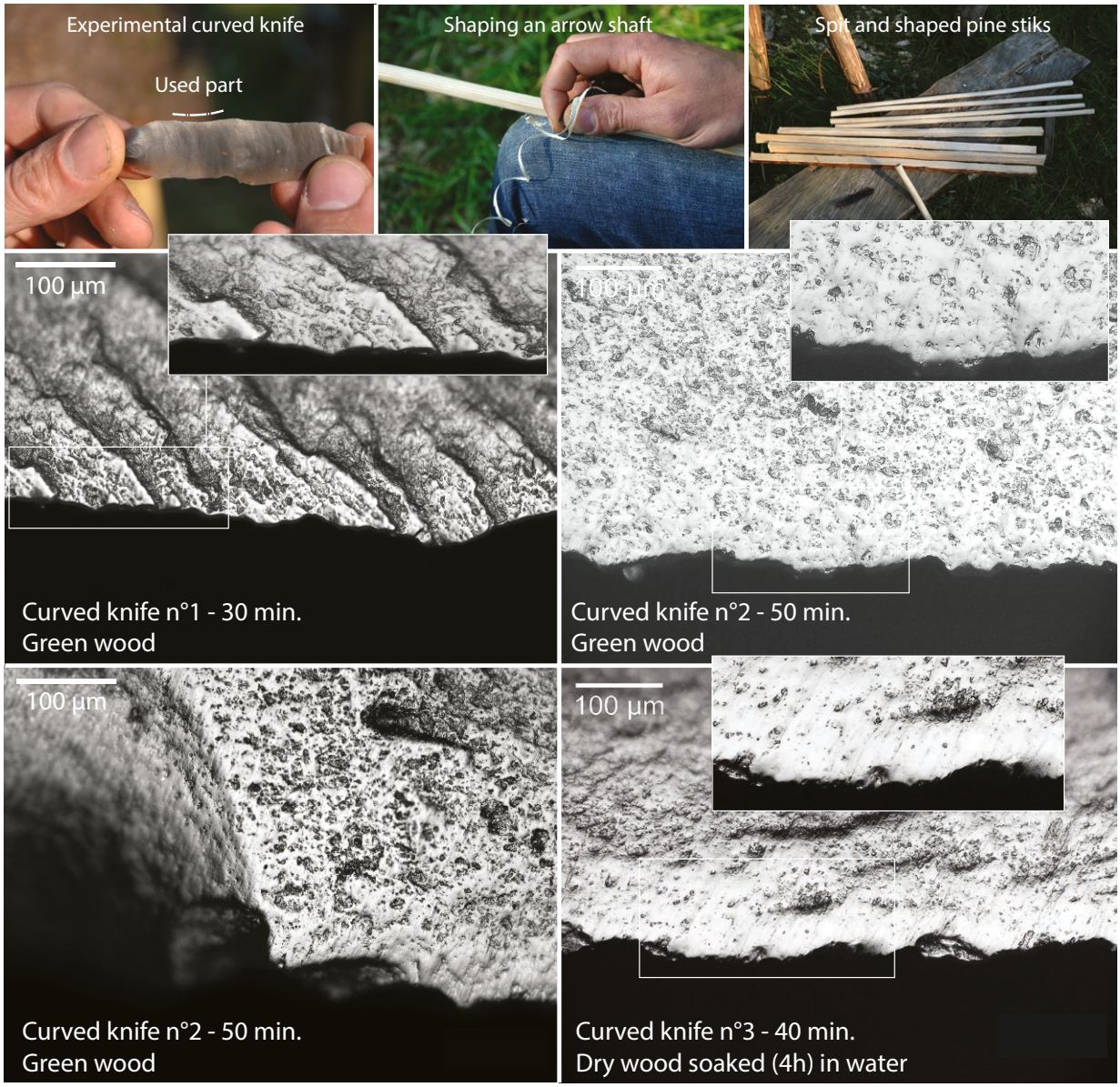


Fig. 23. Use-wear generated experimentally via the working of *Pinus sylvestris* with a positive rake angle (Drawings: M. Reduron; Pictures and CAD: J. Jacquier).

Abb. 23. *Experimentell erzeugter Gebrauchsverschleiß durch die Bearbeitung von Pinus sylvestris mit positivem Spanwinkel (Zeichnungen: M. Reduron; Bilder und CAD: J. Jacquier).*

broadens the potential hypotheses quite considerably. The working of sticks or splints of wood plays an important role in numerous spheres of activity, including both wickerwork and the manufacture of shafts for projectiles. The latter possibility merits particular reflection, as a central objective of the lithic production does seem to be oriented towards the manufacture of backed points. For the Final Palaeolithic, the only hafts known to date are made of wood, and more precisely of split pine (Rust 1943; Meadows et al. 2018; Hartz et al., 2019), yet the manufacture of shafts for arrows requires much more than the simple splitting of a tree trunk. The wood pieces produced by splitting have a polygonal cross-section and therefore require a further and considerable step of shaping in order to produce rods with the diameter and circular cross section that are ideal for the fabrication of shafts. Was this how the curved knives at Le Closeau were used? Initial experimental results seem promising (Fig. 23), and moreover, the species of wood the most often identified among the wood charcoal at the site, which is the result of sub-contemporaneous wildfires, is *Pinus sylvestris* (Pernaud in Bodu 1998).

An equivalent functional signal in the other tested loci

While we will not cover all of the details regarding the results obtained in our studies of the other loci, as this work is still ongoing and the comparative analysis is not completed, we can, however, already present the general profile of each and compare

them, at least in their broad strokes, with the profile of locus 36. Further nuances will no doubt be underlined in the next publications, but the general technological and functional orientation of these other loci follow the same tendencies as observed in locus 36, that is to say not very economical production schemes for the manufacture of blanks for backed points, a small proportion of retouched tools, an extremely low utilisation rate, and a functional spectrum centred around plant work and butchery (Fig. 24).

Given the general appearance of the majority of the loci of the upper level, i.e., a lack of structures or combustion features, the presence of lithic heaps, and an extremely reduced formal toolkit, it is very possible that the specific functional orientation of those loci that were tested extends to others on the site. However, we should note that some rare loci, such as loci 1 or 14, have richer typological assemblages and therefore may also have distinct functional orientations. This observation can, however, be further qualified: while these sectors have higher quantities of retouched pieces, this equipment remains dominated by points, and the total tool count still remains low relative to the quantity of unmodified pieces.

An accumulation of task-specific workshops?

In a publication focusing on the identification of hunting stands or stations in the Upper Palaeolithic of the Paris Basin (Bodu et al. 2011), the Late Azilian at Le Closeau was prudently compared to Binford's (1980) "hunting stands" or "processing sites":

Here we find dozens of small loci containing few lithic objects, expedient flaking sequences mostly oriented towards the production of backed points and a nearly complete absence of other tool types. The faunal remains found in these loci, though they are few, confirm that hunting activities took place. Taken separately, each of these loci could be considered as a hunting camp. But once again, this is only if we do not consider the possibility that these highly specialized loci were complementary to zones in which hides were worked (represented by a few loci where end scrapers are abundant), or with the only locus out of the 50 excavated that yielded thick borers (Bodu et al. 2011: 241)

While the traces identified on the tools reveal an unsuspected quantity of work related to the processing of vegetal matter and tend to minimize butchery activities, the results of our study confirm the hypothesis of a very specific orientation of a

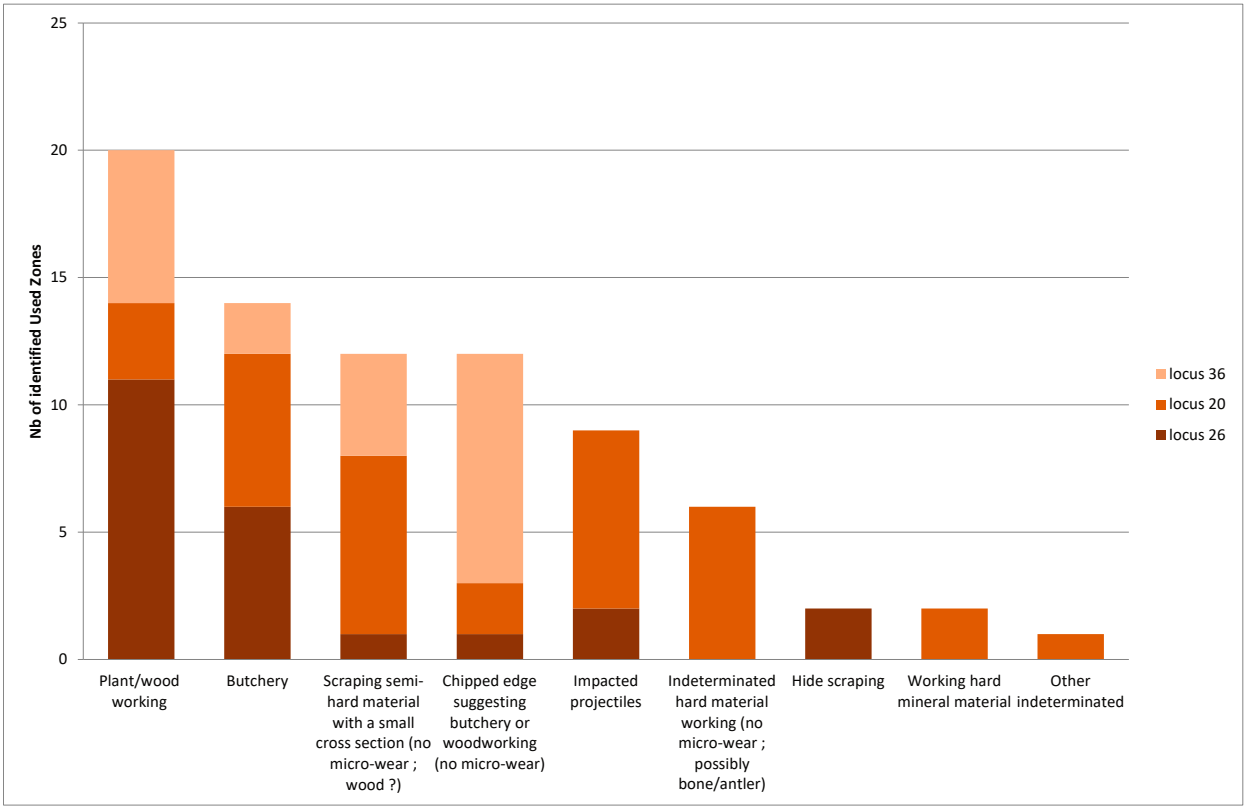


Fig. 24. Functional spectrum of locus 36, 20 and 26 resulting from the use-wear analysis. Locus 20 and 26 were not studied as exhaustively as 36, but in a very extensive manner (exhaustive study of the retouched artefacts; study of 649 and 862 of the most laminar unmodified blanks respectively).

Abb. 24. *Funktionsspektrum der Fundstellen 36, 20 und 26, das sich aus der Analyse der Gebrauchsspuren ergibt. Fundstellen 20 und 26 wurden nicht so ausführlich wie 36, aber sehr umfangreich untersucht (ausführliche Untersuchung der retuschierten Artefakte; Untersuchung von 649 bzw. 862 der flächigsten unmodifizierten Rohlinge).*

considerable proportion of the loci towards the production of backed points. The recurrent nature of this techno-economic profile, that we can perceive at other loci, but also seems generalizable at the scale of the entire site, suggests that even if certain loci operated together, these complementary relationships were rare. In other words, and given our results, it would appear that Le Closeau is more likely the result of an accumulation of successive occupations, or rather uses, i.e., stopover or workshop sites with very specific functions, rather than the result of a few occupations having produced numerous complementary loci as was observed at the Belgian site of Rekem (De Bie & Caspar 2000). This cumulative process could be responsible for the formation of certain loci, as suggested by the autonomy of heaps 1 and 3 within locus 36.

A complexified economic model of the Azilian

If what De Bie & Van Gils (2006) evoke while discussing Azilian occupations in the Belgian Campine, i.e. that repeated use or certain locations, notably those located close to sources of water, is an essential characteristic of Azilian mobility during the Allerød, then Le Closeau does not deviate from the norm, even if the situation we have described above does present some originality. While the loci and their degrees of complementarity require further refinement, this tendency of the different loci at the site towards a focus on projectile blank production does not seem to have any equivalents in, at the least, the northern half of France. The large site of Chaloignes (Mozet-sur-Louet, Maine-et-Loire, France) is described as a succession of residential campsites based on the near-total absence of refits between loci, the presence of a diverse Azilian toolkit on each of these loci, and the use-wear results of roughly 100 pieces (Marchand et al. 2009, 2011). At Warluis (Oise, France), distinct sectors separated by spaces of 100 to 200 metres were discovered (Ducrocq 2010; Ducrocq et al. 2017), and each of them, which currently remain independent as no refits have been discovered between them, presents a very specific technoeconomic profile. Locus IV strongly evokes the loci at Le Closeau and it would appear to be an area that is strictly oriented towards the production of small blade blanks. This sector is small, with only 84 pieces (Ducrocq 2010). Locus IX, only containing 24 pieces, of which a strong proportion is retouched, would appear, moreover, to be a small activity area. Sector VII is a collection of juxtaposed small concentrations of fewer than 100 pieces, and it is interpreted as a collection of small stopover sites with a wide variety of materialized activities and, moreover, a fireplace (Ducrocq 2010; Ducrocq et al. 2017). The Azilian occupation at Saleux (Somme) presents itself as an organized succession of sub-circular loci whose densest parts cover 40 to 60 m^2. The loci are often centred around a simple fireplace, i.e., constructed directly on the flat surface of the ground, and happen to be rich in typological elements and backed points (Coudret & Fagnart 2006, 2015). Each locus has been interpreted as a residential site likely occupied during a whole season, with domestic and hunting related activities both been represented, and a degree of complementarity between these units has been proposed.

While this brief review underlines the specificity of Le Closeau, it also highlights the diversity on these large Azilian sites during the Allerød. It would appear that these vast sites, which exceed, at least in some cases, the largest known Magdalenian campsites in size, are the result of various modes of occupation: from vast campsites organized into complementary loci (a context that has, for the time being, only been demonstrated at Rekem in Belgium), to successions of small residential camps, to accumulations of task-specific sites.

This diversity has also been identified in the central Rhineland, where fall and summer campsites, characterized by a non-centralized use of space and a diversity of faunal and petrographic remains, are contrasted with fall and winter campsites, which are more discreet, centred around a fireplace and are often dominated by a single hunted species and a single type of raw material (Street et al. 2006). Isolated fireplaces were also discovered in this region and provide information on the activities that were occurring over the Allerød landscape, outside of these larger campsites (ibid.). This diversity gives us an idea of the complexity that characterizes Azilian settlement strategies and seems at odds with the commonly held beliefs regarding the economies of Allerød hunter-gatherers : Small, highly mobile groups dependent on dispersed and unpredictable resources (Naudinot et al. 2019: 14).

And what about the internal chronology of the upper level?

This novel reading of the assemblages in the upper level pushes us to reconsider the previous hypotheses regarding the internal chronological attributions of the different loci. Since the 1990s (Bodu & Valentin 1997; Bodu 1998) these chronological attributions were dependent on technical variability observed across the various loci – laminar index, degree of technical investment in volume preparation and maintenance – and a specific choice to give these criteria chronological value. The most simplified and least laminar of these productions were considered to be chronologically the latest, while those that targeted slightly more invested laminar production were attributed the "middle" period, intermediary between the latest Azilian in the upper level of Le Closeau and the Early Azilian of the lower level (Bodu & Valentin 1997; Bodu 1998; Bodu 2000; Mevel & Bodu 2018). The chronological value given to these variations contributed to the construction of an interpretive paradigm whereby the technoeconomic changes identified between the Magdalenian and the Azilian were seen as participating

the gradual and progressive abandontment of Magdalenian lifeways (see Bodu 2000; Valentin 1995, 2008; Mevel 2013; Naudinot et al. 2019). Yet the stratigraphic resolution of the site has not allowed for the confirmation of this hypothesis, and the radiometric dates obtained on wood charcoal only succeeded in dating natural wildfires that postdated the human occupations (Cary 1998), providing only a global *terminus ante quem*. Such variation in other contexts has, moreover, been interpreted in a different manner. On the Azilian site of Rekem, important variability in the care taken in regard to raw material selection, volume preparation and maintenance, the degree of volume exploitation, and the relative abundance of blades was observed (De Bie & Caspar 2000), yet the abundant refits conducted at the site confirm the relative contemporaneity of the majority of the loci. In this context, this variation was interpreted as distinct functional objectives and variable degrees of know-how expressed by knappers (ibid.).

At Le Closeau the large quantity of materials and loci, in addition to the relative homogeneity of the exploited flints, make conducting inter-locus refits quite arduous and laborious, which has discouraged the undertaking of such an endeavour at the scale of the site. The question of the contemporaneity of the loci of the upper level at Le Closeau can therefore only be approached indirectly, via a discussion of the potential complementarities between loci. Yet the techno-functional data presented in this article, notably pointing towards a recurrent functional orientation for the different loci tested, pleads in favour of the progressive accumulation site formation hypothesis. Therefore, and in contrast to what has been perceived at Rekem, our understanding of the anthropogenic formation processes that underlie the creation Le Closeau does not disqualify the choice to attribute a chronological significance to the technical variability documented between the loci. This scenario of formation by accretion of specialized uses does not support the chronological hypothesis either.

The question is far from being resolved. After a quick re-examining of the collections, it would appear that the fluctuating indices of laminarity, as well as the variable degree of technical investment in the preparation and maintenance of volumes, are quite tenuous, underlining the necessity to quantitatively assess these axes of variability. Such an effort is and will be integrated into future analyses.

Conclusions

The techno-functional analysis of the lithic industry at Le Closeau has allowed us to question the operation of the different loci and reflect upon the ways in which this vast Azilian site was occupied. Given the preliminary results, and given the techno-typological profile and spatial characteristics of the different loci, Le Closeau seems to correspond to an accumulation of multiple task-specific visits oriented towards the production of blanks compatible with the needs and norms of Azilian projectile point technology. A few loci with a richer diversity in typologically domestic equipment, while rare, seem to deviate from this general tendency. Continued study should allow us to see whether these locally "atypical" loci operated in a complementary fashion with the task-specific loci that characterize the site more generally. In the meantime, this seeming specialization is quite different than the commonly presented portrait of the Azilian economy.

This apparently original functional profile contributes to a diversity that we currently do not have an adequate handle on. Admittedly, we are not aided by the delicate and tenuous contrasts between residential campsites and more specialized sites, as during the Allerød the rare identified habitation structures are light and discreet (see Gelhausen 2004), and the traces left by combustion areas are often limited to a few burned flints, possibly a lightly rubified surface, and only very rare veritable combustion structures (Mevel et al. 2017). In this respect, the crossing of technological, functional, and spatial approaches is essential for apprehending the economic finalities of lithic production and site function with greater accuracy.

It is also of note that a certain "fidelity to places", materialized via their repeated use, seems to have been a recurrent feature of Azilian mobility strategies (De Bie & Van Gils 2006). This contributes to the difficulty faced when attempting to characterize sites, as it gives a false image of similarity and homogeneity across sites that are constituted by a diversity of occupations and uses. This should incite us to collectively apply integrated techno-functional approaches more broadly, combining petrography, technology, refits, and use-wear on vast and shared samples. As a matter of fact, the identification of the functional finality of documented production sequences and understanding of the operation and ways in which sites were occupied that such an approach allows will permit us to better articulate the significance of the variability observed between sites in regards to the density of materials, the organization of space, or the abundance of the formal toolkit. To date, Azilian sites having been subjected to such an approach are rare, yet the publication of the Rekem site (De Bie & Caspar 2000) clearly demonstrates how profitable such an integrated approach can be. The normalization of such an approach would certainly refine our understanding of Azilian mobility strategies, but at a broader scale we need to also move beyond an economic reading of this period that is far too "lithic centric". Functional analyses of toolkits broaden our perspectives by providing indirect access to all the technical chains that interact and articulate with flint tools.

For example, our study of Le Closeau provides with the opportunity to investigate the economy of vegetal

resources during the Allerød. While the number of tools used to work vegetal matter remains modest, it must nevertheless be underlined how exceptional such evidence is in Upper Palaeolithic contexts. Moreover, certain tools identified by use-wear find perfect equivalents in the Terminal Palaeolithic and the Mesolithic (curved knives), and these underline the continuity of certain practices and therefore highlight the role functional analyses can play in the construction of historical perspectives. This particular tool class remains unknown in Magdalenian contexts, and may therefore contribute to the novel technical package that is associated with the emergence of the Azilian. The identification of comparable tools at the Federmesser and Swiderian site of Lubrza 10 in Poland (Sobkowiak-Tabaka & Kufel-Diakowska 2018) suggests, moreover, that this may be a feature shared over very broad geographical scales.

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Literature cited

Beugnier, V. (2007). Préhistoire du travail des plantes dans le nord de la Belgique. Le cas du Mésolithique ancien et du Néolithique final en Flandre. *In*: V. Beugnier & P. Crombé (Eds.), *Plant processing from a prehistoric and ethnographic perspective. Proceedings of a workshop at Ghent University (Belgium), November 28, 2006*. BAR International Série 716, Oxford, 23-40.

Beugnier V. & Crombé P. (2007). L'outillage commun du premier site d'habitat néolithique découvert en Flandre (Belgique). Étude fonctionnelle de l'industrie lithique taillée du site de Waardamme (3e millénaire av. J.-C.). *Bulletin de la Société préhistorique française* 104 (3): 525-542.

Bignon O. (2008). *Chasser les chevaux à la fin du Paléolithique dans le Bassin parisien. Stratégies de subsistance et des modes de vie au Magdalénien et à l'Azilien ancien*, British Archaeological Reports, BAR International Series, Oxford

Bignon-Lau O. (2020). About the early Azilian way of life in the Paris basin: economical and spatial insights from zooarchaeological data. *In*: S. Grimm, M.J. Weber, L. Mevel & Y. Sobkoviak-Tabaka (Eds.), *From the Atlantic to Beyond the Bug River. Finding and Defining the Federmesser-Gruppen / Azilian*, RGZM – Tagungen 40, Mainz, 25-50.

Binford L. R. (1980). Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45: 4-20.

Bodu P. (1998) (Ed.). *Le Closeau. Deux années de fouille sur un gisement azilien et belloisien en bord de Seine. Rueil-Malmaison (Hauts-de-Seine).* Document final de synthèse de sauvetage urgent, AFAN, unpublished excavation reports

Bodu P. (2000a). Les faciès tardiglaciaires à grandes lames rectilignes et les ensembles à pointes de Malaurie dans le sud du Bassin parisien: quelques réflexions à partir de l'exemple du Closeau (Hauts-de-Seine). *In*: P. Crotti (Ed.), *Méso 97, actes de la table ronde "Épipaléolithique et Mésolithique", Lausanne, 21-23 novembre 1997*, Musée cantonal d'archéologie et d'histoire, Cahiers d'archéologie romande81, Lausanne, 9-28.

Bodu P. (2000b). Que sont devenus les Magdaléniens du Bassin parisien ? Quelques éléments de réponse sur le gisement azilien du Closeau (Rueil-Malmaison, France). *In*: B. Valentin, P. Bodu & M. Christensen (Eds.), *L'Europe centrale et septentrionale au Tardiglaciaire. Confrontation des modèles régionaux de peuplement, actes de la table-ronde de Nemours, mai 1997*, APRAIF, Mémoires du Musée de Préhistoire d'Île-de-France7, Nemours, 315-339.

Bodu P. & Mevel L. (2008). Enquête autour des lames tranchantes de l'Azilien ancien. Le cas du niveau inférieur du Closeau (Rueil-Malmaison - Hauts-de-Seine, France). *L'Anthropologie* 112: 509-543.

Bodu P. & Valentin B. (1997). Groupes à *Federmesser* ou aziliens dans le sud et l'ouest du Bassin parisien. Propositions pour un nouveau modèle d'évolution. *Bulletin de la Société préhistorique française* 94 (3): 341-347.

Bodu P., Debout G. & Bignon O. (2006). Variabilité des habitudes tardiglaciaires dans le Bassin parisien: l'organisation spatiale et sociale de l'Azilien ancien du Closeau. *Bulletin de la Société préhistorique française* 103 (4): 711-728.

Bodu P., Olive M., Valentin B., Bignon-Lau O. & Debout G., (2011). Où sont les haltes de chasse ? Discussion à partir des sites tardiglaciaires du Bassin parisien. *In*: F. Bon, S. Costamagno & N. Valdeyron (Eds.), *Haltes de chasse en Préhistoire. Quelles réalités archéologiques ?, P@lethnologie* 3: 231-252.

Bolus M. (1992). *Die Siedlungsbefunde des späteiszeitlichen Fundplatzes Niederbieber (Stadt Neuwied). Ausgrabungen 1981–1988*, Monographien des Römisch-Germanischen Zentralmuseums 22, Bonn.

Cary S. (1998). Le contexte chronologique: discussion à propos des datations du Closeau. In. P. Bodu (Ed.), *Le Closeau. Deux années de fouille sur un gisement azilien et belloisien en bord de Seine. Rueil-Malmaison (Hauts-de-Seine)*, Document final de synthèse de sauvetage urgent, AFAN, unpubublished excavation report, 49-59.

Caspar J.-P., Féray P. & Martial E. (2005). Identification et reconstitution des traces de teillage des fibres végétales au Néolithique. *Bulletin de la Société préhistorique française* 102 (4): 867-880.

Coudret P. & Fagnart J.-P. (2006). Données préliminaires sur les habitats des groupes de la tradition *Federmesser* du bassin de la Somme. *Bulletin de la Société préhistorique française* 103: 729-740.

Coudret P. & Fagnart J.-P. (2015). Recent research on the final Palaeolithic site of Saleux (France, Somme). *In*: N. Ashton & C. Harris (Eds.), *No Stone Unturned, Papers in Honour of Roger Jacobi*, Lithic Studies Society, London, 135-155.

De Bie M. & Caspar J.-P. (2000). *Rekem. A Federmesser camp on the Meuse River Bank*. IAP & Leuven University Press, Archeologie in Vlaanderen Monografie3 & Acta Archaeologica Lovaniensia Monographiae 10, Asse-Zellik & Leuven

De Bie M. & Van Gils M. (2006). Les habitats des groupes à Federmesser (azilien) dans le Nord de la Belgique. *Bulletin de la Société préhistorique française* 103 (4): 781-790.

Ducrocq T. (2010). Des traces discrètes d'occupations paléolithiques et mésolithiques dans le marais de Warluis (Oise): les sites VI et IX. *Revue archéologique de Picardie* 1-2: 5-40.

Ducrocq T., Paris C., Coutard S. & Juhel L. (2017). Des haltes du Paléolithique final dans la vallée du Thérain: le gisement de Warluis VII (Oise). *Revue archéologique de Picardie* 1-2: 11-56.

Fat-Cheung C., Chevallier A., Bonnet-Jacquement P., Langlais M., Ferrié J.-G., Costamagno S., Kuntz D., Laroulandie V., Mallye J.-B., Valdeyron N. & Ballista S. (2014). Comparaison des séquences aziliennes entre Dordogne et Pyrénées: état des travaux en cours. *In*: M. Langlais, N. Naudinot & M. Peresani (Eds.), *Les groupes culturels de la transition Pléistocène-Holocène entre Atlantique et Adriatique, actes de la séance de la Société préhistorique française, Bordeaux, 24-25 mai 2012*, Société préhistorique française, Séance 3, Paris, 17-44.

Floss H. (2000). Le couloir Rhin-Saône-Rhône: axe de communication au tardiglaciaire? *In*: C. Cupillard & A. Richard A. (Eds.), *Les derniers chasseurs-cueilleurs d'Europe occidentale (13000 - 5500 av. J.-C.), actes du colloque international de Besançon, 23-25 octobre 1998*, Presses universitaires franc-comtoises, Annales littéraires 699, Besançon, 313-321.

Gelhausen F. (2011). *Siedlungsmuster der allerødzeitlichen Federmesser-Gruppen in Niederbieber, Stadt Neuwied*, Monographien des Römisch-Germanischen Zentralmuseums 90, Bonn.

Gelhausen F., Kegler J. F. & Wenzel S. (2004). Latent dwelling structures in the Final Palaeolithic: Niederbieber IV, Andernach-Martinsberg 3, Berlin-Tegel IX. *Notae Praehistoricae* 24: 69-79.

Grimm S.B. (2019). *Resilience and Re-organisation of Social Systems during the Weichselian Lateglacial in Northwest-Europe. An evaluation of the archaeological, climatic, and environmental records*, Monographien des Römisch-Germanischen Zentralmuseums 128, Bonn.

Guéret C. (2013a). Identité et variabilité de l'outillage lithique du Premier Mésolithique en Belgique et dans le Nord de la France. Les apports de l'approche fonctionnelle. *In*: B. Valentin, B. Souffi, T. Ducrocq, J.-P. Fagnart, F. Séara & C. Verjux (Eds.), *Palethnographie du Mésolithique. Recherches sur les habitats de plein air entre Loire et Neckar, Actes de la table-ronde internationale de Paris, 26 et 27 novembre 2010*, Société Préhistorique Française, Séances de la Société Préhistorique française 2, Paris, 147-167.

Guéret C. (2013b). *L'outillage du Premier Mésolithique dans le Nord de la France et en Belgique. Eclairages fonctionnels*. PhD., Dissertation, Université de Paris 1

Guéret C. & Jacquier J. (2019). La transition Pléistocène Holocène dans le Nord-Ouest de l'Europe vue par le prisme de la tracéologie lithique: essai de synthèse. *In*: J.-P. Fagnart, L. Mevel, B. Valentin & M.J. Weber (Eds.), *L'Europe du nord-ouest autour de 9600 cal. BC: quels changements? Actes de la session 3 du XXVIIIe Congrès préhistorique de France organisé à Amiens du 30 mai au 4 juin 2016*. Société préhistorique française, Paris, 363-379.

Hartz, S., Weber, M.J., Meadows, J. & Klooß, S. (2019). One in a hundred – the rediscovery of a potential arrow shaft from Stellmoor (Schleswig-Holstein, Northern Germany). *In*: B.V. Eriksen, E. Rensink & S. Harris (Eds.), *The Final Palaeolithic of Northern Eurasia. Proceedings of the Amersfoort, Schleswig and Burgos UISPP Commission Meetings*, Schriften des Museums für Archäologie Schloss Gottorf Ergänzungsreihe 13, Kiel, 155-168.

Ihuel E., Mevel L. & Rabanit M. (2018). L'Azilien récent du locus B des Pinelles à Prigonrieux (Dordogne). *In*: A. Averbouh, P. Bonnet-Jacquement & J.-J. Cleyet-Merle (Eds.), *L'Aquitaine à la fin des temps glaciaires - Aquitaine at the end of the Ice Age. Les sociétés de la transition du Paléolithique final au début du Mésolithique dans l'espace nord aquitain. Actes de la table ronde organisée en hommage à Guy Célérier, PALEO* numéro spécial, 147-152.

Jacquier J. (2015). *Approche fonctionnelle de l'outillage lithique à l'aube de l'Holocène dans le Nord-Ouest de la France*. PhD., Dissertation, Université Rennes I.

Juel Jensen H. (1994). *Flint tools and plant working. Hidden traces of stone age technology*. Aarhus University Press, Aarhus.

Langlais M., Chevallier A., Fat-Cheung C., Jacquier J., Marquebielle B. & Naudinot N. (2020). The pleistocene-holocene transition in Southwestern France: A focus on the laborian. *Quaternary international* 564: 37-47.

Langlais M., Laroulandie V., Jacquier J., Costamagno S., Chalard P., Mallye J.-B., Petillon J.-M., Rigaud S., Royer A., Sitzia L., Cochard D., Dayet A.-L., Fat Cheung C., Le Gall O., Queffelec A. & Lacrampe-Cuyaubère F. (2015). Le Laborien récent de la grotte-abri de Peyrazet (Creysse, Lot, France), Nouvelles données pour la fin du Tardiglaciaire en Quercy. *Paleo* 26: 79-115.

Langlais M., Delvigne V., Gibaud A., Jacquier J., Perrin T., Fernandes P. & Delpuech A. (2018). La séquence archéostratigraphique du Cuze de Sainte-Anastasie (Cantal): nouvelle approche des industries lithiques du Paléolithique final au Mésolithique, *Bulletin de la Société préhistorique française* 115 (3): 497-529.

Lanos Ph. & Dufresne Ph. (2019). ChronoModel version 2.0: Software for Chronological Modelling of Archaeological Data using Bayesian Statistics. Available from https://chronomodel.com/.

Little A. & Van Gijn A.-L. (2017). Enigmatic plant-working tools and the transition to farming in the Rhine/Meuse Delta, *Analecta Praehistorica Leidensia* 47: 1-11.

Marchand G. (Ed.) (2009). Un habitat azilien en Anjou: les Chaloignes à Mozé-sur-Louet, Maine-et-Loire, *Gallia Préhistoire* 51: 1-111.

Marchand G., Naudinot N., Phillibert S. & Sicard S. (2011). Chasse aux haltes sur un site azilien de l'Ouest de la France. *P@lethnologie* 3: 271-294.

Meadows, J., Heron, C., Philippsen, B. & Weber, M.-J. (2019). Dating the lost arrow shafts from Stellmoor (Schleswig-Holstein, Germany). *Quartär* 65: 105-114.

Mevel L. (2013). Les premières sociétés aziliennes: nouvelle lecture de la genèse du phénomène d'azilianisation dans les Alpes du nord à partir des deux niveaux d'occupations de l'abri de La Fru (Saint- Christophe-la-Grotte, Savoie), *Bulletin de la Société préhistorique française* 110 (4): 657-689.

Mevel L. (2017). *Des sociétés en mouvement. Évolution des sociétés magdaléniennes et aziliennes des Alpes du nord françaises*. CTHS, Documents préhistoriques, 34, Paris.

Mevel L. & Grimm S.B. (2019). From one camp to another. First results of a comparative techno-economic analysis of the Federmesser-Gruppen lithic industries from the Central Rhineland. In: B.V. Eriksen, E. Rensink & S.K. Harris (Eds.), *Proceedings of the Amersfoort and Schleswig meetings of the uispp commission for "the final palaeolithic of northern eurasia"*, Untersuchungen und Materialien zur Steinzeit in Schleswig-Holstein und im Ostseeraum, Kiel, 105-136.

Mevel L., Fornage-Bontemps S. & Bereziat G. (2014a). Au carrefour des influences culturelles ? Les industries lithiques de la fin du Tardiglaciaire entre Alpes du nord et Jura, 11500-9500 CalBC. *In*: M. Langlais, N. Naudinot & M. Peresani (Eds.), *Les groupes culturels de la transition Pléistocène-Holocène entre Atlantique et Adriatique, actes de la séance de la Société préhistorique française, Bordeaux*, Société préhistorique française, Séance 3, Paris, 45-81.

Mevel L., Pion G. & Fornage-Bontemps S. (2014b). Changements techniques et géographie culturelle à l'extrême fin du Paléolithique dans les Alpes du nord françaises. Les stratigraphies de l'abri de La Fru (Savoie) revisitées. *In*: J. Jaubert, N. Fourment & P. Depaepe (Eds.), *Transitions, ruptures et continuité en préhistoire, actes du 27e Congrès préhistorique de France, Bordeaux - Les Eyzies, 31 mai - 5 juin 2010*, Société préhistorique française, Paris, 527-546.

Mevel L., Ihuel E. & Rabanit M. (2017). L'occupation azilienne des Pinelles à Prigonrieux (Dordogne). Discussion autour d'un assemblage lithique de la seconde partie de l'Allerød. *Bulletin de la Société préhistorique française* 114 (2): 315-338.

Mevel L. & Bodu P. (2018). Le Closeau revisité. Actualités et perspectives autour des occupations Aziliennes du Closeau (Rueil-Malmaison, Hauts-de-Seine). *In*: A. Averbouh, P. Bonnet-Jacquement & J.-J. Cleyet-Merle (Eds.), *L'Aquitaine à la fin des temps glaciaires: les sociétés de la transition du Paléolithique final au début du Mésolithique dans l'espace Nord aquitain*, Paléo numéro spécial, 203-214.

Naudinot N. (2010). *Dynamiques techno-économiques et de peuplement au Tardiglaciaire dans le Grand-Ouest de la France*, PhD., Dissertation, Université de Rennes 1.

Naudinot N., Fagnart J.-P., Langlais M., Mevel L. & Valentin B. (2019). Les dernières sociétés du Tardiglaciaire et des tout débuts de l'Holocène en France, *Gallia Préhistoire* 59: 4-45.

Osipowicz G. (2019). Plant processing in the Late Mesolithic Poland: in search for function of the mysterious "curved knives". *Archaeological and Anthropological Sciences* 11 (7): 3613-3628.

Pelegrin J. (2000). Les techniques de débitage laminaire au Tardiglaciaire: critères de diagnose et quelques réflexions. *In*: B. Valentin, P. Bodu & M. Christensen (Eds.), *L'Europe centrale et septentrionale au Tardiglaciaire. Confrontation des modèles régionaux de peuplement, actes de la table ronde internationale de Nemours, 14-16 mai 1997*, APRAIF, Mémoires du musée de Préhistoire d'Île-de-France 7, Nemours, 73-86.

Perlès C. (1991). Economie des matières premières et économie du débitage: deux conceptions opposées? *In*: Collectif (Ed.), *25 ans d'études technologiques en Préhistoire, XIe rencontres internationales d'Archéologie et d'Histoire d'Antibes*, APDCA, Juan-les-Pins, 35-45.

Rust A. (1943). *Die alt- und mittelsteinzeitlichen Funde von Stellmoor*, Karl Wachholtz, Neumünster

Sobkowiak-Tabaka I. & Kufel-Diakowska B. (2019). The shining piece of the puzzle: evidence of plant use in the Late Palaeolithic, *Archaeological and Anthropological Sciences* 11: 1373-1389.

Street M., Gelhausen F., Grimm S. B., Moseler F., Niven L., Sensburg M., Turner E., Wenzel S. & Jöris O. (2006). L'occupation du bassin de Neuwied (Rhénanie centrale, Allemagne) par les Magdaléniens et les groupes à Federmesser (aziliens). *Bulletin de la Société préhistorique française* 103 (4): 753-780.

Van den Dries M. & Van Gijn A.-L. (1997). The representativity of experimental usewear traces. In: R. Ramos-Millán & M.A. Bustillo (Eds.), *Siliceous rocks and culture*, Editorial de la Universidad de Granada, Granada, 499–513.

Van Gijn A.-L. (1989). *The wear and tear of flint: principles of functional analysis applied to Dutch Neolithic assemblages*, Analecta Praehistorica Leidensia 22, Leiden.

Van Gijn A.-L. (2010). *Flint in focus: lithic biographies in the Neolithic and Bronze Age*, Sidestone Press, Leyden.

Van Gijn A.-L. (2014). Science interpretation in microwear studies. *Journal of archaeological Science* 48: 166-169.

Valentin B. (1995). *Les groupes humains et leurs traditions au Tardiglaciaire dans le Bassin Parisien. Apports de la technologie lithique comparée*. PhD., Dissertation, Université de Paris 1.

Valentin B. (2000). L'usage des percuteurs en pierre tendre pour le débitage des lames. Circonstances de quelques innovations au cours du Tardiglaciaire dans le Bassin parisien. *In*: G. Pion (Ed.), *Le Paléolithique supérieur récent: nouvelles données sur le peuplement et l'environnement, actes de la table ronde de Chambéry, 12-13 mars 1999*, Société préhistorique française, Mémoires 28, Paris, 253-260.

Valentin B. & Hantaï A. (2005). Transformations de l'industrie lithique pendant l'Azilien. Etude des niveaux 3 et 4 du Bois-Ragot. *In*: A. Chollet & V. Dujardin (Eds.), *La grotte du Bois-Ragot à Gouex (Vienne) Magdalénien et Azilien. Essai sur les hommes et leur environnement*. Société préhistorique française, Mémoires 38, Paris, 89-182.

Valentin B. (2008a). *Jalons pour une paléohistoire des derniers chasseurs (XIVe-VIe millénaire avant J.-C.).* Publications de la Sorbonne, Cahiers archéologiques de Paris 1 1, Paris.

Valentin, B. (2008b). Productions lithiques magdaléniennes et aziliennes dans le bassin parisien: disparition d'une économie programmée. The Arkeotek Journal, Association Européenne d'Archéologie des Techniques: 2 (3).