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## Research Article

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# Neolithization Processes of East Belgium: Supra-Regional Relationships Between Groups Highlighted by Technological Analysis of Lithic Industry

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**Abstract:** Technological analysis of variations in blade production and the flow of siliceous raw materials revealed new understandings of different types of socio-economic functioning on a supra-regional scale. In this article, we are focusing on supra-regional relationships between technical groups and the social dynamics involved in early Neolithic mobility within the communities of East Belgium. A detailed technological analysis was done to highlight discrete characteristics that permit the identification of distinct technical groups within the village of Vaux-et-Borsset. Four technical groups have been identified in the Blicquy/Villeneuve-Saint-Germain village, whereas two technical groups have been highlighted for the previous Linear Pottery culture (LPC) occupation. The search for the origin of the different technical groups was to understand the micro-processes of Neolithization in East Belgium. A central area with a high-density population during the pioneer LPC colonization, Hesbaye became a peripheral occupation area of the Blicquy/Villeneuve-Saint-Germain culture. This fringe territory seemed to attract neighbouring communities in different ways. Multidirectional dynamics seems to characterize this small territory leading to the coexistence of a high diversity of technical groups.

**Keywords:** Early Neolithic, East Belgium, lithic industry, technological analysis, technical traditions

## 1 Introduction

The Neolithic developed in temperate Europe with the Linear Pottery culture (LPC), which spread from Transdanubia (Hungary) to the Paris Basin (France) during the second half of 6th millennium BC. Studies on the LPC underline its great homogeneity over a vast Central-Western European territory, particularly in

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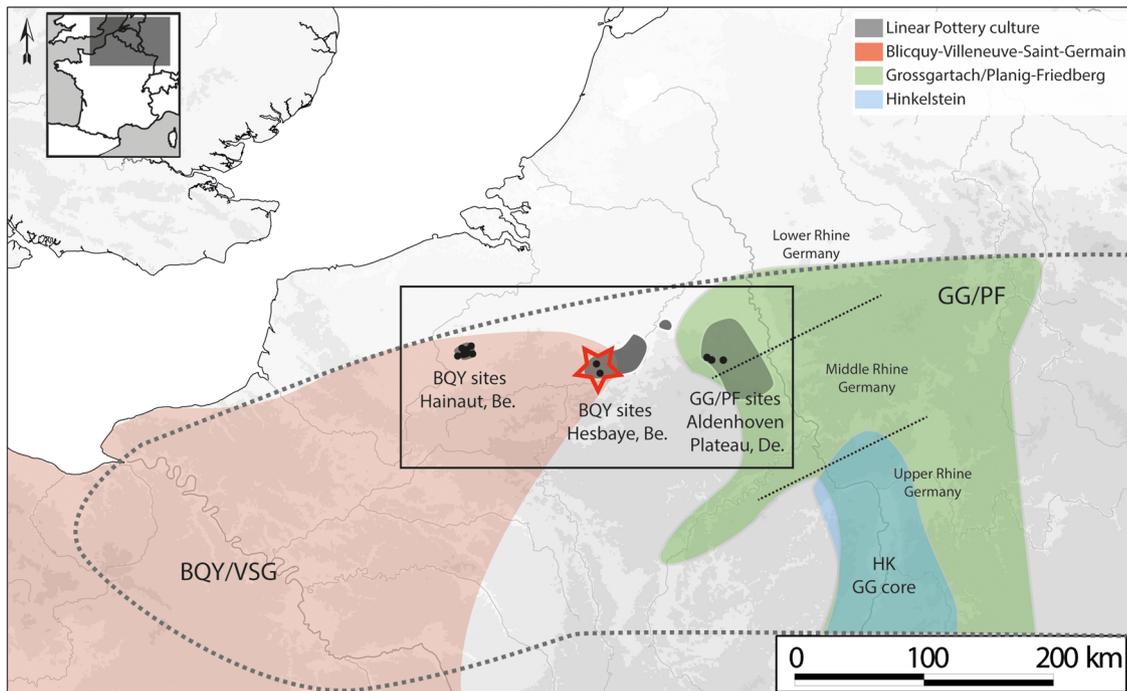
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architectural models, to such an extent that Coudart speaks of “A great and a long civilization: the first and, perhaps, the last ‘fully European identity’” (Coudart, 2009, p. 218). Indeed, at the turn of the 6th to the 5th millennium BC, a historical turning point occurred in the continental neolithization of Europe as the Linear Pottery culture broke up into a mosaic of cultural entities. The northern half of France and Belgium was occupied by the Blicquy/Villeneuve-Saint-Germain culture (BQ/VSG; according to Burnez-Lanotte, Ilett, & Allard, 2008). In west Germany, the first post-LPC occupations are linked to the emergence of the Hinkelstein (HK) culture in the middle and upper Rhine regions, which was followed by the Grossgartach (GG), the Planig-Friedberg (PF) and then the Rössen (Rö), which extended then to the south-western part of Central Europe (Denaire et al., 2017). The Aldenhoven Plateau, in north-western Germany, has only delivered sites from the middle stage of the Grossgartach culture, after a massive depopulation at the end of the LPC (Zimmermann, 2009). Some particular clusters can be identified in the inhabited area. Here, we will focus on the eastern fringe of the Blicquy/VSG culture where two sites have been dug. They are around 100 km from the western cluster located in West-Belgium in the Dendre sources and around 60–80 km from the Middle Neolithic site (in German chronology) of the Aldenhoven Plateau (Figure 1). So, three clusters can be distinguished. Our goal is to better understand the dynamics at play during the first cultural transition of the neolithization processes of the Hesbaye region due to its unique location at a crossroads between different cultural entities (BQ/VSG and GG/PF).

To shed light on the mechanisms, our approach goes beyond the definition of cultures based on stylistic categories of artefacts. To understand the disruptions that are taking place in the socio-economic structure of these first agro-pastoral populations, we will focus on the gestures and know-how that these populations employed to produce their lithic tools. This novel definition of the lithic technical traditions aims to better



**Figure 1:** Map of the studied region. The red star indicates the geographical area in question (part of Hesbaye region in Belgium). The red dot is the key site of this study, Vaux-et-Borset, while the post-Linear Pottery culture sites indicated in black served as points of comparison and are representing the three clusters under study. The grey dotted lines mark the maximum extension area of the Linear Pottery culture, while the regional concentrations for our study area (framed in black) are indicated by grey solid areas.

decipher the identity of the groups involved. The intergenerational transmission of technical know-how represents a heuristic approach to understand the mechanisms of historical transition (Müller, 2016).

## 2 Materials and Methods

The starting point of this study is focused on the Early Neolithic sites of Vaux-et-Borset. To establish comparisons, the recently excavated site of Ath has been selected for the western cluster, and the data of five post-LBK German sites have been used for the eastern cluster.

### 2.1 Vaux-et-Borset, a Key Site for East Belgium

The sites of Vaux-et-Borset “Gibour” and “À La Croix Marie-Jeanne” (Villers-le-Bouillet) constitute the heart of our analysis because they are the reference sites for the Early Neolithic in the *Hesbaye Liégeoise* (East Belgium). Under the direction of J.-P. Caspar and C. Constantin (Constantin & Burnez-Lanotte, 2008), a program of excavations (1989–1999) encompassing an area of 20,000 m<sup>2</sup> partially explored the two adjacent villages dating to the earliest phase of the Neolithic Hesbaye: one belongs to the Linear Ceramic culture (LPC or “Omalian”) and the other to the Blicquy/Villeneuve-Saint-Germain (BQ/VSG). The settlement belonging to the Linear Pottery culture revealed two categories of spatial organization: an enclosure and a village. These consist of at least five dwellings and their associated construction pits, along with a complex of 16 silos and 35 pits, which are mainly concentrated within the enclosure.

The neighbouring Blicquian settlement is divided between two sectors of which almost 13,000 m<sup>1</sup> have been explored. It has not been possible to determine a clear plan of the settlement due to intense erosion, particularly on the crest of the plateau. Nonetheless, the characteristics of certain features that resemble complexes of construction pits, and a number of refittings, suggest that the settlement included at least five buildings (Burnez-Lanotte, Caspar, & Constantin, 1993; Burnez-Lanotte, Caspar, & Vanguetaine, 2005).

The study is focused on the 1,923 blades from the site: 754 from the LPC site of Vaux-et-Borset and 1,169 from the BQ site.

### 2.2 Comparison Sites: Representation of the Surrounding Clusters

For the western cluster area, a large sample of the BQ lithic industry has been recently studied (Denis, 2017), and the general data of this study will be mentioned. But a key site will focus our direct comparisons by using an unpublished dataset from Ath “les Haleurs.” The West Zone Operational Directorate of the Walloon Heritage Agency led a preventive excavation operation in Ath, prior to a vast real estate project called “les Haleurs.” This intervention took place in three phases from May 2015 to August 2017 (Deramaix, Zeebroek, Jadin, & Denis, 2018). The excavation there uncovered an Early Neolithic site covering approximately 1.2 ha and, as such, it is the largest village of this period studied in the Ath region (Hauzeur, 2008, p. 130). In addition, it is the first settlement established along the eastern arm of the Dender (Constantin & Burnez-Lanotte, 2008). Finally, the “les Haleurs” site has the particularity of having the remains of two Early Neolithic cultures cohabiting within 3 m of each other: LPC and Blicquy/Villeneuve-Saint-Germain.

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<sup>1</sup> Here migration is used as defined by Hofmann, 2020, p. 229: “migration as a subset of mobility is reserved for longer-term or permanent resettlement.”

Thus, the site of Ath “les Haleurs” is a key site for a better understanding of the relations between the western and eastern Early Neolithic clusters of Belgium. All of the LPC and BQ/VSG blades have been studied, that is to say 497 artefacts (314 LPC and 183 BQ).

For the German cluster, lithic artefacts from six sites were analysed. Sites are located along the Rur, covering the entire chronological sequence from late Grossgartach to late Rössen. These sites have been largely described elsewhere, and we invite the interested reader to refer to these publications for more information (synthesis in Gehlen, Langenbrink, & Gaffrey, 2009; Gehlen & Schön, 2009a, 2009b; Nowak, 2013, pp. 182–183). The archaeological material from these sites is clearly less abundant, and only 435 blades have been recorded in well-dated structures (12 in Langweiler 10; 22 in Langweiler 12; 84 in Hambach 260; 27 in Müddersheim; and 228 in Inden 1 and 62 in Inden 3). To ensure the statistical reliability of the analysis, we will often use the German data as a whole.

All the data observed on the 2,855 blades are available in Supplementary Material.<sup>2</sup>

### 2.3 Method: Highlighting Discrete Technical Characters

The technological analysis proposed here seeks to define and characterize the technical identity of LPC and post-LPC knappers within the three clusters presented earlier. We will here focus on the knapping of flint blades, which required a long and sustained learning process, this learning resulted in the creation of “habits” or technical regularities (e.g. Pelegrin, 1985). Hence, the deciphering of the method of debitage, and of the percussion techniques used, reveals the steps and the strategic operations of the *chaîne opératoire*, thereby allowing us to track technical gestures and procedures that are nonessential but which are a strong expression of identity. Previous studies on LPC blade production, supported by numerous refittings made at the village of Verlaine (e.g. Allard, 2005, 2007), suggested the distinction of two “styles” within the Western LPC. These styles are related to two different operating schemes (Allard, 2005, p. 58 *versus* p. 153): differences within the opening of the striking platform, within the maintenance of the striking platform and the core. One of the styles includes large axial and lateral maintenance flakes knapped by direct hard hammerstone, testifying to phases of the total or partial reshaping of the block typical of this type of debitage. But these general differences within the *chaîne opératoire* are strongly echoed in the products sought by the knappers, that is the blades. For the studied contexts and specifically Vaux-et-Borset, discrete characteristics, mostly confined to the treatment of the striking platforms and to the preparations for the detachment of the blades, have been highlighted in relation to these styles (Denis & Burnez-Lanotte, 2020). But other technical characteristics also suggest that we can go beyond the definition of these two styles. We highlighted five different technical groups based on 12 criteria: raw material, stage of production, fragmentation, butt nature, overhangs preparation, tool used for overhang preparation, section, operative codes (they convey the order in which previous removals were detached), regularity (macroscopic appreciation of the edges and arris regularity and straightness of the profile), butt dimensions, blade dimensions, and typology. We claim that the use of blades as a privileged vector of analysis in contexts where refittings are impossible is particularly relevant. From this perspective, it is then a question of highlighting technical behaviours in the course of the *chaîne opératoire* of blade production, whose variability cannot be justified by (i) the production context, (ii) the constraints of the raw material, (iii) functional constraints, and (iv) nor variability of skill level between knappers. To validate the reliability of these different assertions, we conducted a correspondence analysis to better assess the weight of the different characteristics observed and, when necessary, their combination. For the purpose of the correspondence analysis, we organised the data of the aforementioned variables in a binary form, as most of the observations had nominal character. For the analysis, we used a CAPCA add-in for MS Excel created by Torsten Madsen (<https://www.archaeoinfo.dk/>). The goal of the correspondence analysis is to verify whether the structure of empirically

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<sup>2</sup> See <https://doi.org/10.1515/opar-2020-0180>.

**Table 1:** Raw material identified on the studied blades from the three clusters

In nb	Western cluster (Ath)		Hesbaye (Vaux)		Eastern cluster	Total
	LPC	BQ	LPC	BQ	Post-LPC	
Campanian	<b>141</b>	<b>3</b>	626	486	<b>17</b>	<b>1,273</b>
Maastrichtian	<b>12</b>	—	75	84	—	<b>171</b>
Ghlin	56	110	<b>3</b>	<b>376</b>	—	<b>545</b>
Turonian	20	9	—	—	—	<b>29</b>
Bartonian	<b>3</b>	<b>13</b>	—	<b>93</b>	—	<b>109</b>
Rullen	—	—	—	—	276	<b>276</b>
Rijckholt	—	—	—	—	42	<b>42</b>
Lanaye indet.	—	—	—	—	47	<b>47</b>
Other	40	33	9	51	10	<b>143</b>
Indeter.	42	15	41	79	43	<b>220</b>
<b>Total</b>	<b>314</b>	<b>183</b>	<b>754</b>	<b>1,169</b>	<b>435</b>	<b>2,855</b>

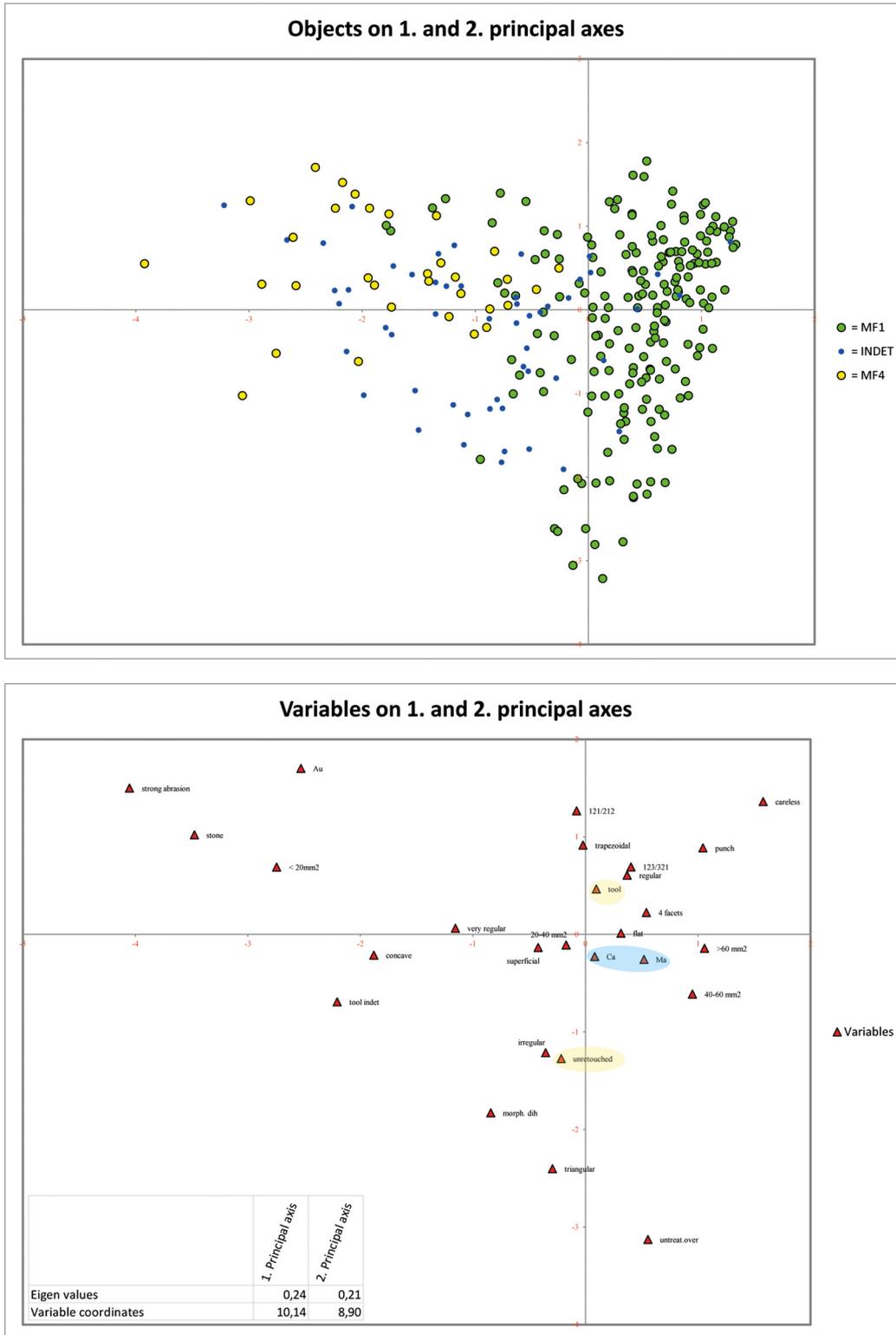
The exogenous raw materials for each cluster are indicated in bold.

defined technological groups is relevant. Entities were classified by defined technological groups (MF<sup>3</sup> to MF5). Data of both datasets show a relative homogeneity with maximum eigenvalue on the first axis of the LPC dataset making only 0.27 and 0.42 for the Blicquy dataset. As a test, we took the values of cumulative percentages explaining the position of individual variables on five axes for a cluster analysis to understand the relationship of variables within a dataset. Cluster analysis was performed using jamovi software (Kas-sambara & Mundt, 2020; R Core Team, 2021; Seol, 2020; The jamovi project, 2021). We deduced two main clusters for the LPC and three for the BQ, defining the technological groups.

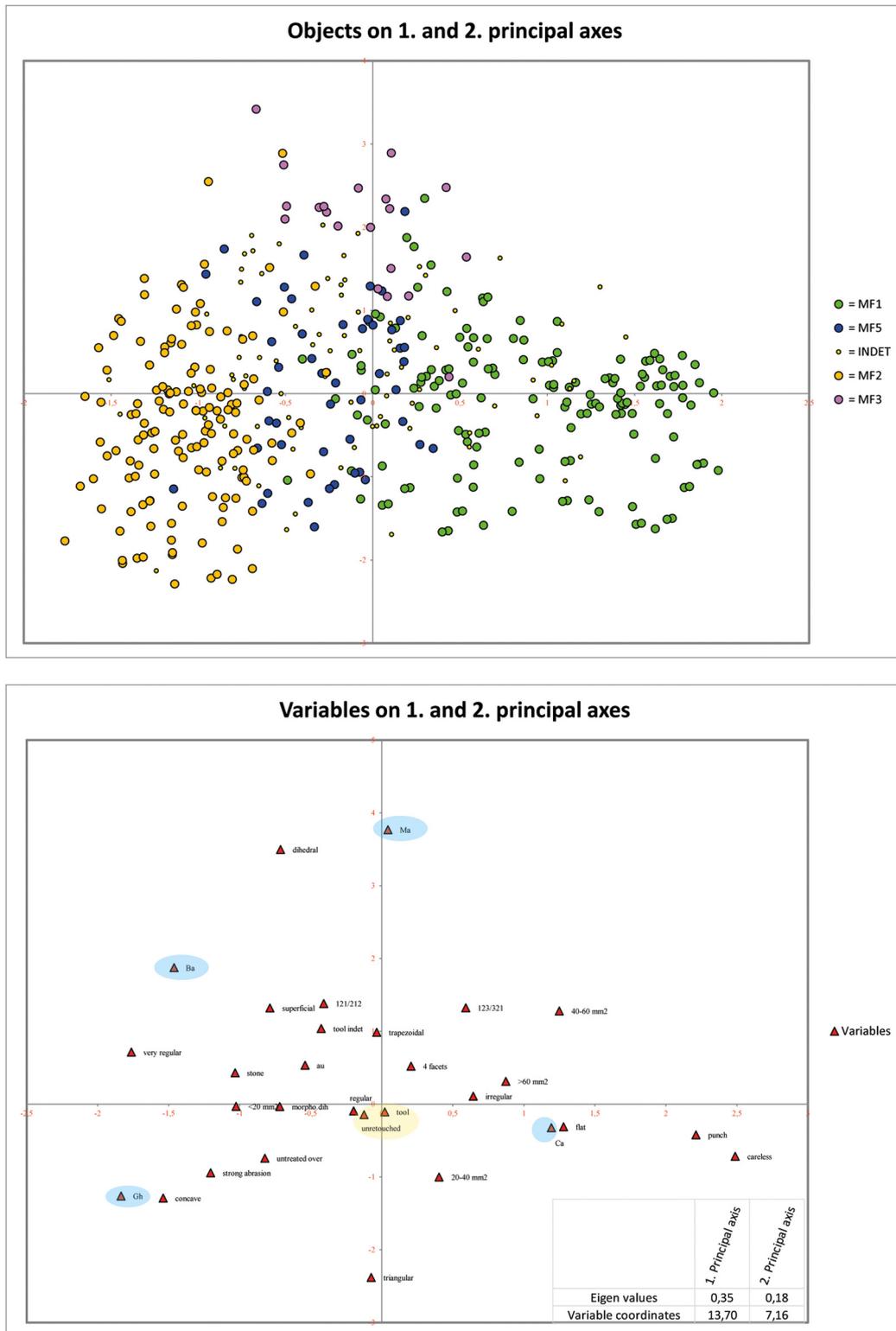
We can now discuss the four limitations mentioned previously.

- (i) The production context is here domestic and comparable between the different data.
- (ii) Intrinsic constraints of the raw material are linked to morphology, size or quality of the blocks. Morphology and size can have an important impact on the shaping of the blocks, but basically, they have not impacted the full development of blades debitage. Quality is the most important limiting factor. In Vaux-et-Borset, four sources of raw materials have been used (Table 1). Two can be considered as local or regional: the Campanian flint and the Maastrichtian flint (“grenu” flint) (e.g. Allard, 2005). On the BQ site, two exogeneous raw materials have so far been identified: the Ghlin flint originating from the Mons Basin at 100 km distance (Collin, 2019; Leblois, 2000) and the Bartonian flint from the Paris Basin (Allard, Bostyn, & Fabre, 2005; Blanchet, Plateaux, & Pommepuy, 1989), 200–250 km from the site. The exogeneous raw material can be of very high quality, but generally, the clastic properties of these different flints are quite comparable and wouldn’t require any specific technical gestures, for example in the preparation of the platforms. In the western cluster, almost the same raw materials are used, but circulation networks are reversed. An important change of the raw material spectrum can be underlined for the eastern cluster as its procurement is mostly from the Aachen/Maastricht outcrops area (Grooth, 2011), which is closest to the sites. Rullen, Rijckholt or unspecified Lanaye flints are also of comparable quality, especially for the blocks selected to produce blades. The distribution of variables on the first two axes of the correspondence analysis conducted on the dataset of Vaux-et-Borset (Figure 2) demonstrates that the LPC technical criterion linked to the preparation of the debitage (horizontal axis) is entirely independent of the local raw materials that are largely dominant (more than 90%). On the contrary, the BQ distribution (Figure 3) of all the technological variables taken into account seems more related to the raw material. So, here the variation of treatment

<sup>3</sup> The acronym MF is linked to the French *Manière de Faire* – i.e. procedure.



**Figure 2:** Correspondence analysis made on LPC data from Vaux-et-Borset settlement to verify, whether the structure of empirically defined MF1 and MF4 technological groups is relevant. The different variables selected are related to the raw materials (Campanian-Ca, Maastrichtian-Ma, Ghlin-Gh, Bartonian-Ba, Others-Au), the butts (flat, concave, morphologically dihedral, dihedral), the overhang preparation (untreated, superficial abrasion, strong abrasion, careless preparation), the tool used to prepare overhang (stone tool, punch, indeterminate), the section of the blades (triangular, trapezoidal, 4 facets), the operative codes (123/321 *versus* 212'/121'), the regularity of the blades (very regular, regular, irregular), the dimensions of the butt (inferior 20 mm<sup>2</sup>; between 20 and 40 mm<sup>2</sup>; between 40 and 60 mm<sup>2</sup>; more than 60 mm<sup>2</sup>) and if the blades are tools or not (unretouched).



**Figure 3:** Correspondence analysis made on Blicquy data from Vaux-et-Borset settlement to verify whether the structure of empirically defined MF1, MF2, MF3 and MF5 technological groups is relevant. See descriptive variables in the caption of Figure 2.

of raw material is related to chronology, and the same raw material – i.e. Maastrichtian flint – can be knapped in a very different manner between LPC and BQ. The technical criteria identified as relevant to distinguish between different groups are not really related to the quality of the raw material.

- (iii) Functional constraints are related to the morpho-dimensional nature of the blanks selected to be modified as a tool. Table 2 presents the different kinds of tools identified in the contexts under study. The LPC and German post-LPC toolkit are quite comparable: scrapers, retouched blades, sickles, truncated pieces and drillers dominate. The main difference observed is the massive appearance of burins in BQ contexts. Blades selected to make burins are in similar numbers in both local and exogeneous raw materials (Denis & Burnez-Lanotte, 2020). Furthermore, the characteristics of the burin's blanks are unspecified when compared to other tools: dimensions or sections are the same (Table 3). The correspondence analysis confirms that the criteria that define the technical groups are independent of functional constraints. For BQ (Figure 3), both variables tool/unretouched have no weight in the distribution. For the LPC (Figure 2), both variables are close to intersections of axes but are drawn by data related to the vertical axis, which is driven by the blades section variables. This is explained by the knapper goal, which is to produce blades with regular trapezoidal section (e.g. Allard, 2005; Denis, 2017), and as we can see on the plot and in Table 3, triangular blades are fewer in number and less prominent in the toolkit. The criteria selected to highlight different technical groups are “subtle” as they are barely visible and have no impact on the final product itself and are not in response to any functional constraints.
- (iv) The evaluation of different motor skills requires an assessment of the level of knapper skills. The production of tool blanks in Linear Pottery culture and Blicquian Early Neolithic sites falls within

**Table 2:** Toolkit identified on the studied blades from the three clusters

In % nb	Western cluster (Ath)		Hesbaye (Vaux)		Eastern cluster	Total
	LPC	BQ	LPC	BQ	Post-LPC	
Retouched	20	23	32	40	34	33
Scraper	48	17	34	9	22	24
Burin	2	30	0	16	0	8
Sickle	7	6	11	4	10	7
Truncated	5	6	6	8	5	6
Driller	4	5	6	4	8	5
Double/multiple	2	3	1	3	5	3
Arrowhead	3	—	2	4	1	3
Splinter piece	3	—	2	2	2	2
Other	1	5	1	2	4	2
Fragments	7	5	7	8	8	7
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>
Without modification	15	42	29	32	22	28
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

Pieces indicated without modifications are blades that could have been used without any modifications of the blanks. They have some small unintentional retouches or shiny parts. A use-wear analysis is required to confirm their attribution or not to the toolkit.

**Table 3:** Dimensions and characteristics of the section of the blanks selected to make burins and other kind of tools

BQ	Burins	Other tools
Average width (mm)	19.6	19.3
Average thin (mm)	5.8	5.4
Triangular section (nb/% nb)	21 namely 27%	114 namely 28.5%
Trapezoidal section (nb/% nb)	49 namely 63%	243 namely 61%
4 Facets and more (nb/% nb)	8 namely 10%	43 namely 10.5%

the same technical environment (e.g. Allard, 2005; Allard & Bostyn, 2006). The objectives of the blade production focus on the creation of small blades with a trapezoidal cross-section, measuring at most 10 cm in length, 18–20 mm in width and 4–6 mm in thickness. During the BQ/VSG culture, long blade production appears (Bostyn, 1994) and is linked to specialized producers with a very high level of know-how (Bostyn, 1994, 1997; Denis, 2017), but the production of such blades didn't happen locally (Denis, 2019) as it is specific to the Paris Basin. Furthermore, the different groups are individualised as to specific gestures and tools. This variability is not related to the main criteria, which are combined to assess the level of knappers skill (Klaric, 2018): (i) *general cognitive criteria*; (ii) *strategic cognitive criteria*; (iii) *universal motor-skill criteria*, and (iv) *general productivity and quality criteria*. One set of criteria can be discussed further, the *tactical cognitive criteria*. Here, the degree of care and precision invested in preparing removals or certain key surfaces can be indeed different between the groups. But as the knappers did not use the same tool, we think we have to observe this level of detail within the same gestures/tools pool of data and not between different pools. Within our groups, there are some variations related to idiosyncratic manifestation of individual knappers, which could be related to the level of skill (Allard & Denis, in preparation).

Therefore, the technical variability that we observe of blades' discrete characters can also be supported by a deep analysis of the whole *chaîne opératoire*, especially when refittings are possible. But many of the archaeological contexts do not offer the possibility of conducting such studies. We support the idea that an accurate technological study of blades, which are of course the products of knappers, can provide relevant data on the existence of different technical groups. We can interpret the existence of these technical groups as a reflection of different ways of doing things, the acquisition of which is linked to apprenticeship (e.g. Pelegrin, 1985). The transmission between generations lead to the definition of technical traditions, which reflect group identity.

### 3 Results: Diversity of Technical Groups

#### 3.1 The Hesbaye: Five Technical Groups in Vaux-et-Borset

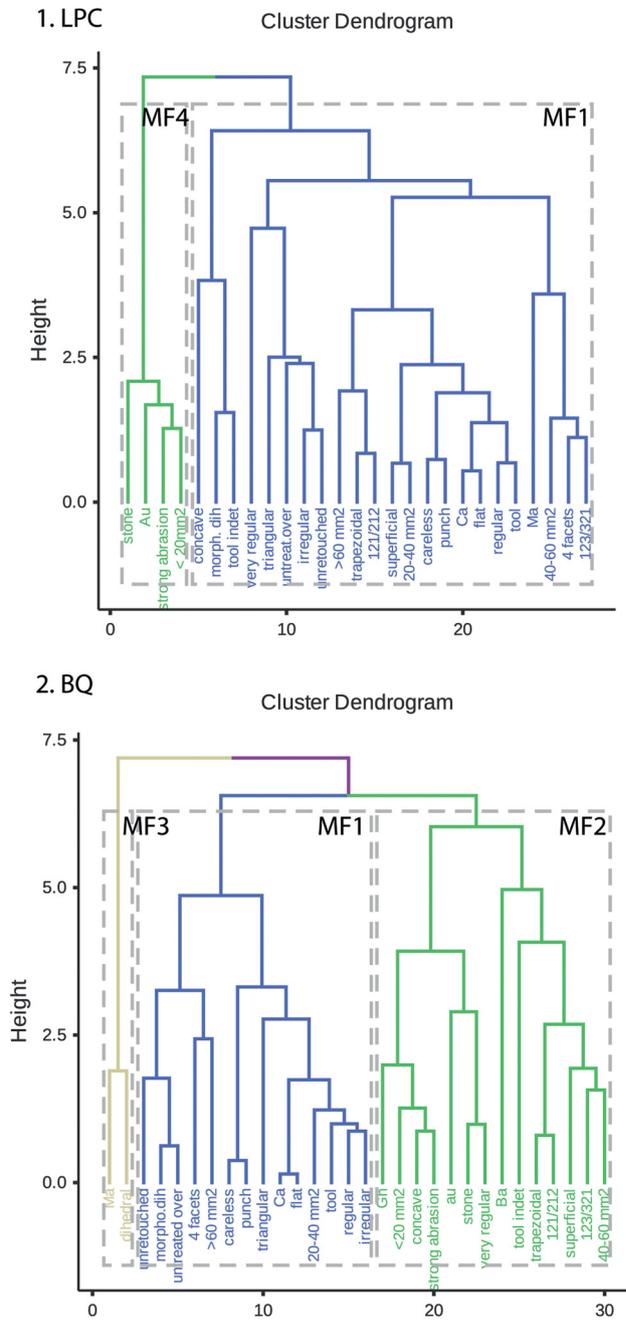
The blade production of the site of Vaux-et-Borset has been the subject of a detailed study (Denis & Burnez-Lanotte, 2020), supported here by the cluster analysis that gives more credit to the discrete distinction previously made on LPC artefacts (Figure 4, no. 1). The LPC is thus characterized by two technical groups: MF1 is dominant over MF4. In the Blicquian sector, four modes of production coexisted (Table 4) and three are visible on the cluster analysis (Figure 4, no. 2):

- three are identified through local materials (MF1, 3 and 5)
- the fourth is identified through exogenous materials (MF2).

A strong correlation has been found between the absence of treatment of the striking platform and the use of a punch for the preparation of overhangs, a criterion on which the identification of MF1 is based (Figure 5, nos. 1–5). Butts are wide and thick. It seems that there is no clear bias towards regular trapezoidal section blades, and they are of low regularity.

The second mode (MF2) is defined by the removal of small flakes on the striking platform, which is intended to create concavities, where knappers put their punch (Figure 5, nos. 6–9). Furthermore, they change their tool to prepare the overhangs, using at this point a stone tool. Butts are very small, so blades are more regular and knappers are clearly looking for regular trapezoidal section blades.

A third mode (MF3), only observed on flint blades made from Maastrichtian flint, also attests to the work of knappers who created small flakes from the striking platforms. However, the main aim here was to create dihedrals (Figure 5, no. 14), which helped to position the punch. Blades are very regular with a trapezoidal section shape clearly sought.



**Figure 4:** Cluster analysis made on the values of cumulative percentages explaining the position of individual variables on the five axes of the correspondence analysis to understand the relationship of variables within the LPC dataset (no. 1) and the Blicquy dataset (no. 2). The main technical groups are well identified within the structures. See descriptive variables in the caption of Figure 2.

MF4 is distinguished from MF1 by the use of a stone tool to prepare the overhang and the care put into the preparation conducted to obtain the smaller butt. The cluster analysis reinforces the clear individuation of this group that we were interpreted as purely anecdotal phenomenon (details in Denis & Burnez-Lanotte, 2020, p. 40). It seems that this group is mostly related to non-localized raw materials.

Finally, the last mode (MF5) was identified on a small number of BQ blades made from Campanian Hesbaye flint. The modalities of the treatment of the striking platforms are ambiguous. Smooth, flat butts predominate, but the proportion of blades with smooth, concave butts, which are morphologically or technically dihedral, are markedly higher than for the first mode (MF1). This suggests perhaps either the co-existence of different modalities, or a somewhat poorer mastery or a reinterpretation of the procedures

**Table 4:** Technical characteristics of the different “ways of doing things” identified on the BQ/VSG site of Vaux-et-Borset (Hesbaye, Belgium)

Vaux-et-Borset_BQ	MF1	MF5	MF2	MF3
Raw material	Campanian	Campanian	Ghlin/Bart.	Maastrich.
Overhang preparation	Punch	Stone	Stone	Indet.
Butts dimensions (mm <sup>2</sup> )	30–40	10–20	10–20	25–35
Type of butts	Flat	Flat	Concave	Dihedral
Striking platform	Flat	Indet.	Facetted	Facetted
% of trapezoidal blades	60	50	65	80
% of 212' Codes	45	70	80	60
Regularity	+	+++	+++	+++
nb of pieces	173	53	118	23

for creating facets, or rejuvenation of partial tablets and not entire tablets. The preparation of their overhangs is carried out using a stone tool. Furthermore, the blades are considerably more regular, which goes hand in hand with much smaller butts than those observed for MF1. Finally, another criterion is also used to encourage the reflection on the technical variability of these productions, the operative codes (Binder, 1984, 1991). These operative codes reflect the order of the previous removals on the upper side of blades. The blades of code 123/321 indicate a knapping sequence, which sees the successive withdrawal of a blade after the one adjacent to it. Code 212' blades indicate the knapping of the central blade before the two blades on either side. These codes make it possible to specify the arrangement of the debitage (Pelegrin in Astruc, Gratuze, Pelegrin, & Akkermans, 2007; Binder & Gassin, 1988). Code 212' ensures the production of blades with a regular trapezoidal cross-section. For this purpose, the knappers must use a recurring formula in the succession and position of the debitage of the blades (specific arrangement), which allows for many blades with a regular trapezoidal cross-section. Here, the examination of the operative codes indicates that the MF5 knappers were familiar with and were capable of implementing schemes that were specific to the type of debitage required for this repeated production of regular blades with a trapezoidal section, as with the MF2 and MF3 modes. This is not the case for the knappers of the first group (MF1).

By extending our study geographically, we seek the origin and relationships between the different technical groups identified.

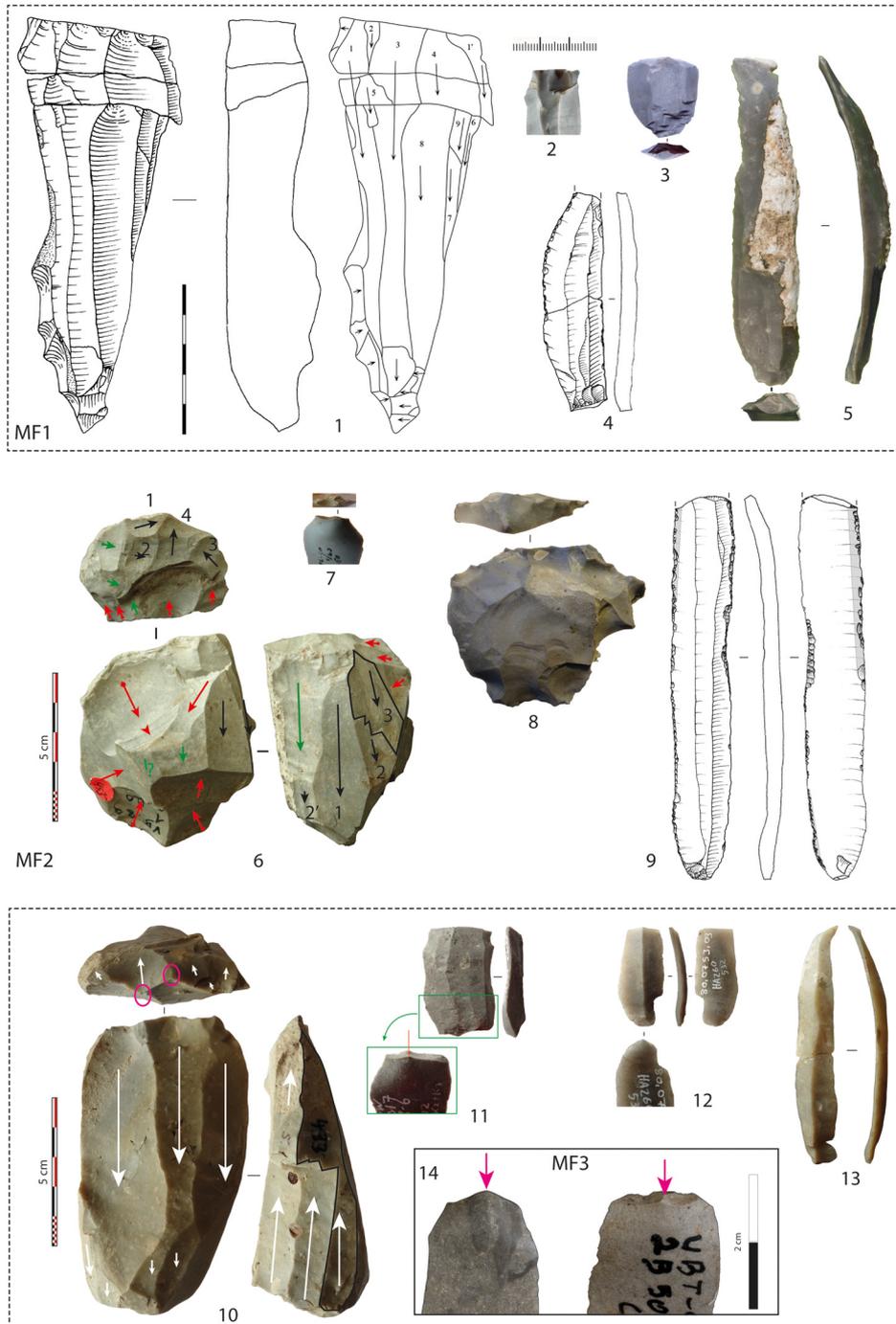
### 3.2 The Western Cluster: Three Technical Groups at Ath

The technical composition within the western cluster seems quite different. At the present state of our research, we identified three technical groups.

The LPC is represented by two technical groups. The first one corresponds to the MF1 already presented earlier (Table 5). This way of doing is mostly identified on raw material from Hesbaye region (i.e. Campanian and Maastrichtian flints from Hesbaye), but few pieces on regional flint from Hainaut, especially Ghlin flint ( $n = 5$ ), have also been treated by the same mode (Figure 5, no. 3).

At least, a second technical group can also be highlighted (MF7; Table 6). Careful preparation of overhang is made by a stone tool as the smaller dimensions of the butts seem to testify. Blades are slightly more regular than MF1. The platform of the cores is mostly flat, but there is an important difference in proportion of flat butts between MF1 and this technical group: only 60% of blades compared to the 92% of the MF1 (or 80% in Vaux-et-Borset). In counterpart, concave and morphologically dihedral butts are more frequent. It could indicate that the rejuvenation of the platforms is less often made by huge complete tablet but more often by partial tablets. These characteristics are so in between MF4 and 5.

On the BQ village of Ath, only one technical group can be identified, and its characteristics are in line with MF2 (Table 7). The raw material exploited is preferentially the Ghlin flint. Tertiary Bartonian flint from the Paris Basin presents similar characteristics.



**Figure 5:** Illustrations of the technical characteristics of the three most important technical groups identified. MF1 (nos. 1–5); MF2 (nos. 6–9); MF3 (nos. 10–13). 1: Core in Campanian flint from Hesbaye, Verlainne settlement, structure 01 (collection E. Vanderhoeft), drawing and diacritical sketch from Allard, 2005, pl. 95. 2: Flat butt of a blade in Campanian flint, Vaux-et-Borset, BQ, © *Unamur/Savê-dva*. We can see a little negative from the careless preparation of overhang made by punch. 3: Blade in Ghlin flint, Ath “les Haleurs,” LPC, AWaP, Operational Directorate West Zone. Flat butt and careless preparation by punch. 4 and 5: Entire blade in Campanian flint from Vaux-et-Borset, LPC (no. 5, *DTP/CAD: C. Swijsen*) and BQ (no. 4). Blades are not very regular, huge butt, careless preparation. 6: Core in Ghlin flint, Vaux-et-Borset, BQ. We can see in black the special faceting of platform, also visible on the tablet no. 8, Ghlin flint, Ath “les Haleurs,” BQ, AWaP, Operational Directorate West Zone. It can produce blades with concave butts or morphologically dihedral butts as no. 7, Ghlin flint, Vaux-et-Borset, BQ or no. 9, Bartonian flint, Hainaut region, Ellignies-Sainte-Anne, according to Denis, 2017. Blades are very regular, and butts are small. 10: Core, Rullen flint, Müddersheim, Eastern cluster. Opposite debitage and faceted platforms. The facets are designated to place the punch. The small blades (no. 13, Rullen flint, Hambach 260) have so often dihedral butts (no. 11, Rijckholt flint, Langweiler 12 and 12, Rullen flint, Hambach 260). This distinctive feature is also identified at Vaux-et-Borset on MF 3, no. 14, BQ, Maastrichtian flint.

**Table 5:** Summary indicating the descriptive technical criteria of the blades attributed to MF1, at Ath “les Haleurs,” LPC settlement

Site/Date	Ath_LPC_MF1					
Nb total	49 Proximal blades (42 in Hesbaye flints; 5 in Ghlin; 2 in unspecified Mons Basin)					
Overhang preparation	Punch		Without		Indeterminate	
nb and %	28	<b>57</b>	14	<b>29</b>	7 <b>14</b>	
Surface butt (mm <sup>2</sup> )	45.3		52.6		51.3	
Types butt	Flat	Concave		Morpho. dihedral	Dihedral	Others
nb and %	45	<b>92</b>	3	<b>6</b>	1	<b>2</b>
Section 2 facets			13			<b>29</b>
Section 3 facets			29			<b>64</b>
Section 4 facets			3			<b>7</b>
Total			45			<b>100</b>
Ope code 123/321			9			<b>39</b>
Ope code 212'/121			14			<b>61</b>
Total			23			<b>100</b>
Very and regular			28			<b>65</b>
Irregular			15			<b>35</b>
Total			43			<b>100</b>

The percentage is indicated in bold.

**Table 6:** Summary indicating the descriptive technical criteria of the blades attributed to MF7, at Ath “les Haleurs,” LPC settlement

Site/Date	Ath_LPC_MF7					
Nb total	42 Proximal blades (14 in Hesbaye flints; 12 in Ghlin; 16 unspecified Mons Basin)					
Overhang preparation	Stone				Indeterminate	
nb and %	33	<b>79</b>		9	<b>21</b>	
Surface butt (mm <sup>2</sup> )			23.22			
Types butt	Flat	Concave		Morpho. dihedral	Dihedral	Others
nb and %	25	<b>60</b>	10	<b>24</b>	4	<b>10</b>
Section 2 facets			12			<b>33</b>
Section 3 facets			19			<b>53</b>
Section 4 facets			5			<b>14</b>
Total			36			<b>100</b>
Ope code 123/321			6			<b>40</b>
Ope code 212'/121			9			<b>60</b>
Total			15			<b>100</b>
Very and regular			28			<b>70</b>
Irregular			12			<b>30</b>
Total			40			<b>100</b>

The percentage is indicated in bold.

### 3.3 The Eastern Cluster: Specific Technical Characteristics in the German Rhineland post-LPC

The number of technical groups in the different assemblages of the eastern cluster remains difficult to assess due to the low number of blades, but we can exploit the data to highlight differences or proximity within the Hesbaye technical characteristics (Table 8).

**Table 7:** Summary indicating the descriptive technical criteria of the blades attributed to MF2, at Ath “les Haleurs,” BQ settlement

Site/Date	Ath_BQ_MF2									
Nb total	83 Proximal blades (48 Ghlin flint, 24 unspecified Mons Basin and 11 Bartonian flint)									
Overhang preparation	Stone			Without			Indeterminate			
nb and %	43	<b>52</b>	32	<b>39</b>	8	<b>10</b>				
Surface butt (mm <sup>2</sup> )	21.2			42.3			26.5			
Types butt	Flat		Concave		Morpho. dihedral		Dihedral		Others	
nb and %	21	<b>25.3</b>	23	<b>27.7</b>	25	<b>30.1</b>	3	<b>3.6</b>	11	<b>13.3</b>
Section 2 facets			21				<b>28</b>			
Section 3 facets			45				<b>60</b>			
Section 4 facets			9				<b>12</b>			
Total			75				<b>100</b>			
Ope code 123/321			8				<b>24</b>			
Ope code 212'/121			26				<b>76</b>			
Total			34				<b>100</b>			
Very and regular			61				<b>75</b>			
Irregular			20				<b>25</b>			
Total			81				<b>100</b>			

The percentage is indicated in bold.

Three elements can be underlined:

- (i) The preparation of blade overhangs with the punch technique, typical for MF1, is almost inexistent. On the 107 blades with a butt conserved and an overhang prepared, only five pieces could testify of the use of the punch.
- (ii) In contrast, faceted platforms dedicated to obtain dihedral to be used by the knappers for initiating the fracturing and the blade debitage are very well documented (Figure 5, nos. 10–13). On the 177 blades with a butt conserved, 22.6% of dihedral butts can be mentioned. Furthermore, this kind of preparation is very well documented on the cores, where the intentionality is obvious (Figure 5, no. 10). This kind of preparation was mentioned as typical for MF3 at Vaux-et-Borset. As MF3, blades with dihedral butts are more frequently trapezoidal blades. Cores related to this kind of preparation show something very particular, which were never documented in the Early Neolithic assemblages of Belgium nor Northern France: debitage is often rotating. Even if sometimes it seems that both platforms are exploited simultaneously, blades rarely present opposite negatives of removal. Only 3.7% of blades have been identified. This low number is still higher than Vaux-et-Borset, where LBK blades provide only 0.5% of blades with opposite negatives and the BQY blades a little bit more (0.9%).
- (iii) Finally, it seems that there is also a little component with some flat butts and overhangs prepared with a stone hammerstone. Butts are small, but blades are not very regular. Operative codes do not show any domination of 212' arrangements as the German blades as a whole.

## 4 Discussion

### 4.1 Origin of the Technical Variability in Vaux-et-Borset

On the BQ site of Vaux-et-Borset, a high technical diversity has been highlighted by the identification of four different technical groups. To better understand this diversity, we are looking at the origin of the different groups.

**Table 8:** Summary indicating the descriptive technical criteria of the blades according to the techno-morphology of their butts, all sites from the German Rhineland, eastern cluster

Post-LPC Rhine/butt	Flat butt								Dihe morpho								Dihedral							
	Stone	Punch	No	Indet	Stone	Punch	No	Indet	Stone	Punch	No	Indet	Stone	Punch	No	Indet								
Nb total	75								39								40							
Overhang preparation nb and %	12	16	4	5	30	40	29	39	3	8	1	3	23	59	12	31	11	28	0	0	10	25	19	48
Surface butt (mm <sup>2</sup> )	38.2								39								40.1							
Section 2 facets	26			<b>40</b>					10				<b>27.0</b>				7		19.4					
Section 3 facets	35			<b>53.8</b>					20				<b>54.1</b>				26		72.2					
Section 4 facets	4			<b>6.2</b>					7				<b>18.9</b>				3		8.3					
Total	65			<b>100</b>					37				<b>100</b>				36		<b>100</b>					
Ope code 123/321	14			<b>58</b>					7				<b>44</b>				11		52					
Ope code 212'/121	10			<b>42</b>					9				<b>56</b>				10		48					
Total	24			<b>100</b>					16				<b>100</b>				21		<b>100</b>					
Very and regular	41			<b>55</b>					26				<b>67</b>				26		<b>65</b>					
Irregular	34			<b>45</b>					13				<b>33</b>				14		<b>35</b>					
Total	75			<b>100</b>					39				<b>100</b>				40		<b>100</b>					

The percentage is indicated in bold.

The technical characteristics of BQ MF1 have been identified not only in the LPC village of Vaux-et-Borset but also within the Verlaine site (Allard, 2005) and other LPC sites in the Hesbaye region (e.g. Cahen, Caspar, & Otte, 1986). It is also dominant in the second BQ site of Hesbaye, namely Darion (Denis, 2017). We can therefore speak of a real local technical tradition (labelled tradition beta), which attests to continuity during the LPC/BQ transition. Furthermore, we highlighted that MF1 is also well represented at Ath, within the LPC context and mostly on blades made from Hesbaye flint. Criteria described in other LPC technological studies in the western cluster also suggest the presence of this MF1 (Allard, 2005; Deramaix, 1990). Thus, it seems that there is a difference within the extension territory of the beta tradition during the chronological sequence. During recent stages of the LPC, knappers from this tradition, originated from Hesbaye, moved toward Hainaut. But at the transition towards BQ/VSG, there is a reduction of the territory of this group of knappers toward Hesbaye.

The co-existence of MF4 in the LPC site of Vaux-et-Borset remains unclear as its technological characteristics could be compared to MF7 identified at Ath, mostly on local raw material. So, it could perhaps indicate a western influx of population at Vaux-et-Borset. But broader corpora need to be studied to search for this technical group within Hesbaye and even in LPC from German Rhineland where some of this technical criterion seems to be present in post-LPC contexts.

The technical characteristics of MF2, identified on exogeneous flints from BQ Vaux-et-Borset village, are typical of the blade production of West Belgium (Hainaut) (Denis, 2017). This has also been supported by the Ath study and is probably true of the Paris Basin too (Bostyn, 1997; Bostyn, Charraud, & Denis, 2019). It has been demonstrated that the presence of this technical tradition (labelled alpha) linked to exogeneous material in Vaux-et-Borset is the result of the mobility of a group between the Hainaut and the Hesbaye, including high-level knappers (Denis, 2014). In the state of our research, this technical tradition could also originate from the Linear Pottery culture, at least in the Paris Basin (Allard, 2005).

So, there is a clear opposing mobility pattern between LPC and post-LPC in Middle Belgium. During the LPC, dynamics linked to Neolithic colonization are oriented towards the West. During the BQ/VSG, these dynamics are reversed. But other relationships with neighbouring communities can be suggested.

Some technical characteristics of MF3 have indeed been pinpointed in German Rhineland assemblages through the identification of specific gestures which deliberately create a dihedral. Due to the fact that this technical particularity is more frequent at these West German sites, we would suggest that it points an East-West dynamic. The question also arises whether these technical particularities originate from the local LPC or not. Given the current data, it is difficult to assess this question. The presence of faceted preparation is mentioned during the earlier phase of the LPC (Balkowski, Classen, & Peters, 2016), but we cannot determine whether the faceting goal is the same. So, this question remains to be answered at some future point.

Finally, MF5 seems to share technical characteristics both from MF1 and MF2 (Table 4). We previously suggested that this could indicate that this way of doing reflects the syncretism of two technical traditions supported by the fact that knappers from both traditions met in Vaux-et-Borset (Denis & Burnez-Lanotte, 2020). It could also be the reason why we can't identify this group on the cluster analysis as its characteristics are at the crossroads of MF1 and MF2 as shown in Figure 3, where MF5 is so the closest to 0.

## 4.2 The Hesbaye Area: A Peripheral and Frontier Cluster

The research of technical particularities within blade production reveals in Vaux-et-Borset a diversity of BQ technical practices. Four different ways of doing things have been highlighted, distinguishing four technical groups. One (MF5) seems the result of the interaction between the knappers of two of the other groups (MF1 and MF2). So, we can suggest that the diversity of blade production is the result of the coexistence of three socio-technical groups individualized by their proper gestures and tools, inherited from apprenticeship. In addition, the previous study of the second BQ/VSG site of Darion has underlined that some blades present very peculiar technical preparation that has not been described here, which could be attributed to another way of doing (MF6) (Denis, 2017, p. 101). This reinforces the apparent high diversity of technical practices in this geographical area during the BQ/VSG culture where only two sites have been discovered. On the contrary, during the LPC, that region was very densely occupied (e.g. Jadin, 2003) and is characterized by a stronger technical homogeneity. The cultural transition is thus characterized by a diversification of the technical practices among knappers in East Belgium.

How can we explain this diversification? From the lithic perspective, the Hesbaye region located at the fringe of the BQ/VSG culture seems to have been inhabited by different socio-technical groups possessing strong ties between neighbouring regions, whatever their cultural affiliation. The status of the geographical area also seems to change within the framework of cultural transition. Located at the heart of high-density population area during the LPC culture, it becomes a peripheral area of the BQ/VSG culture, so a frontier zone between different groups. This frontier status could explain the coexistence here of different socio-technical groups, which do not seem to characterize the western part (i.e. Hainaut or Paris Basin) of the BQ/VSG (Denis, 2017; Bostyn et al., 2019). Testing a sociological model, a field study conducted on ceramic production has validated the model, suggesting that “interactions between groups living in close proximity and using different technological standards favours polarization given the ‘negative’ influence, namely the influence reinforcing differentiation rather than integration” (Roux et al., 2017, p. 321). We could here face a situation close to that where different communities live in the same area so interact regularly but reinforce their cultural affiliation through this polarization phenomenon.

The search for discrete criteria within blades production offers so original results that open new insights in the understanding of social interactions at the beginning of the Neolithic in North-Western Europe.

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