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Lithic armatures manufacture during the Late Glacial and the beginning of the Early Holocene between North-Eastern Italy and South-Western France: production methods and techniques

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Abstract

This Ph.D thesis focuses on manufacturing modalities of lithic armatures during the Late Glacial and the first part of the Early Holocene in two specific areas: North-Eastern Italy and South-Western France. Since the earliest studies between the end of 19th and the beginning of the 20th century, the typological variability of lithic armatures and other specific traits in lithic and osseous technology have allowed establishing a cultural separation between the Western-Atlantic and Mediterranean-Balkan regions after the Gravettian period. According to the latest studies the former is characterized by the Solutrean-Badegoulian-Magdalenian-Azilian-Laborian sequence, whereas the second one attests to the development of the Early and the Late Epigravettian. Both regions analysed are then characterized by evidence referring to the Sauveterrian.

The aim of this project was to contribute to the definition of the cultural framework in these two regions and to verify if this clear typological specificity corresponds to a difference in production modalities, especially on manufacturing methods and retouch techniques. To answer this question, armatures from six sites located in South-Western France and North-Eastern Italy have been analysed. For the Italian area we selected Late Epigravettian and Sauveterrian sites from Friuli and the Venetian Pre-Alps and Alps spanning from the latest part of the Oldest Dryas (GS-2a) to the beginning of the Early Holocene (17.000-10.000 cal BP). For the French area we choose two multi-layered sites covering approximately the same chronological span of the Italian ones and referred to the Upper Magdalenian, Early and Late Azilian and Early Laborian. Any Late Laborian and Sauveterrian French sites have been analysed.

Armatures were examined by applying a specifically designed methodology. This is based on two complementary approaches, an experimental and a technological one. Both were aimed at reconstructing the whole *chaîne opératoire* of armatures manufacture. Three main experimental sessions were carried out: the 1st experimentation was dedicated to the investigation of retouch techniques, the 2nd one was aimed at examining the microburin blow technique and the 3rd was focused on other fracturing techniques effective to achieve a controlled fracture. The experimental sample was then analysed by combining a low and high magnifications analysis and a quantitative approach creating a new protocol for the study of lithic backed armatures. Such a combined approach is often used in use-wear analysis but has rarely been applied to the production of lithic artefacts.

Applying this type of analysis at a large scale allowed observing the variability of Late Glacial armatures in a new light. Despite the considerable morpho-functional divergences among armatures from the two territories analysed, common transformations concerning blanks selection and both retouch methods and techniques were recorded. Although the reason to such a trend can be research into the similar environmental transformations occurred in both areas along the Late Glacial and the beginning of the Early Holocene which may similarly affect different human groups, the occurrence of analogous technical practise over a large territory suggests the presence of important social networks linking Eastern and Western societies across time.

Riassunto

Questa tesi di dottorato analizza le modalità di fabbricazione delle armature litiche durante il Tardoglaciale e l'inizio del primo Olocene in due aree specifiche: l'Italia nord-orientale e la Francia sud-occidentale. Fin dai primi studi della fine del XIX e l'inizio del XX secolo, la variabilità tipologica delle armature litiche dopo il Gravettiano ha permesso di stabilire una divisione culturale tra le regioni atlantico-occidentali e quelle mediterraneo-balcaniche. La prima ha visto il susseguirsi di diverse culture (Solutreano, Badegouliano, Maddaleniano, Aziliano e Laboriano), mentre la seconda è caratterizzata da una maggiore continuità culturale che ha portato allo sviluppo dell'Epigravettiano antico e recente. All'inizio dell'Olocene entrambe le aree studiate presentano evidenze riferibili al Sauveterriano.

L'obiettivo di questo progetto di ricerca è di contribuire alla definizione del quadro culturale di queste due regioni è di verificare se a questa chiara diversità morfo-tipologica corrisponde una differenza nelle modalità di produzione e in particolare nella selezione dei supporti e nei metodi e nelle tecniche di ritocco. Per raggiungere questo obiettivo sono state analizzate le armature di due siti della Francia sud-occidentale e di quattro dell'Italia nord-orientale. Per l'area italiana sono stati selezionati siti dell'Epigravettiano recente e del Sauveterriano localizzati in Friuli e nelle Prealpi e Alpi venete datati tra la fine del Dryas antico (GS-2a) e l'inizio dell'Olocene (17.000-10.000 cal BP). Per quanto riguarda l'area francese, invece, abbiamo scelto due siti pluristratificati che coprono approssimativamente lo stesso arco cronologico di quelli italiani e si riferiscono al Magdaleniano superiore, all'Aziliano antico e recente e al Laboriano antico. Non è stato possibile analizzare armature riferibili al Laboriano recente e al Sauveterriano francese.

Le armature sono state studiate tramite una metodologia appositamente elaborata. Quest'ultima si basa su due approcci complementari, uno sperimentale e uno tecnologico. Entrambi mirano a ricostruire l'insieme delle catene operative che portano alla produzione delle armature. Sono state realizzate tre principali sessioni sperimentali: la prima dedicata alle tecniche di ritocco, la seconda alla tecnica del microbulino e la terza all'identificazione di altre tecniche utili ad ottenere una fratturazione controllata del supporto. In seguito, il campione sperimentale è stato esaminato combinando un'analisi a basso e alto ingrandimento e un analisi quantitativa. Si è quindi elaborato un approccio integrato spesso utilizzato nell'ambito dell'analisi funzionale, ma raramente applicato per la ricostruzione delle modalità di fabbricazione di strumenti litici.

L'applicazione di questa metodologia ha permesso di osservare la variabilità delle armature sotto una nuova luce. I risultati delle analisi effettuate indicano che nonostante le notevoli differenze da un punto di vista morfo-funzionale tra le armature delle due aree prese in esame, molteplici sono i punti in comune. Questi riguardano soprattutto le modalità di selezione dei supporti, i metodi e le tecniche di ritocco, che in diversi periodi del Tardoglaciale sembrano se-

guire un evoluzione simile. Sebbene i motivi di queste affinità tecnologiche potrebbero essere ricondotti alle dinamiche climatico-ambientali che colpiscono entrambe le regioni durante il Tardoglaciale e l'inizio dell'Olocene, la presenza degli stessi comportamenti tecnici su ampia scala non può che essere il risultato di un'importante rete di connessioni tra i gruppi umani delle regioni atlantico-occidentali e quelle mediterraneo-balcaniche.

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Summary

Preface

Aim of the study

This Ph.D thesis focuses on manufacturing modalities of lithic armatures during the Late Glacial and the first part of the Early Holocene in two specific areas: North-Eastern Italy and South-Western France. Due to their high typological variability through time and space this tool category has been widely used as one of the main *fossiles directeurs* to identify specific cultural traditions of the Upper Palaeolithic and Mesolithic. This variability, along with other specific features (i.e. typology of hard animal tissue items and artistic expressions), allowed to highlight a cultural separation between the Western-Atlantic and the Mediterranean-Balcanic regions after the Gravettian (Breuil, 1913). The former is characterized by the Solutrean-Badegoulian-Magdalenian-Azilian-Laborian sequence (Langlais et al., 2014a; Langlais et al., 2014b; Naudinot et al., 2019), whereas the second one attests the development of the Early and the Late Epigravettian (Broglio and Improta 1995; Fontana et al., 2020; Martini, 2007). Both areas are then characterized by evidence referring to the Sauveterrian in the Early Mesolithic (Barbaza and Valdeyron, 1991; Valdeyron, 1994; Visentin, 2018).

The aim of this project is to contribute to the definition of the cultural framework in these two regions by applying a wider technological approach, focusing on manufacturing methods (starting from blanks selection) and retouch techniques applied and, more generally, in the way of conceiving projectile weapons during this crucial time span. Such analysis allowed us to better understand specific technical and socio-cultural traditions, trying to emphasise variations and/or continuity into each chrono-cultural sequence and possible common trends between the two analysed territories, during a period marked by significant climatic and environmental changes. In fact, despite the considerable development of technological studies applied to lithic assemblages (Tixier et al., 1980; Boëda, 1986, 1994; Inizan et al., 1999, Arzarello et al., 2011), armatures are rarely integrated in the process of reconstruction of the *chaînes opératoires* and a shared methodology suitable for their analysis is still missing. For this reason we developed a methodology based on two complementary approaches: an experimental and a technological one, aimed at reconstructing the whole chaîne opératoire of armatures production. Retouch techniques were examined by combining qualitative (including analysis at low and high magnifications) and quantitative approaches.

Structure of the thesis

This work is divided into 3 Parts, each of which is sub-divided into different Chapters. Part 1 is introductory and aimed at presenting the geographical, paleoenvironmental and chrono-cultural setting of the analysed regions (Chapter 1 and 2). A greater focus is dedicated to lithic artifacts and in particular to objectives, reduction schemes and armatures variability in each cultural tradition dated between the end of the GS-2 and the Early Holocene in Northern Italy and Southern France. In Chapter 3 the main approaches developed for the analysis of lithic armatures are presented along with the methodology and the three experimental sessions carried out.   Part 2 is dedicated to the analysis of the archaeological series. It was developed trying to maintain a similar structure according to evidence of each site. In Part 3 a synthesis of results obtained for each site is illustrated by comparing them with available bibliographic references. Then an attempt of comparison between the Western Atlantic sequence and the Mediterranean one has been performed trying to interpret the nature of similarities and differences recorded.

Part 1 - General framework and methodology

Chapter 1 - Regional setting and paleoenvironmental data

1.1. Geographical and geological notes

2.1.1. South-Western France

The South-Western France is divided a into two large regions: the Nouvelle-Aquitaine and the Occitanie (Fig.1.1) This area includes in its mid part the entire Garonne and Dordogne drainage basin (i.e. Aquitaine Basin), the “Sands of the Landes” to the west, the northern side of the Pyrenees to the south, and the Massif Central up to the Rhone valley to the east.

The Pyrenees (Fig.1.2) stretches 450 km from the Mediterranean Sea to the Atlantic Ocean creating a natural border between France and Spain. It was formed during the Late Cretaceous and Eocene as the result of the north-south Alpine compression, reaching the highest altitude in its central portion (approximately 3.400 m a.s.l.). The slopes are extremely asymmetric: the north side descends abruptly, whereas the southern side is larger and less steep. This morphological divergence also corresponds to different environmental conditions. The northern slope is more humid and linked to an Atlantic climate, whereas the southern one is drier and arid due to the Mediterranean influence. The medium-high altitude mountains (also known as Axial Zone) are formed by crystalline rocks dating back to the Palaeozoic (Zwart, 1979). As far as the northern slope is concerned, chert outcrops are found in the Tertiary/Cretaceous sedimentary formations of the Pre-Pyrenees and in the flysch deposits located to the west. They are well known to be of low knapping quality and often available as small blocks (Fat-Cheung, 2015; Lacombe, 2005; Simonnet, 2007, 2003, 1999).

The Aquitaine Basin (Fig.1.2) is a large sedimentary basin propagating in the area between the Pyrenees, the Massif Central and the Atlantic Ocean. The Strait of Poitou (northeast of Bordeaux) connects the Aquitaine basin to the Paris basin. At the centre of the plain runs the Garonne River along a south-east/north-west axis with its numerous tributaries flowing down from the Pyrenees and the Massif Central. In the northern part of the basin the Dordogne River runs from east to west. Both the Dordogne and the Garonne flow into the Atlantic Ocean. From a geological viewpoint this area comprises a more or less regular sequence of sedimentary formations (Simon-Coinçon et al., 1997). A limestone borderland located north-west, corresponding to the ancient calcareous platforms of the Cretaceous (Charentes and Perigord) and Jurassic (Poitou, Quercy and Grand Causses), divides the Aquitania Basin from the heart of the Massif Central. These formations are extremely rich in good quality flint nodules (Turq et al., 2017). Rivers and streams originating in the Massif Central cut these plateaus forming deep canyons and gorges.

The Massif Central (Fig.1.2) is a mountain range characterized by an extremely asymmetric profile partly affected by the Alpine orogeny during the Paleogene. The south-eastern sector (Cévennes) reaches higher altitudes, while the north-west one is less elevated (Limousin). Its central part is mainly composed of granitic and metamorphic rocks (Simon-Coinçon et al., 1997).

1.1.2. North-Eastern Italy

Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia and Emilia-Romagna are the regions comprising North-Eastern Italy (Fig.1.1). This area includes the coast of the Adriatic Sea, both high and medium altitude mountains and the plain. The northern portion is occupied by the Eastern Alps (Fig.1.2) encompassing, from west to east, the Dolomites, the Carnic Alps and the Julian Alps. From a geological viewpoint, rock outcropping spans in age from the Permian to the entire Mesozoic. They are sedimentary formations interbedded with volcanic layers. The orogenesis of the Alps took place between the Cretaceous and the Miocene, although some secondary processes are still in place.

The Pre-Alps (Fig.1.2) sets a boundary between the high Alpine and the plain. This zone includes Mesozoic and Cenozoic sedimentary rocks, such as limestones, sandstones and pelitic rocks. The Cretaceous formations, especially the Maiolica, Scaglia Variegata and Scaglia Rossa, are the richest in flacking cherts. Several middle altitude mountains groups develop along a west-east axis: the Lessini mountains, the Asiago Plateau (Plateau dei Sette Comuni), the Monte Grappa, Belluno Pre-Alps (including the Cansiglio Plateau), Carnic Pre-Alps, Julian Pre-Alps and the Karst.

The northern part of the plain can be divided between two main areas: the Po plain crossed by the Po River (the longest river in Italy) which runs west-east and flows into the Adriatic Sea and the Venetian-Friulian plain (Fig.1.2). This latter is formed by alluvial megafans and fans related to the activity of the main easternmost Alpine rivers during the Pleistocene (mostly during the LGM) (Fontana et al., 2010) flowing from north-west to south-east (e.g. Adige, Bacchiglione, Brenta, Piave, Livenza and Tagliamento) and from north-east to south (Isonzo). Two hill groups, the Berici and the Euganei, emerge in the middle of the Venetian plain (Fig.1.2). The former is composed of calcareous formations, whereas the second one has a volcanic origin. The Southern Po plain (Fig.1.2) extends between the Apennine foothills and the southern limit of the Po River. It consists of a belt of alluvial fans trending to the north towards the centre of the plain. Their formation is linked to the glacial periods of the Middle and Upper Pleistocene (Cremaschi and Nicosia, 2012).

Figure 1.1 - Political subdivision of Southern France and Northern Italy (from Visentin, 2017).

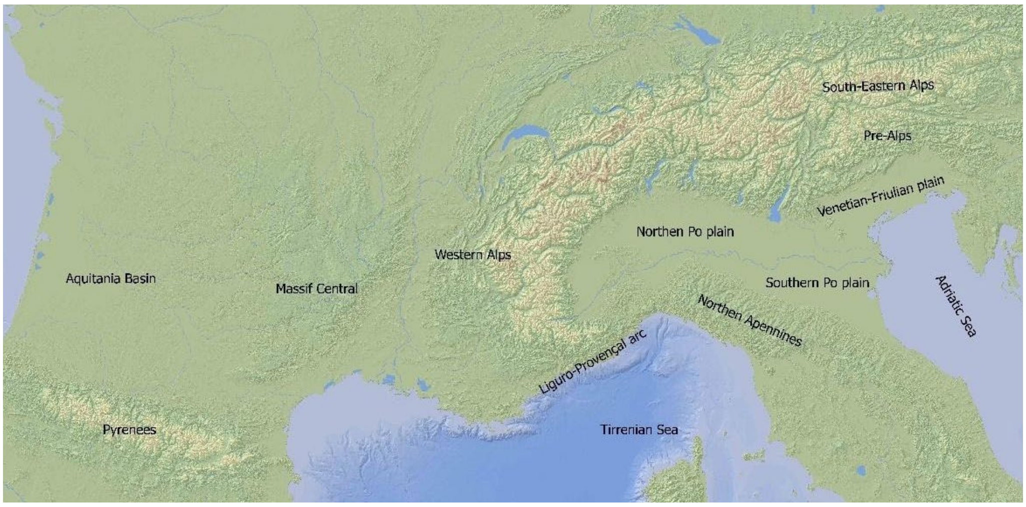


Figure 1.2 - Geography of South-Western France and North-Eastern Italy.

1.2. The chronostratigraphic context

1.2.1. The end of the Pleistocene

After the LGM, Europe has been characterized by significant climate oscillations well documented by the Greenland ice and marine cores and the continental records (Elliot et al., 2002; Rasmussen et al., 2014, 2007, 2006; Svensson et al., 2006). Thanks to the work of synchronisation of these paleoenvironmental data by INTIMATE group an extremely detailed chronology for the Late Glacial and the Holocene has been established (Blockley et al., 2012).

Based on the variations of δ18 O in the Greenland ice cores the last 120,000 years were subdivided into Greenland Stadials (GS) and Greenland Interstadials (GI) (Rasmussen et al., 2014). The last part of the Pleistocene examined in this dissertation corresponds to the second part of GS-2 (GS-2.1a), GI-1 and GS-1 (Fig.1.3):

- The **GS-2** corresponds to a cold period. Its final phase was characterized by Henrich stadial 1 (HS1) which is dated between 18000 and 15600 cal BP (according to Sanchez

Goñi and Harrison, 2010). HS1 corresponds to massive iceberg discharges into the North Atlantic Ocean provoking a sea-surface cooling and a significant impact in the terrestrial climate (Naughton et al., 2009).

- The **GI-1** is a mild climate phase dated between 14692±4 and 12896±4 cal BP and interrupted by a brief colder episode. It was subdivided into five sub-events, from ‘a’ to ‘e’ according to the oscillations of δ 18 O values (Björck et al., 1998).
- The **GS-1** represents a brief and abrupt cold phase dated between 12896±4 cal BP and the beginning of the Early Holocene (11703±4 cal BP). Its origin was largely discussed and numerous forcing factors have been proposed (MacLeod et al., 2011). At present most studies agree to relate this phenomenon to a either slowing down or cessation of the North Atlantic thermohaline circulation (THC) related to the emission of freshwater from ice sheets into the North Atlantic Ocean (Clark et al., 2002, 2001). Other causes have been also suggested (e.g., Firestone et al., 2007; Renssen et al., 2000).

Another widely employed nomenclature used for dividing the final Pleistocene is the sequence Oldest Dryas, Bølling, Older Dryas, Allerød and Younger Dryas. These episodes originally corresponded to biostratigraphic changes in pollen records of Denmark (Iversen, 1954; Jessen, 1935), Netherlands (Van Geel et al., 1989) and Northern German (Menke, 1968), but they have subsequently been applied also to other contexts with different meanings. Moreover, the chronostratigraphic position of the Oldest Dryas and Older Dryas chronozones was not unequivocal: different authors have used the same name to indicate different cold events (Ravazzi et al., 2007). Although S.O. Rasmussen and colleagues (2014) argued that these terms should be restricted to northern regions (*sensu* Mangerud et al., 1974), in the last years the Late Palaeolithic literature of Southern Europe associated the Bølling, Older Dryas and Allerød (i.e. Bølling-Allerød interstadial) to GI-1 and Younger Dryas to GS-1. The Oldest Dryas is generally used to indicate the last cold phase of the GS-2 (e.g., Langlais et al., 2014;

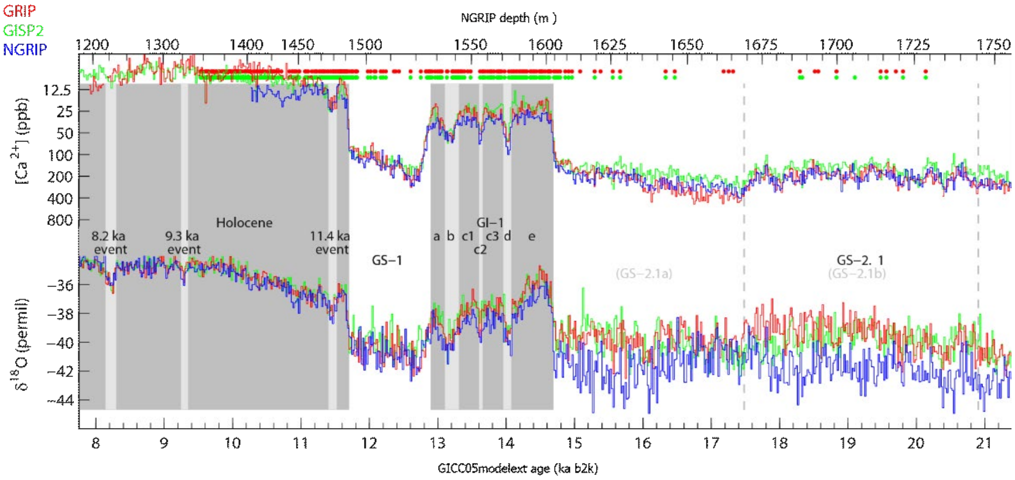


Figure 1.3 – Subdivision of the 21000 years cal BP according to average values of δ18O from GRIP (red), GISP2 (green), and NGRIP (blue) on the GICC05modelext time scale (from Rasmussen et al., 2014 modified).

Naudinot et al., 2019, 2017).

A terminological question that needs to be clarified concerns the term “Late Glacial”. Some Authors used this word to identify the entire period between the LGM and the beginning of the Holocene (e.g. Lambeck et al., 2011; Ravazzi et al. 2007), whereas others only the span of time comprising the GI-1 and the GS-1 (Cohen and Gibbard, 2019; Litt et al., 2001; N. Naudinot et al., 2019; Naudinot et al., 2017b). In these last cases the phase before the GI-1 is named Late Pleniglacial or Pleniglacial. Other Authors even used the Henrich event 1 (Oldest Dryas in continual records) as a limit between the Pleniglacial and Late Glacial (Langlais et al., 2014c). In this dissertation we followed the subdivision proposed for the Italian contexts by Ravazzi et al. (2007) in which the phase between the end of the LGM and the GI-1 is merely defined “the first part of the Late Glacial”, while the period between GI-1 and the beginning of the Holocene is termed “Late Glacial”.

1.2.2. The Early Holocene

The Holocene climate warming is recorded in all the Greenland ice cores and dated to 11703±99 cal BP (Rasmussen et al., 2014, 2006a). A formal subdivision of the Holocene was firstly based on palynologically-defined biozones (Mangerud et al., 1974) named Preboreal, Boreal, Atlantic, Subboreal and Subatlantic. However, time-division in vegetational response to climate change is applicable only at the local or at most at regional scale. Thus a formal subdivision in Early, Middle and Late Holocene has been recently proposed by Walker and colleagues (2014): Early–Middle Holocene boundary was placed at 8.2 ka BP (i.e. short-lived cooling event triggered by glacial meltwater outflow into the North Atlantic Sea), while Middle–Late Holocene at 4.2 ka BP (i.e. a mid- and low-latitude aridification event). It is important to highlight that the Early Holocene is characterized by four significant events according to $\delta^{18}O$ values: the Preboreal Oscillation, the 9.95 ka $\delta^{18}O$ anomaly, the 9.3 ka event and the 8.2 ka event (Rasmussen et al., 2007).

1.3. The paleoenvironmental framework

1.3.1. South-Western France

The high morphological variability of South-Western France reflects a diversity in the landscape and environmental history during the Late Glacial and the Early Holocene. In relation to the localisation of the French sites examined in this dissertation (i.e. Troubat and Pont d’Ambon), we will focus on two specific areas: the northern slope of the Pyrenees and the Aquitaine basin, with a major attention to Dordogne.

If the pollen records are abundant in the Northern slope of the Pyrenees since the early ‘90s (Andrieu et al., 1993; Aubert et al., 2004; Beaulieu et al., 1994; Jalut et al., 1998, 1992; Jalut and Turu, 2009; Reille and Andrieu, 1995), it is not the case for the Aquitaine Basin, where environmental data were previously provided only by archaeological deposits (e.g. Célérier, 1994; Leroi-Gourhan and Girard, 1979; Paquereau, 1979). Only recently eight pollen sequences from the Dronne and Caudeau Basins allowed to better characterize the flora adaptation to the climatic oscillations of the Late Glacial and the beginning of the Holocene in this area (Bertran et al., 2009; Leroyer, 2018, 2006).

1.3.1.1. GS-2 (first part of the Late Glacial)

As far as the Pyrenees are concerned, the front of the major glaciers reached its maximum extent before the onset of the LGM (Andrieu, 1987; Andrieu et al., 1988; Hérail and Jalut, 1986; Jalut, G. et al., 1988; Jalut et al., 1992; Mardonnes and Jalut, 1983) extending up to an altitude of around 400 m a.s.l. Thus, during the beginning of the first part of Late Glacial the high and middle altitude mountains were probably not available and still partially glaciated. The only exception regards the eastern Pyrenees (Delmas et al., 2008). The different stages of deglaciation process are still poorly defined (Aubert et al., 2004; Jalut and Turu, 2009; Reille and Andrieu, 1995), although some evidence suggests that glaciers were already confined into cirques in the final part of the GS-2 (Delmas et al., 2008). In the unglaciated territories the pollen record documents (Jalut and Turu, 2009) an open steppe environment dominated by light-demanding herbs, such as *Gramineae* and *Artemisia.* The arboreal component, represented by the *Pinus* and *Juniperus*, was poorly attested.

At the same time the Northern Aquitaine Basin was characterized by a similar open and steppe environment. Data are provided by "les Adrivaux" pollen sequence (Dronne Valley) (Leroyer, 2018). The landscape was dominated by herbaceous species, such as Poaceae and *Artemisia,* added to a wide range of steppe herbs. Among the ligneous species, which are extremely rare, *Salix*, *Pinus*, *Juniperus* and *Betula* are recorded.

This type of environment favoured the development of steppe ungulates, such as reindeer, saiga antelope, horse and bison. Ibex and chamois populated higher altitudes (Costamagno, 2001, 1999; Costamagno et al., 2009, 2008). The red deer is also well documented confirming the high adaptability of this species to open environments (Drucker et al., 2003; Drucker and Célérier, 2001).

1.3.1.2 The GI-1 (Bølling-Allerød Interstadial)

The important climate warming recorded by the Greenland ice core at the beginning of the GI-1 (Bølling biozone) slightly affects both the plain and mountains landscape. As regards the northern slope of the Pyrenees, this period coincides to a forest expansion with an increase of *Juniperus* and *Betula*, followed by *Salix* and *Hippophae rhamnoides* (Andrieu et al., 1993; Jalut and Turu, 2009; Penalba, 1989; Peyron et al., 2005; Reille and Andrieu, 1995). These heliophilous species associated with a decrease of steppe herbs indicate both an increase in temperature and rainfalls, although the vegetation remains fairly open both at low and middle altitude (Aubert et al., 2004; Jalut and Turu, 2009). The Allerød coincides with a further expansion of tree species configuring a mixed forest composed by *Pinus* and *Betula* (Aubert et al., 2004; Jalut and Turu, 2009). *Quereus ilex* pollens are regularly recorded but in low percentage. The treeline reached an upper limit of around 1700-1800 m a.s.l. (Andrieu et al., 1993).

In the Aquitaine Basin (Bertran et al., 2009; Leroyer, 2018, 2006) the pollen profile of "La Brunetière" at Pombonne (Caudeau Valley) reveals a significant increase of *Juniperus* at the onset of the Bølling-Allerød interstadial. However, tree pollens remain scarce, whereas steppic taxa are still largely dominant. The transition to the Allerød seems to have a minor impact in this region: despite the development of a forest dominated by *Pinus*, *Betula* and *Juniperus*, steppic taxa (e.g., *Artemisia*, *Gramineae)* are still well documented both in the pollen profiles of "Beauclair" (Dronne Valley) and "Bois des Penauds" (Buffebale Valley).

An open landscape during the Bølling is also confirmed by fauna assemblages dominated by steppe animals (except for red deer). Conversely, the onset of the Allerød attests to the expansion of woodland species other than red deer, such as wild boar and roe deer and a decrease of steppe ones (saiga antelope, horse and bison) (Costamagno et al., 2009, 2008). Moreover, reindeer populations did not persist in the South-Western France region beyond the Bølling (Langlais et al., 2012). High-medium altitude Pyrenees sites attest the exploitation of ibex and chamois (Fat-Cheung, 2015).

1.3.1.3. The GS-1 (Younger Dryas)

The cooling occurred during GS-1 is well recorded also by the continental pollen diagrams. In the Pyrenees, arboreal expansion stopped and the timberline fell to 1300 m a.s.l. (Andrieu et al., 1993). Herbaceous and steppic taxa (e.g. A*rtemisia*, *Chenopodiaceae* etc.) reappeared, but with modest percentages (Aubert et al., 2004; Jalut and Turu, 2009; Reille and Andrieu, 1995). The northern Aquitaine Basin shows a similar trend (Leroyer, 2018) with a decline in arboreal pollens (still dominated by *Pinus*, *Betula* and *Salix*) and an increase of *Artemiasia*, *Gramineae and* Cyperaceae. Unfortunately, the pollen sequence (Bois des Penauds) referred to this period does not cover the entire GS-1 and results remain partial. This drastic and rapid climate change partially influenced the animal community. Faunal remains preserved in archaeological sites belong both to forested species (red deer, boar wild boar, roe deer and rabbit) and to more open environments (horses and bovids). Few reindeer remain were found in layers dated to the Younger Dryas (e.g., Dufaure layer 3, Duruthy layer 2, Sainte-Eulalie layer 2, Gazel layer 6), although their stratigraphic position was probably affected by post-depositional processes (Costamagno et al., 2009).

1.3.1.4 The Early Holocene

The vegetation response to the drastic increase in temperature recorded at the beginning of the Early Holocene (Alley et al., 1993) is rather gradual in both mountain and plain areas.

During the Preboreal herbaceous steppe species (*Artemiasia*, *Gramineae and Cyperaceae*) decrease in low-medium altitudes (Aubert et al., 2004; Jalut et al., 1992; Jalut and Turu, 2009), while *Pinus* reached medium-high (e.g. La Pouretère at 1700 m a.s.l) only during the Boreal (Aubert et al., 2004). *Betula* rapidly increases in altitude (e.g. La Borde and La Pouretère). The expansion of deciduous trees is attested first by *Quercus*, *Corylus* and *Ulmus* (Preboreal) and later by *Tilia*, *Fraxinus*, *Alnus* and *Fagus* (Atlantico) (Jalut et al., 1998).

Information concerning flora in the lowlands during the Early Holocene is more abundant compared to that from the Late Glacial. Palynological data for the Dordogne region were obtained from 5 sites: Les Fieux (Nizonne Valley), Les Ecures (Pude Valley), La Ribeyrie (Caudeau Valley), Beauclair (Dronne Valley) and the bottom of the Beunes sequence (Leroyer, 2018). Results show the progressive settlement of a mixed forest during the Preboreal with *Pinus, Juniperus* and broad-leaved species (*Salix, Betula, Corylus, Quercus, Ulmus*) in association to steppe plants. Only later mesophile taxa become dominant composing a dense vegetal cover.

1.3.2. North-Eastern Italy

After the LGM, Northern Italy was characterized by relevant landscape and environmental changes in response to the gradual climatic amelioration. On the one hand, the sea level rise involved the disappearance of a considerable amount of coastal areas (Correggiairi et al., 1996; Lambeck et al., 2014, 2011), on the other hand the deglaciation and re-afforestation of inner areas up to low-medium altitudes made new territories available (Ravazzi et al., 2007). The reconstruction of the vegetational history of the southern side of the Alps is based on pollen records from five main sites: Palughetto mire – Cansiglio Plateau (Veneto, Italy) (Vescovi et al., 2007), Piccolo Lake of Avigliana (Piedmont, Italy) (Finsinger et al., 2011, 2008, 2006; Finsinger and Tinner, 2006), Annone Lake (Lombardy, Italy) (Wick, 1996), Pian di Gembro (Lombardy, Italy) (Pini, 2002) and Origlio Lake (Ticino, Switzerland) (Tinner et al., 1999), in addition to several minor sites (Heiss et al., 2005; Joannin et al., 2013; Kaltenrieder et al., 2004; Wick, 2004). On the other hand data for the plain were collected from the palaeobotanical sites of Ca` Fornera (VE), Casaletto Ceredano (CR), Galzignano (PD), Ghedi (BS), San Dona di Piave (VE), Venice Lagoon (VE) and the Fimon Lake in the Berici hills (Peresani et al., 2021).

1.3.2.1. GS-2 (first part of the Late Glacial)

During the LMG the sea level drop between -120 m and -135 m (Lambeck et al., 2014; Pellegrini et al., 2018) bringing to light a vast alluvial land (Adriatic Plain) that together with the Po Plain and the Venetian-Friulian Plain formed the so-called Great Po Plain (*sensu* Peresani et al., 2021) (Fig. 1.4). The Adriatic Sea coastline was located between Pescara and Zadar (Maselli et al., 2014; Surić and Juračić, 2010). This territory was circumscribed by the northern and central Apennines, the southern side of the Alps, and the Dinarides. A detailed synthesis of the plain ecozones was proposed by Peresani et al. (2021) in which three different types of environment were described. At a general level active megafans and stable surfaces were covered by semi-deserted vegetation (*Artemisia*, *Hippophae, Gramineae* and *Juniperus)*, while riversides attested to trees such as *Betula* and *Alnus.* Dryer areas were inhabited by *Juniperus* heaths and *Pinus sylvestris* parkland surrounded by steppe. The plain area was populated by large ungulates as documented by Settepolesini quarry (FE), in which the presence of Bison is dated to 16341-15877 cal BP (Sala, 2007). Bison is also attested in the Northern Apennines slope (Govoni, 2003).

The fronts of the major glaciers in the southern slope of the Alps reached their maximum advance at the outlet of the valleys around 26–25 ka cal BP (Braakhekke et al., 2020; Ivy-Ochs et al., 2018; Monegato et al., 2017) and the lowland edges of the Po-Plain at 22000 cal BP (Orombelli et al., 2004). Evidence shows that deglaciation at low altitude started before 18000–17500 cal BP all over the Alps and deglaciated areas were colonized by open woods and shrublands at around 17500 cal BP (Tinner et al., 1999). The formation of slightly more closed forest occurred at 16000–15800 cal BP in both the western (Finsinger et al., 2006; Tinner et al., 1999) and eastern part of the Alps (Friedrich et al., 1999; Monegato et al., 2007). The most attested specimens are *Betula*, *Larix decidua*, *P. Cembra*, *P. sylvestris* associated with large amounts of herbs (e.g. *Artemisia*) and shrubs (e.g. *Juniperus*). The medium altitudes were ice-free just before the Bølling (e.g. Palughetto site at 1040 m a.s.l and Pian di Gembro at 1350 a.s.l) and most likely unforested (Peresani et al., 2021; Ravazzi et al., 2007; Vescovi et al., 2007). The ancient layers (L. 17-13) of Riparo Tagliente (226 m a.s.l.), the only north-eastern pre-alps site dated to the end of GS-2, show a faunal assemblage dominated by ibex, marmot, auroch and bison.

1.3.2.2. The GI-1 (Interstadial Bølling-Allerød)

An abrupt environmental change is recorded at both the low and high altitudes between 14800–14300 cal BP reflecting the climatic warming of the beginning of Greenland Interstadial 1 (Rasmussen et al., 2014). The treeline reached an upper limit of around 1700 m a.s.l. and forest structure and density changed. At this time Pre-Alps forests had a variable composition, with dominance of *Pinus sylvestris*, *Juniperus*, *Larix* and *Betula* in the Western Alps (Finsinger et al., 2006) and of *Pinus sylvestris*, *Larix*, *Picea*, *Pinus mugo* and *Betula*, in the Eastern Alps (Vescovi et al., 2007). A second vegetational turnover is recorded at 13500–12600 cal BP in most areas of the southern slope of the Alps (Palughetto, Pian di Gembro, Annone Lake, Origlio Lake and Piccolo Lake of Avignana): *Pinus* pollens decrease, while thermophilous plants increase, such as *Quercus*, *Tilia* and *Ulmus*. The brief cooling events recorded in the Greenland ice cores (namely GI-1d, GI-1c2 and GI-b) during this overall warm period slightly influence the vegetation causing at least a contemporaneous expansion of xerophytes and thermophilous trees (Vescovi et al., 2007). The beginning of the Bølling led to complete afforestation also of the Venetian-Po plain.

The animal community is dominated by forest-related species (red deer, roe deer, wild boar) and mountain species (ibex and chamois). Red deer and wild boar are the most represented in valley bottom sites: Upper layer of Riparo Tagliente (Bartolomei et al., 1982), phase I of Riparo Soman (Tagliacozzo and Cassou, 1994) and Riparo Biarzo (Rowley-Conwy, 1996). Conversely, ibex and chamois are more represented at middle altitude sites: phase I of Villabruna and Riparo Dalmeri (Aimar and Giacobini, 1995; Bertola et al., 2007).

1.3.2.3. The GS-1 (Younger Dryas)

The environmental response to GS-1 climate oscillation in the southern side of the Alps is well documented. The forest reduced and herbaceous taxa re-expanded in association with *P. cembra*, *Larix* and *Betula,* even in the lowlands, at the expense of *Quercus*, *Alnus Ulmus*, *Tilia*, and *Corylus.* However, the treeline was still above 1400 m a.s.l. in most of the Alps (Gobet et al., 2005; Vescovi et al., 2007). At Palughetto the end of the Younger Dryas recorded an increase of pollens of thermophilous plants and a gradual decrease of *Artemisia* and other light-demanding herbs as a consequence of the climatic warming at the Pleistocene-Holocene transition (Vescovi et al., 2007). Archaeological sites dated to the Younger Dryas yielded faunal remains attesting to the hunting of chamois and ibex, followed by red deer at both low (Riparo Soman phase II; Tagliacozzo and Cassou, 1994) and middle altitude (Riparo la Cogola; Fiore and Tagliacozzo, 2004).

1.3.2.4. Early Holocene

The environment south of the Alps markedly responded to the drastic climatic amelioration in the Early Holocene. Pollens from the Palughetto mire (Ravazzi and Vescovi, 2009) and Ledro Lake (Joannin et al., 2013) indicate a significant transformation of the forest composition: from coniferous forests to mixed ones with spruce or pine and broad-leaved species (e.g., *Quercus*, *Ulmus* and *Tilia* at Ledro Lake). A similar reduction of cold-adapted trees is observed also at Lavarone Lake (Filippi et al., 2007) and Fimon Lake in Berici Hills (Valsecchi et al., 2008). This latter recorded a major *Corylus* expansion as well as at Origlio Lake (Finsinger and Tinner, 2006) and Lago di Annone (Wick and Mohl, 2006). Pollens from Piccolo Lake of Avignana suggest, after the Younger Dryas, the establishment of a temperate continental mixed-oak forest (Finsinger et al., 2006). The beginning of the Holocene also affects the coastal plain. Significant is the appearance of *Quercus ilex*, accompanied by mixed oak–holm oak elements (Cacciari et al., 2020).

Analysis of position and depth of the brackish lagoonal peat deposits allowed following the sea-level rise in response to melting glaciers during the Late Glacial and the Holocene. The Adriatic Sea level increased from – 130 m during the LGM to – 40/45 m at ca. 10000 yr BP, reaching its Maximum Marine Ingression at ca. 5000 yr BP (Correggiairi et al., 1996). From

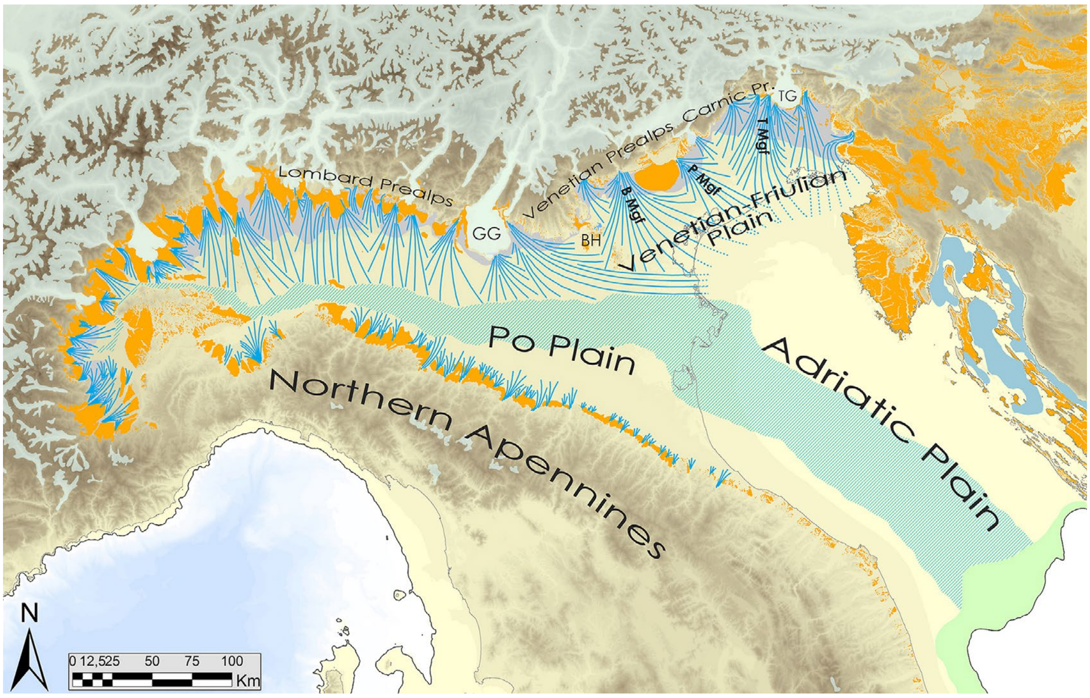


Figure 1.4 - Map of the Great Adriatic-Po Region (from Peresani et al., 2021 modified).

a more global perspective, Lambeck and colleagues (2014) calculated that the main phase of sea level rising after the LMG occurred between 16500 cal BP to 8200 cal BP at an average rate of rise of 12 m·ka$_{-1}$ with periods of greater (e.g., 14500-14000 cal BP) and lesser (e.g., 12500-11500 cal BP) growth.

1.4. Synthesis

The environmental response to global climatic changes occurred with different pace and rhythms in the two analysed areas. The Oldest Dryas designs a similar steppe environment with open woodland composed of *Pinus*, *Juniperus* and *Betula* in both Northern Italy and South-Western France, while the climate warming at the beginning of GI-1 had different effects in the two regions. The southern slope of the Alps and the Great Po Plain records a quickly mixed forest expansion (conifers and birch) up to 1700 m a.s.l. and an important increase of thermophilous plants throughout the end of the GI-1 (Allerød). By contrast, the vegetation of the Aquitaine Basin and the northern slope of the Pyrenees remains fairly open and dominated by steppic taxa until the onset of the Allerød when an increase of *Betula* and *Pinus* (always in association to high percentage of herbaceous species) is recorded. After a decline of arboreal pollen during the Younger Dryas, the response of the vegetation to the climatic amelioration of the Holocene appears, again, much slower in South-Western France than in the southern Alpine area.

Moving to neighbouring territories, the French Alps and Swiss Plateau record a first reforestation of the low and mid-altitude belts by *Betula* (Bølling) and then by *Pinus* (Allerød)

(Cupillard et al., 2015; David, 2001; Ortu et al., 2010; Wick, 2000). Compared to the Southern slope the Alps thermophilous plants are rarely documented during the interstadial. In Western-Central Europe climate warming during GS-1e is marked by the onset of an open birch woodland dominated by herbaceous taxa and then by birch-pine woodland during the Allerød period (Leroyer, 1997; Litt et al., 2001).

Although climatic changes affected all of Europe, adaptation of vegetation was generally different around the Atlantic coasts and northern Europe compared to the territory south of the Alps. As proposed by some Authors (Naudinot et al., 2017b) the higher summer temperatures of Southern Europe (Heiri et al., 2014; Larocque and Finsinger, 2008) and the presence of mesophilous broadleaved trees refugia in the Po plain before GI-1 (Kaltenrieder et al., 2009; Ravazzi et al., 2004) likely allowed a rapid expansion of temperate trees forests since the Bølling-Allerød interstadial.

Chapter 2 - Chrono-cultural background

2.1. The French Western Atlantic sequence

2.1.1. The first cultural classifications

After some feeble attempts dated to the second half of 19th century and the beginning of the 20th (e.g. Lartet, 1864; Lartet and Christy, 1864; Mortillet de, 1872; Piette, 1889), one of the first scholar to suggest a clear separation of Europe in two main cultural regions at the end of the Palaeolithic was H. Breuil (1913) during the "*Congrès international d'Anthropologie et d'Archéologie préhistoriques*" held in Genève in 1912. The Author argued the existence of a Mediterranean region and an Atlantic one: « *Dans l'état actuel des recherches, on peut déjà nettement discerner deux vastes provinces paléolithiques supérieures à évolution assez tranchée, que l'on pourrait appeler, l'une méditerranéenne, l'autre atlantique* » (Breuil 1913, p. 171) (Fig. 2.1).

At the beginning of the XX century the *Solutréen-Magdalénien-Azilien* sequence was recognised. The variability of lithic artefacts, animal hard tissue items and artistic representations allowed a separation of some of these periods into sub-phases: thanks to the excavation of Laugerie-Haute (Dordogne) P. Peyrony (1938) defined four phases for the Solutrean (*Proto-Solutréen, Soluntréen inférieur, Soluntréen moyen* and *Soluntréen supérieur)*, whereas H. Breuil (1937), after the excavation of Placard (Charente) and la Madeleine (Dordogne), subdivided the Magdalenian into 6 evolutionary steps (*Magdalénien* I, II, III, IV, V and VI). The distinction between these two cultural traditions was immediately clear. In this sense the words of H. Breuil referring to the Magdalenian are explicative: « *Quelle différence avec les beaux silex si finement éclatés et retouchés, en roche soigneusement sélectionnée du Solutréen supérieur! [...] En revanche, l'outillage osseux a tout de suite son caractère bien défini, les aiguilles ne manquent jamais, les sagaies sont nombreuses. »* (Breuil 1913 p.201). On the other hand, the Azilian was defined in the Pyrenees following the finding of Mas d'Azil (excavated by É. Piette in 1887) and La Tourasse (excavated by J. Chamaison in 1891-1982) in the late 19th century. These discoveries allowed to partially fill a time gap between the Magdalenian and the Neolithic which had caused several discussions among scholars (Piette, 1895). Since the first studies the transition from the Magdalenian to the Azilian was perceived as a drastic and a quick event. In fact, H. Breuil (1913) used the term "revolution" to describe the profound changes in the cultural material: «*Plus d'art animalien, seulement des peintures sur galet et sur paroi d'éléments schématiques ou géométriques. Révolution dans le travail de l'os et de la corne de cerf [...]et il' en est de même pour les silex... »* (Breuil 1913 p. 216).

Some years later L. Coulonges (1928) excavating the sites of Le Martinet and Le Roc Allan (in the municipality of Sauveterre-la-Lémance, Lotet-Garonne, Nouvelle Aquitaine) identified two well-defined assemblages. The older one is characterised by small backed bladelets and triangular microliths and the recent one attested to numerous trapezes. The Author named the former Sauveterrian, while the latter was attributed to the *Tardenoisian*. The same lithic industry was then found by R. Lacam and A. Niederlender at Cuzoul de Gramat (Lacam et al., 1944). In 1954 L. Coulonges emphasised the extremely small size of Sauveterrian artefacts and their clear difference from Azilian assemblages (Coulonges, 1954).

Despite the lack of radiocarbon dates and of a shared and systematic methodology, the second part of the Upper Palaeolithic and the Mesolithic were already perceived as a period characterised by significant transformations. Important questions concerning the reason for such changes and their origin are addressed for the first time: for example H. Breuil (1913) hypothesised an eastern origin of the Magdalenian. Otherwise G. de Mortillet (1894) explained the Magdalenian-Azilian transition as the result of reindeers migration. É. Piette (1895) proposed the hypothesis regarding the morphological differences between Magdalenian and Azilian harpoons. According to this Author the higher thickness of red deer antlers compared to reindeer ones determined a change in harpoons cross-section (from cylindrical to flat). Thus, the raw material had a major influence on tool morphology.

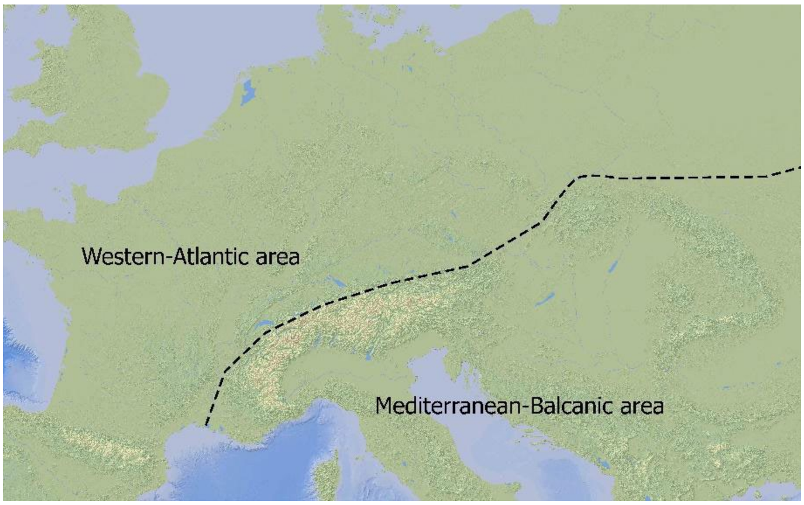


Figure 2.1 - Cultural subdivision of the Europe.

2.1.2. The second half of the 20th and the beginning of 21st century

At the beginning of the second half of the 20th century the increase of prehistoric studies and the development of a typological approach (de Sonneville-Bordes and Perrot, 1956), in association with the introduction of radiocarbon dating method, allowed a better definition of Late Palaeolithic and Mesolithic cultural traditions. Chrono-typological synthesis, based on the presence/absence and percentages of specific *fossiles directeurs*, were established for several periods and regions (e.g. Célérier, 1979; de Sonneville-Bordes and Perrot, 1956; G.E.E.M., 1972a, 1969; Onoratini, 1982; Rigaud, 1982; Schmider, 1971; Sonneville-Bordes, 1966, 1959). Nevertheless, compared to the southern regions of Europe (e.g., Italy), in which the chronostratigraphic approach was applied for a longer time, the influence of the palaethnology (e.g. Binford, 1979, 1980, 1978; Clarcke, 1978; Leroi-Gourhan, 1945, 1943) and the earlier development of a technological approach (e.g. Boëda, 1994, 1986; Geneste, 2010;

Inizan et al., 1999; Pelegrin et al., 1988; Tixier et al., 1980) gave the opportunity to elaborate new theories based on the spatial organisation of sites and the socio-economic behaviour of human groups. This new approach was firstly applied in several sites of the Paris Basin, such as Pincevent, Étiolles, Marsangy and Verberie (e.g. Audouze et al., 1981; Bodu and Valentin, 1997; Fagnart, 1997; Karlin et al., 1986; Leroi-Gourhan and Brezillon, 1972, 1966; Olive, 1988; Pigeot, 1987; Schmider, 1992; Valentin, 1995) and then spread in the rest of the country (e.g., Fat-Cheung, 2015; Fornage-Bontemps, 2013; Lacombe, 1998; Langlais, 2007; Mevel, 2013, 2010; Naudinot, 2013, 2010) drawing a new perspective of the "*Paleohistoire*" (Valentin, 2006). All these studies led to re-define the rhythms of the Magdalenian, Azilian and Sauveterrian evolution and to identify "new" facies (e.g., Badegoulian, Laborian, Ahrensburgian, etc.) which were previously unknown (Ducasse, 2012; Fat-Cheung, 2020; Fat Cheung et al., 2014; Fontana et al., 2018; Langlais et al., 2020, 2014c; N. Naudinot et al., 2019; Valdeyron et al., 2008).

2.1.3. The Magdalenian

The Magdalenian chronological model has undergone numerous modifications since its early recognition and for a long time its chronological limits have been widely discussed (Bordes, 1958; Breuil, 1937; Laplace, 1966; Lartet, 1864; Piette, 1889). Up to now it is divided into three main phases whose limits slightly change according to publications (Langlais, 2007; Langlais et al., 2016; Pétillon, 2015):

- **Lower Magdalenian** (approximately 20500-18000 cal BP)
- **Middle Magdalenian** (approximately 19000-16000 cal BP)
- **Upper Magdalenian** (approximately 16500-13800 cal BP)

The effects of climatic constraints on northern expansions of human groups are evident during the **Lower Magdalenian** (Miller, 2012). Sites are concentrated in South-Western Europe, mainly in Southern France and North-Eastern Spain. This period attests to the onset of the Magdalenian colonisation of the Pyrenees (La grotte de Scilles, Lespugue, Haute-Garonne; Langlais et al., 2010), which were partially covered by glaciers (Aubert et al., 2004; Jalut and Turu, 2009; Reille and Andrieu, 1995). Recent studies on lithic artefacts allowed to clearly discern the beginning of the Magdalenian from the Badegulian, indicating a progressive transformation between these two cultural traditions (Ducasse, 2012; Ducasse and Langlais, 2007; Langlais et al., 2010b). Bone equipment does not particularly change, still evoking the Badegoulian technical systems (Langlais et al., 2010b). The Lower Magdalenian hunting equipment is characterised by marginal backed bladelets produced on microbladelets with a twisted profile associated, exclusively in South-Western France, with shouldered points (Bazile, 1999; Langlais, 2007; Lenoir, 2003) (Fig. 2.2). Although recent studies focusing on lithic artefacts (Cazals and Langlais, 2006; Langlais, 2007, 2003; Langlais et al., 2010a; Primault et al., 2007) have improved our knowledge on this period, data are still incomplete for several aspects.

The advent of the **Middle Magdalenian** coincides with the Heinrich 1 climatic event. This period is considered as the acme of the Magdalenian culture, «*l'âge de la maturité*» according to D. Sacchi, (2003). It is marked by a strong development of reindeer antler industry, in particular the production of a great variability of decorated projectile points (Averbouh et al., 1999; Braem, 2008; Pétillon, 2006, 2015) and the spread of new lithic armatures morpho-types (Langlais et al., 2016, 2014c, 2012). Some of the latter were originally considered as *fossiles directeurs* of specific "facies" of the Middle Magdalenian such as the "*navettes*" (Allain et al., 1985; Malgarini et al., 2016), spear throwers (Cattelain, 2016, 2005), Lussac-Angles points (Allain, 1989; Allain and Descouts, 1953; Bertrand et al., 2003; Malgarini et al., 2016; Pincon, 1988) and scalene bladelets (David, 1996; Lorblanchet, 1989) (Fig. 2.3). The latter were produced by using the microburin blow technique (Langlais, 2008). Furthermore, impressive is the diffusion of figurative artistic expressions in the form of decorated caves and rock-shelters, mobile arts and numerous human representations (Bourdier, 2010; Fuentes, 2014). Although the Middle Magdalenian seems to have extended as far as Poland (Maszycka) and Germany (e.g., Hohle Fels, Munzingen and Florian-Seidl-Strasse), the limit of the ice sheet confined human groups to the south of the Paris Basin, mainly in Cantabria along with Southern and Eastern France (Miller, 2012).

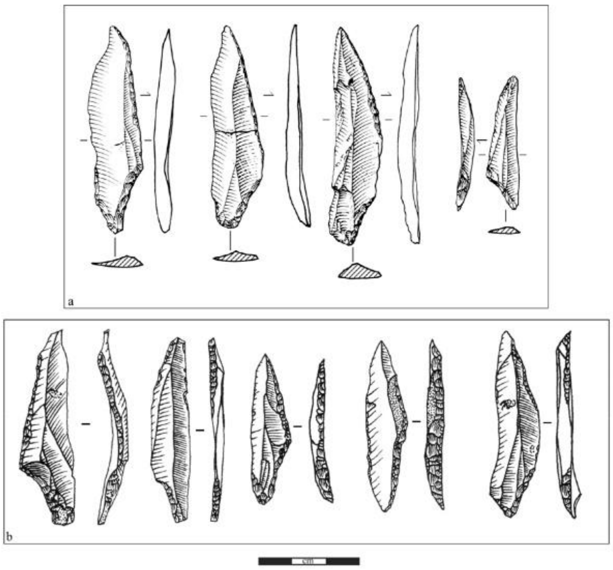


Figure 2.2 – Lower Magdalenian shouldered points. (a: Gandil c.20, drawing M. Jarry ; b: Fontgrasse : drawing F. Bazile) (Langlais 2007 modified).

Lithic production was focused on regular and highly standardised blades and bladelets (Langlais, 2010, 2007; Langlais et al., 2016, 2014c). Direct percussion with an organic hummer is attested as a knapping technique. The manufacture of some of these tools required a great ability of apprenticeship/transmission of technical know-how (*savoir faire*), as well as excellent quality raw material (Angevin and Langlais, 2009; Bundgen, 2002; Lacombe, 1998; Langlais, 2007; Simonnet, 2007). Such needs were satisfied through a wide network of exchange and circulation of raw material (Langlais, 2010; Langlais and Sacchi, 2006; Sécher and Caux, 2017). Hunting practises were focused on large ungulates (horse, Saiga antelope, bovids and reindeer), while small games were rarely captured (Castel et al., 2007; Costamagno, 2003, 2001; Fontana, 1999).

The **Upper Magdalenian** began at around 16000 cal BP. A significant demographic expansion is suggested by a clear increase of sites (Langlais et al., 2016, 2012; Miller, 2012). Throughout this period first evidence of a Magdalenian occupation appears in Northern France (Olive et al., 2019; Boris Valentin, 2008; Valentin, 2006, 1995; Weber, 2012) Belgium (Vermeersch and Maes, 1996), Denmark and England, under the name of "Creswellien" (Barton et al., 2003; Jacobi and Higham, 2011). Also South-Western France and Germany are now more densely occupied (Miller, 2012). The transformation of projectile implements is one of the major differences compared to the previous phase. Antler projectile points lost their decorations, double beveled-points, accompanied sometimes by fork-based points, became dominant (Pétill-

Figure 2.3 – 1-2: Lussac-Angles points from Les Espelugues and from Les Fées, Daleau collection. 3: spearthrower from grotte du Placard. 4: navettes from Arlay. 5: scalene bladelets from Gazel c.7, drawing S. Ducasse.

on, 2007, 2006, 2015) together with "Magdalenian harpoons" (Julien, 1982; Lefebvre, 2011; Pétillon, 2015) (Fig. 2.4). Lithics armatures follow a similar trend showing significant spatial and diachronic diversification (Langlais, 2008, 2007; Langlais et al., 2016, 2014c, 2012). M. Langlais and colleagues (2012) link this high variability of hunting equipment to the intensification of small fauna consumption as suggested by several archaeozoological studies (Cochard, 2004; Cochard and Brugal, 2004; Costamagno and Laroulandie, 2004; Laroulandie, 2009; Le Gall, 1999) which according to Authors might force a diversification of hunting techniques. Upper Magdalenian lithic technical systems are still based on blades and bladelets production, but a greater adaptation to local raw materials is attested (Lacombe, 2005; Langlais, 2010, 2007; Langlais et al., 2016, 2012; Simonnet, 2003). The decrease of request for high technology blades, the reduction of investment in a high-quality flint provisioning together with the schematisation of certain animal representations (Paillet, 2014; Paillet et al., 2013) reflect a general simplification of technical systems and the onset of a progressive dissolution of Magdalenian norms (Langlais et al., 2016; Boris Valentin, 2008). Recent works focused on South-Western France distinguish the "classic" Magdalenian (namely Middle and Upper Magdalenian) in four sub-phases according to the techno-economic organisation of lithic production and the morpho-technological variability of lithics and bones tools in association with radiocarbon dates (Langlais et al., 2016; Pétillon, 2015):

- Early Middle Magdalenian (EMM) dated between 19000-17500 cal BP
- Late Middle Magdalenian (LMM) dated between 18000-16000 cal BP
- Early Upper Magdalenian (EUM) dated between 16500-15000 cal BP
- Late Upper Magdalenian (LUM) dated between 15500-14000 cal BP

2.1.4. The Azilianization process

The onset of the GI-1 corresponds to the gradual disappearance of the Upper Magdalenian technical systems and the establishment of that phenomenon defined as "Azilianisation". The latter strongly affected several aspects of the hunter-gatherer communities: from lithic production to mobility patterns and artistic expressions up to social organisation (Naudinot et al., 2019). Although some regional differences have been highlighted (see *Federmesser* groups in Northern France and the Hambourgien in Northern Europe), this process seems to similarly impact all the "Atlantic" area. Two main phases were identified: an Early Azilian and a Late Azilian. The former developed during the GI-1e/d (Bølling), whereas the latter covered the span of time between GI-1c/b/a (Allerød) and the beginning of the GS-1 (Younger Dryas) (Fat Cheung et al., 2014; Naudinot et al., 2019). Generally the main features associated to the Azilianization process are:

- the rapid diffusion of backed points and the disappearance of Magdalenian armatures morpho-types
- the progressive development of short endscrapers
- the progressive simplification of debitage methods

Figure 2.4 - 1: Double-beveled points from Isturitz. 2: Fork-based points from Isturitz. 3: harpoons from La Vache (from Pétillon, 2015 modified).

- the systematic use of a stone hummer
- the progressive abandonment of figurative art in favour of more schematic and geometric representations
- the progressive decrease of siliceous raw materials exchange
- the progressive decrease of bone industry

Rhythms of the transition between the Magdalenian and the Azilian techno-complexes has been highly debated in recent years (Langlais, 2007; Mevel, 2013, 2010; Naudinot et al., 2019; Naudinot, 2010; Valentin, 2006, 1995). Rejecting the existence of a Final Magdalenian (*sensu* Breuil, 1913; Peyrony, 1936; Sonneville-Bordes de, 1979) characterised by mixed Azilian-Magdalenian mopho-types, which is likely related to post-depositional processes (Langlais, 2007; Mallye et al., 2018; Naudinot, 2010; Valentin, 2006), two cultural aspects e are distinguished during the G-1e (Bølling):

- the persistence of a “terminal” Upper Magdalenian
- the advent of the Early Azilian

Sites attesting Magdalenian assemblages dated around 14000 cal BP are widespread throughout Europe. Several evidences are located in the Pyrenees (Barbaza, 1996a, 1996b, 1996c; Barshay-Szmidt et al., 2016; Dachary, 2002), in the Aquitaine Basin (Detrain et al., 1996; Renard, 1999), in the Paris Basin (Valentin, 1995; Valladas, 1994) and Northern Europe (Barton et al., 2003). In this sense, layer 7 of Troubat (Hautes Pyrénées, France) is a perfect example: archaeological remains are definitely Magdalenian (backed bladelets and Magdalenian harpoons), but radiocarbon dates (one was performed directly on a Magdalenian harpoon) fall between 14000 and 13000 cal BP suggesting a Magdalenian persistence during the Allerød (Barbaza, 2011). Sites attesting to a "terminal" Magdalenian are present also in Spain (Arribas, 1990, 2006; Gonzalez Sainz, 1989).

Nowadays several Authors (Naudinot et al., 2019) claim that this overlapping between Early Azilian and Magdalenian sites is referred to the high plateau in the radiocarbon calibration curve (Rasmussen et al., 2006) rather than the cohabitation of groups with different technical traditions. Such hypothesis is supported by multilayer sites of Murat (Lorblanchet, 1985; M. Langlais and S. Costamagno, monograph in progress), Pont d'Ambon (Célérier, 1998, 1993a) and Bois Ragot (Chollet and Dujardin, 2005) where any interstratification between Upper Magdalenian and Early Azilian occupations is attested.

The **Early Azilian** is well known in most of France: in the Paris Basin and more generally in northern territories (Bodu and Mevel, 2008; Bodu and Valentin, 1997; Naudinot et al., 2018, 2017a; Valentin, 2006), in the South-West (Fat-Cheung, 2020; Fat Cheung et al., 2014) and to the East of the country (Mevel, 2013). Assemblages referred to this phase are fairly homogenous and mainly characterised by curved backed bipoints and monopoints, a regular blades/bladelets production by direct percussion with a soft stone hummer, rare hard animal tissue tools and portable art showing figurative images (e.g., Pincevent III.2, Abri Murat, Rocher and Rocher de l'Impératrice). Excluding armatures and knapping techniques, the main aspects of the Early Azilian culture (Fig. 2.5) remind those of Magdalenian groups, suggesting a progressive transition between these two facies (Bodu and Valentin, 1997; Fat Cheung et al., 2014; Naudinot, 2013; Naudinot et al., 2019). Moreover, in both the Early Azilian and Upper Magdalenian, we observe important maintenance, re-use and recycling process of lithic tools (Bodu and Mevel, 2008) as well as a decrease of raw material circulation compared to the Middle Magdalenian (Lacombe, 2005; Langlais, 2010; Langlais et al., 2012; Simonnet, 2003).

J.Pelegrin (1997) points to the environmental changes (vegetation and hunted preys) occurring during the interstadial and to the shift in knapping techniques from the use of an organic hammer to soft stone as the main cause of the transformation in lithic production between Upper Magdalenian and Early Azilian groups. Furthermore, in Northern France last Magdalenian evidence identified with the term "Cepoy-Marsangy" (Valentin, 2008, 2006) shows a significant spread of backed points (mainly shouldered points), an almost absence of backed bladelets and the use of soft stone hammer for bladelets production. These features led B. Valentin to prudently propose an Early Azilian origin from this particular Upper Magdalenian regional facies.

Concerning the Pyrenees all the main features characteristics of the Early Azilian are present only in the western part, while the rest of the region (e.g. Rhodes II layer 5 and 6, and Balma Margineda layer 10) shows a completely different lithic assemblages already oriented towards the Late Azilian technical systems (Fat-Cheung, 2020; Fat Cheung et al., 2014).

The technical changes initiated during the early phase of the Azilian became clearer starting from the second half of the GI-1 giving rise to the **Late Azilian** techno-complexes. Also this phenomenon is generally interpreted as an adaptation to the faunal and environmental changes occurred during Allerød (i.e. expansion of woodland species), even if it is difficult to identify the exact timing of this shift. A lithic production orientated towards elongated flakes, the disappearance of backed bipoints in favour of curved backed monopoints, the increase of short endscrapers and the abandonment of a figurative art are some of the main features of Late Azilian communities (Fat Cheung et al., 2014; Mevel et al., 2014; N. Naudinot et al., 2019; Valentin, 2006).

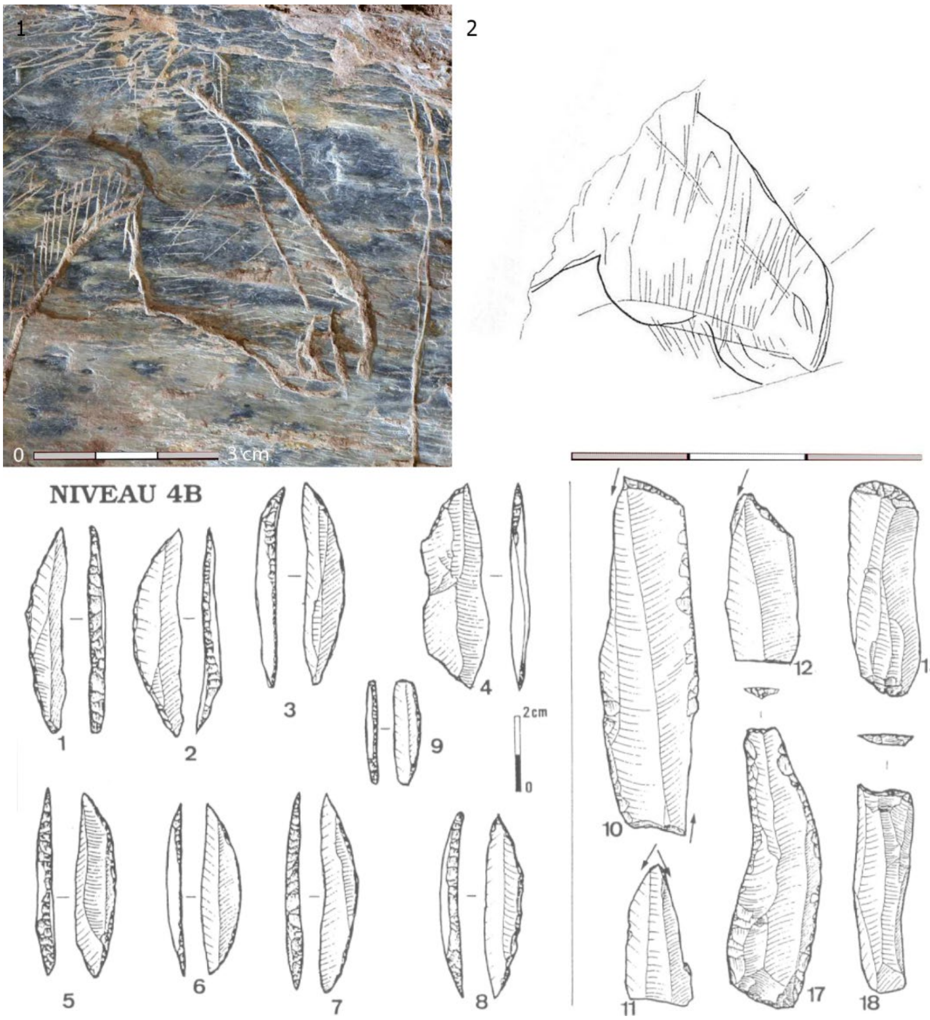


Figure 2.5 – 1: Horse head from Le Rocher de l'Impératrice. 2: Horse head from Pincevent (layer III.20) (from Naudinot et al., 2017). Niveau 4B: Bois Ragot (from Célérier et al 1997).

Again the Pyrenean area deserves a brief mention. It is in this region and in this form (i.e. Late Azilian) that the Azilian was firstly identified in XIX by Piette at Maz-d'Azil (Ariège) and then named *Azilien classique* by M. Barbaza (1997) after the discovery of layer 6 of Troubat (Haute-Pyrenees). Traditional elements of Pyrenean Late Azilian are flat harpoons *"à forme de sapin"*and *"à perforation en boutonnière",* painted pebbles and fusiform backed points

(Barbaza, 2011, 1997; Barbaza and Lacombe, 2005) (Fig. 2.6).

2.1.5. The Pleistocene-Holocene transition

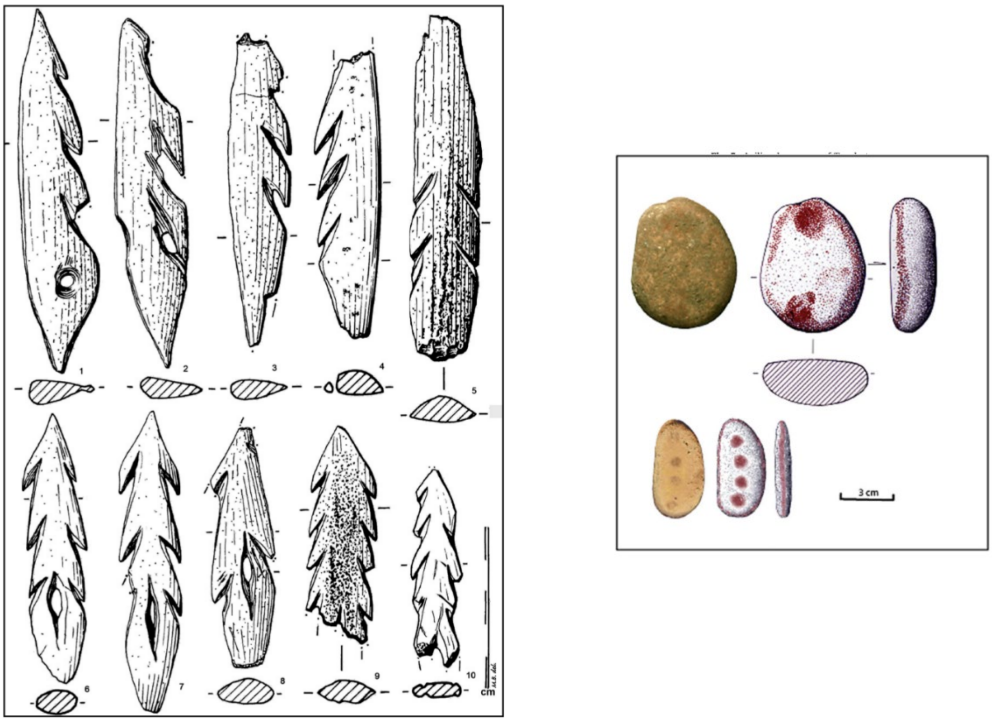


Figure 2.6 – Azilian harpoons (above) and painted pebbles from Troubat (below).

The transition between the Pleistocene and the Holocene attests to the development of the so-called post-Azilian techno-complexes marking an important rupture from the Late Azilian. One of the main changes is the appearance of new types of projectiles. Their variability allows to divide Western Europe into 2 main cultural groups: the Early Laborian (*Malaurie* points and *rectangles*) and the Late Laborian (*Blanchères* and trapezoids) on one side and the Ahrensburgian (large tanged points) and Epiahrensburgian (small tanged points and truncated points) on the other. Actually some trapezoids are attested also in the Ahrensburgian and the Epiahrensburgian (Dewez, 1987; Johansen and Stapert, 1998). From a geographical viewpoint, the Laborian is documented in South-Western France (Fat-Cheung, 2020; Fat Cheung et al., 2014; Langlais et al., 2020, 2015, 2014a), in the North-West (Michel and Naudinot, 2014; Naudinot, 2013, 2008; Naudinot and Jacquier, 2014) and sporadically in the Paris Basin (Fagnart, 1997; B. Valentin, 2008; Valentin, 1995) and South-Eastern France where it is bordered by the Late Epigravettian (Monin, 2000; Naudinot and Tomasso, 2012). Few sites are also mentioned in Southern Spain and even in Belgium and Germany (Langlais et al., 2014a). By contrast, the Ahrensburgian and Epiahrensburgian spread in the Northern European Plain and in Southern England (Vermeersch and Maes, 1996; Vermeersch, 2008). Evidence of Epiahrensburgian penetrations towards the South were detected in North-Western France (Naudinot and Jacquier,

2014) and in the Somme Basin (Fagnart, 2009, 1997; Valentin, 2008; Valentin, 1995).

Next to this high variability in armature morpho-types, these two independent facies are unified by a regular, normalised and straight blades production. Blades dimensions differ according to region (they can be very remarkable, e.g. Paris Basin and Southern England; Fagnart, 1997; Valentin, 1995), but they all have a flat cross-section with acute cutting edges (Fig. 2.7). To underline this common trait N. Naudinot and J. Jacquier (Naudinot and Jacquier, 2014) proposed the name of "Flat Blades Techno-complex" (FBT). These different cultural entities cover approximately the span of time between 12500 cal BP and 11000 cal BP (Fat Cheung et al., 2014; Langlais et al., 2020, 2015, 2014b, 2014a) with the exception of the Pyrenean region in which the Late Azilian seems to persist until the second half of GS-1 (Barbaza, 2011; Fat-Cheung, 2015, 2020; Fat Cheung et al., 2014).

In addition to this significant renovation of lithic production, other important transformations occurred during this period such as an increase in mobility patterns based on raw material circulation and spatio-temporal segmentation of activities (Naudinot, 2013, 2010; Naudinot and Jacquier, 2014; B. Valentin, 2008), a return to an important maintenance, re-use and recycling process of lithic tools (Naudinot and Jacquier, 2014) and to a figurative art(e.g. Pont d'Ambon, c.2; Paillet et al., 2018). The osseous industry is still rare (Langlais et al., 2015, 2014b). According to N. Naudinot and colleagues (2017b) the quick and significant climatic changes occurred during GS-1 that deeply impacted the surrounding environment (Leroyer, 2018) and faunal spectrum (re-appearance of open environment species, such as horses and bovids associated to red deer; Delpech, 1983; Ducassé, 1987; Gilbert, 1984; Langlais et al., 2020, 2014b, 2014a; Pasty et al., 2002) could be the cause of this important socio-economic modification of hunter-gatherer communities. It is interesting to note that any sign of Meso-

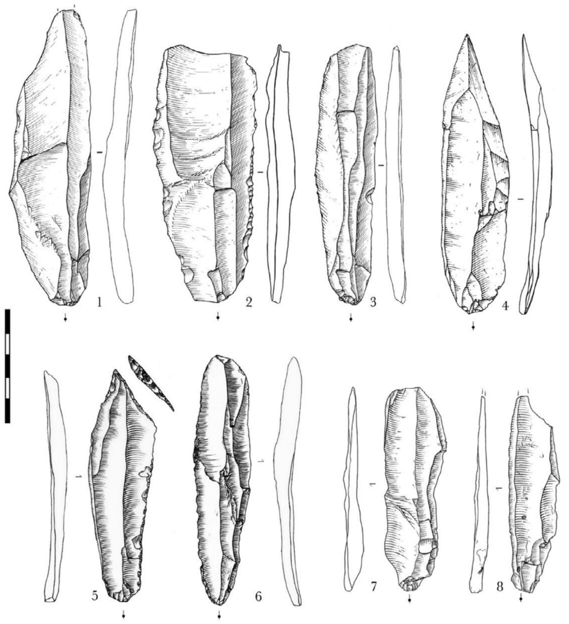


Figure 2.7 - Laborian blades. 1–3: Rochereil, drawings G. Devilder; 4: Champ Chalatras, drawing P. Alix after Pasty et al., 2002; 5–6: La Borie del Rey, drawings C. Fat Cheung; 7–8: Port-de-Penne, drawings C. Fat Cheung. (From Langlais et al. 2020).

lithization is visible in these last French Upper Palaeolithic cultures (Naudinot et al., 2017b, 2019).

2.1.6. The French "Sauveterrian"

After the first discoveries of Le Martinet, Le Roc Allan (Coulonges, 1928) and Cuzoul de Gramat (Lacam et al., 1944), other important Mesolithic sequences were identified, such as Rouffignac (Barrière, 1973, 1972), Baume de Montclus and Châteauneufles-Martigues (Escalon de Fonton, 1966). However, it was only during the 1970's that a real definition of the Sauveterrian was produced, mainly thanks to the work of J.G. Rozoy (1978). At the time he did not use the term Mesolithic for referring to early Holocene cultures in Europe, but he adopted the term Epipalaeolithic. In 1978 he published "*Les derniers chasseurs*" in which he proposed a synthesis of the Mesolithic evidence in France, Belgium, Holland and Switzerland mainly based on a typological approach. Five stages in the evolution of the Mesolithic were recognised: Very Early, Early, Middle, Late and Final spanning the time between the Younger Dryas and 5th/4th millennium. As regards Southern France, 4 main cultural traditions were identified during the Early phase. From west to east there are the Classic Sauveterrian, the Group of the Causses, the Montclusian and the Montadian (Fig. 2.8).

At the same time also S.K. Kozłowski developed a larger scale theory regarding the Eu-

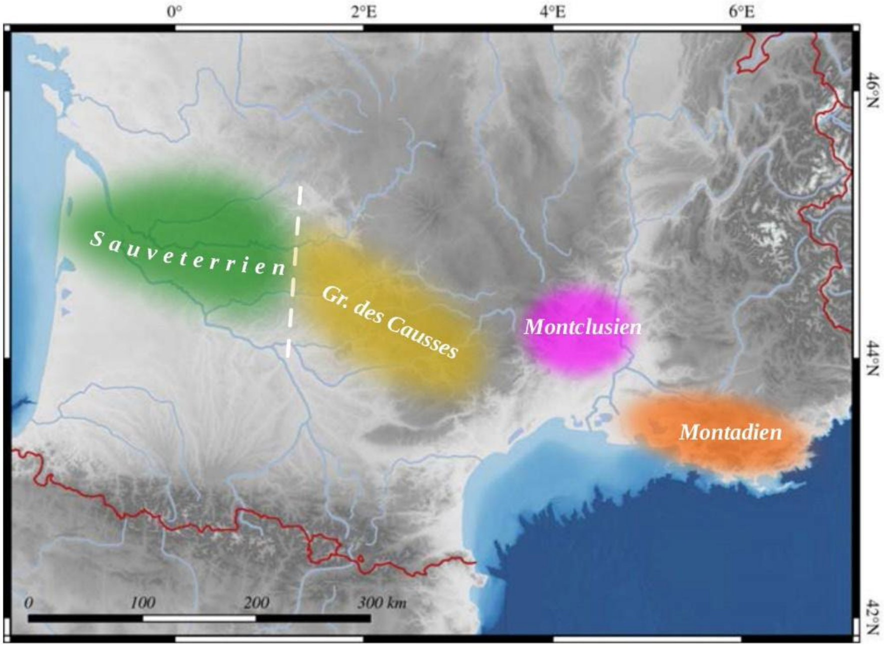


Figure 2.8 - Rozoy (1978) cultural division of Southern France (from Visentin, 2017).

ropean Mesolithic (Kozłowski, 1980, 1976, 1975, 1973). He claimed that Western Europe was divided into 2 main cultural groups at the beginning of the Holocene: the Sauveterrian in Southern France and Northern Italy and the Beuronian in North-Eastern Europe. In the following years, A. Thévenin (Thévenin, 1999, 1996) suggested that the Beuronian took its origins from Late Azilian groups, while the Sauveterrian developed from the Late Epigravettian, taking inspiration from a previous Escalon de Fonton's hypothesis. As a matter of fact, Escalon de Fonton (1966) proposed an origin of the Montadian (Provençal Sauveterrian) from the local Romanellian/Valorguian (Provençal Late Epigravettian).

A greater cultural homogeneity in Southern France was suggested by N. Valdeyron. According to the Author the differences between the groups proposed by Rozoy (1978) did not reflect a territorial diversification but the diachronic evolution of a unique French Sauveterrian techno-complex (Barbaza and Valdeyron, 1991; Valdeyron, 1994). On the other hand, he questioned the similarities between the French Sauveterrian and the Italian "Sauveterriano" (Valdeyron, 2008).

In South-Western France the first part of the Mesolithic (Sauveterrian) was subdivided into 2 main phases called Early Mesolithic and Middle Mesolithic (or Montclusian). This division was mainly based on the morpho-typological variability of lithic armatures of several sites in Quercy (Valdeyron et al., 2008). By contrast, in the Western Alps and pre-Alps the Early Mesolithic was recently divided into three phases (Angelin et al., 2016; Bintz and Pelletier, 1999). The first phase (11200-10500 cal BP) is poorly known and corresponds to the Early Mesolithic (*sensu* Valdeyron et al., 2008). The second phase (10500-9500 cal BP) corresponds to the beginning of the Middle Mesolithic (*sensu* Valdeyron et al., 2008), whereas the third one (9500-8700/8500 cal BP) to the end of Middle Mesolithic (*sensu* Valdeyron et al., 2008). Three different phases (*stade ancient, stade* évolué*, stade recent*) were recognized also in Provence (Escalon de Fonton, 1966; Guilbert, 2003). At a general level the expansion of the Sauveterrian towards the north seems to not cross the 46th parallel of north latitude, i.e. a line running from Lyon to La Rochelle (Perrin, 2020).

By collecting available radiocarbon dates of the Southern France sites, D. Visentin (2017) recognised the beginning of the French Sauveterrian at approximately 11500 cal BP. An important dating overlap (approximately 500 years) with the Late Laborian/Epilaborian is documented (cohabitation of groups with different technical traditions?) (Langlais et al., 2015). The upper limit of the Sauveterrian in South-Eastern France is dated to 8800-8500 cal BP, and in South-Western France to around 8200 cal BP.

2.2. The Epigravettian in Italy and in South-Eastern France

2.2.1. The first chrono-cultural division

At the end of 1950s, the lithic collections referring to the Upper Palaeolithic in Italy were sufficiently numerous to face an initial analysis and subdivision. The first scholar who carried out such work was George Laplace. In the 50s and 60s he defined the Epigravettian (earlier called "*Épipérigordien*" or "*Tardigravettian*") by comparing the Italian lithic assemblages to the French ones previously studied by D. Peyrony. To classify these items he elaborated a new typological list (*Typologie analytique*) based on a hierarchical system (Laplace, 1964a). The Author grouped retouched pieces into different classes and types according to specific technical and morphological features (Laplace, 1974a, 1974b, 1964a; Laplace and Livache, 1975). Following this approach, G. Laplace recognized three different steps of the Epigravettian evolution:

- The Early Epigravettian (20.000 and 16.000 BP)
- The Evolved Epigravettian (16.000 and 14.500 BP)
- The Final Epigravettian (14.500 and 10.000 BP)

The Early Epigravettian was further divided into three sub-phases (Laplace, 1964b): the first one is characterised by the presence of unifacial foliate points, the second one by bifacial foliate points and the third by shouldered points. Later, Palma di Cesnola and Bietti (Palma di Cesnola, 1993; Palma di Cesnola and Bietti, 1983) proposed a similar cultural separation adding an "Initial Early Epigravettian" preceding the foliates phase (Fig. 2.9).

As regards the Evolved and Final Epigravettian, G. Laplace highlighted the necessity to identify regional facies due to the difficulty to identify homogeneous features all along the Italian peninsula. G. Laplace proposed two facies for the Evolved Epigravettian and seven facies for the Final Epigravettian (Laplace, 1964b). This dishomogeneity was further defined during the international congress held at Siena in 1983 where several authors agreed on a division of the Italian Late Epigravettian into five main regions: northern Tyrrhenian, northern and central Adriatic, southern Adriatic, central and southern Tyrrhenian and Sicily (Palma di

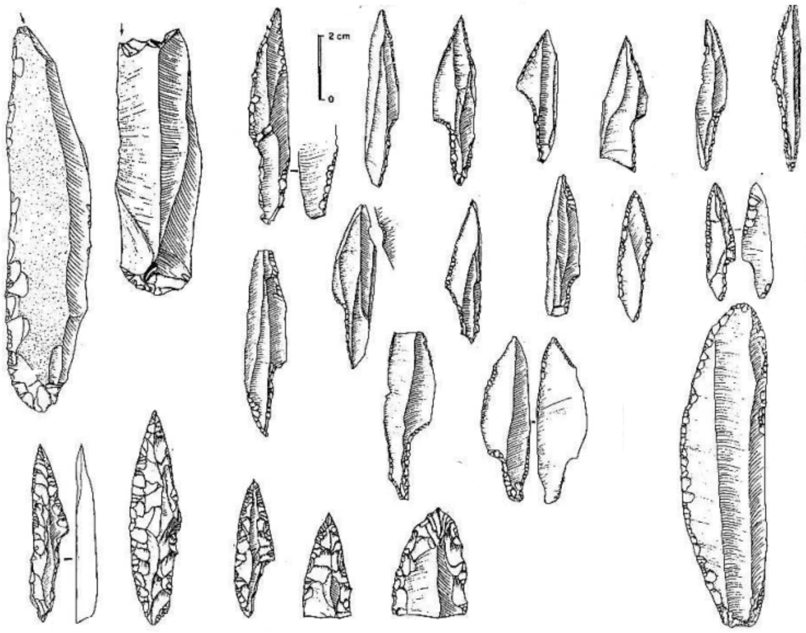


Figure 2.9 - Early Epigravettian of Grotta Paglicci layers 18a-19 (from Palma di Cesnola and Bietti 1983).

Cesnola, 1983). In this regard Palma di Cesnola wrote: «*Che il nostro più tardo Epigravettiano si lasci suddividere in molteplici filoni a carattere regionale e locale corrisponde ad una realtà archeologica ben constatabile. Tale frammentazione è probabilmente il frutto di una minore mobilità dei singoli complessi lungo la nostra Penisola, col conseguente formarsi di unità minori (legate al proprio territorio e ambiente geografico-climatico, ciascuna secondo un suo specifico adattamento) all'interno di una più grande unità tardo-epigravettiana»* (Palma di Cesnola 1993, p. 372). Such a regionalisation process is, thus, generally interpreted as an adaptation to local environmental conditions (Fontana et al., 2020).

The Evolved Epigravettian was considered as a transitional stage encompassing specific features of both the previous (Early Epigravettian) and following phase (Final Epigravettian). According to Palma di Cesnola (1993) long endscrapers prevail over shorter types, geometrics develop along the Tyrrhenian coast, while they are absent along the Adriatic one. Moreover, there is a tendency towards microlithism of backed armatures and the number of shouldered points and bladelets significantly decrease. The Final Epigravettian follows a similar trend, shouldered points totally disappear, dimensions of tools and armatures reduce and endscrapers become shorter (i.e. unguiform and subcircular).

In the following years the difficulty to discern the Evolved and the Final Epigravettian from a typological viewpoint and the high regional variability of such complexes led A. Broglio (1997) to revise this chrono-typological serialisation and to propose a division of the Epigravettian into only two phases according to the main climatic changes: Early Epigravettian for the industries dated to the LGM and to the Pleniglacial and Late Epigravettian for the industries dated between the end of the GS-2/beginning of the GI-1 and the GS-1.

2.2.2. The development of a new approach

For several decades the study of lithic artefacts and the traditional division of the Epigravettian was exclusively based on percentages of diagnostic types (shouldered tools, circular endscrapers, etc.) and the ratios between them (burins vs. endscrapers, or elongated endscrapers vs. short endscrapers). In a few cases this approach was used until recent years (Baills and Bouamer, 2018; Dini and Sagramoni, 2006; Dini and Tozzi, 2005; Martini et al., 2015, 2008).

The first researcher to elaborate a comprehensive criticism of this method was A. Bietti (1990): « *The essential weakness of chronotypology lies in the forcible division of prehistory into archaeological facies, rather than thinking in terms of processes* » (Bietti, 1990, p. 147). The Author, strongly influenced by Processual Archaeology of L. R. Binford, pointed out the necessity to move beyond chrono-typological studies. Moreover, he argued that the study of retouched pieces should systematically involve the "secondary attributes" of Laplace's typology that often were excluded from statistical analysis: « *I also suspect that analysis of them [secondary attributes] would refer more to the functional aspects of the tools, as well as technology and reduction sequences…* » (Bietti, 1990, p. 147).

Also thanks the development of new approaches in France, especially the concept of *chaîne* *opératoire* (i.e. the succession of practical steps and gestures carried out by craftsmen to produce artefacts; Leroi-Gourhan, 1965, 1964, 1945, 1943) and the adoption of a techno-functional and techno-economical approach for the analysis of lithic assemblages (Boëda, 2013, 1994, 1986; Geneste, 2010; Inizan et al., 1999; Pelegrin, 2004, 2000; Tixier et al.,1980), a methodological renovation in lithic studies occurred among the Italian scientific community. The objective shifted from a mere inventory of morpho-types to a deep inquiry into manufacturing processes and uses of past material culture.

This spirit of renewal did not concern exclusively lithic artefacts, but also other categories of items, such as animal hard tissue artefacts and personal ornaments (e.g., Bertola et al., 2007; Cilli et al., 2006; Cristiani, 2012). Also zooarchaeological and taphonomic studies strongly developed and become crucial for the reconstruction of modalities of animal exploitation, seasonality and sites function (e.g. Bertolini et al., 2016; Peresani et al., 2008). Moreover, the methodology of fieldworks changed with an increase of interest in the reconstruction of intra-site spatial organisation, rather than exclusively vertical stratigraphy (e.g. Bertola et al., 2007; Fontana et al., 2018). All these studies gradually allowed a radical transformation of the perception of the Epigravettian: no longer as an assemblage of shapes that change over time, but as a set of human groups whose social structures, beliefs and technical knowledge influence the material culture and behaviour.

2.2.3. Epigravettian divisions beyond typology

Still today the Early Epigravettian is poorly known from a technological and chronological viewpoint. Studies considering production modalities and raw material procurement are extremely rare and scattered in the Italian peninsula. Some examples are: Madonna dell'Ospedale and Fosso Mergaoni (Cancellieri, 2010) in the Marche region, Grotta di Pozzo (Cancellieri, 2010) and Catignano (Serradimigni et al., 2008) in Abruzzo, Grotta delle Settecannelle in Latium (Ucelli Gnesutta et al., 2006), Fondo Focone in Apulia (Cancellieri, 2006) and Grotta dei Fanciulli (layers 5-4) and Grotte de la Péguière (Tomasso, 2014) in the Ligure-Provençal arc . Despite the scarcity of available data and radiocarbon dates, A. Tomasso (2014) proposed a new subdivision of the Early Epigravettian based on a technological comparison of several sites. Namely he identified three main phases:

- EA1 (Fosso Mergaoni, Cantignano and Baume Bonne)
- EA2 (Madonna dell'Ospedale, Grotta dei Fanciulli layer 5)
- EA3 (Grotta dei Fanciulli, layer 4 and Grotte de la Péguière, Grotta del Pozzo, Grotta Paglicci layers 16-17, Grotta delle Settecannelle).

A certain correspondence can be found with the three facies previously identified by Palma di Cesnola in 1983 (Initial Early Epigravettian, Early Epigravettian with foliated points, Early Epigravettian with shouldered points), except for shouldered points that according to A. Tomasso cannot be used as fossil director for the last phase due to their discontinuity in the lithic assemblages « *Les pointes à cran, comme catégorie générale, ne constituent donc pas* *un fossile directeur »* (Tomasso 2014, p. 470).

On the contrary, our knowledge on Late Epigravettian technical systems is extremely improved, especially in North-Eastern Italy due to the much higher number of known sites. Thus, since the late 1990's, a technological approach has been systematically applied to the analysis of lithic assemblages (e.g., Bertola et al., 2007; Cusinato et al., 2004; Duches et al., 2014; Duches and Peresani, 2010; Fontana et al., 2015; Montoya, 2004; Peresani et al., 2000). Other significant studies were carried out in the Ligure-Provençal arc (Tomasso, 2014; Tomasso et al., 2014) and in Northern Tuscany, especially in the Arno and Serchio Valley (Dini and Sagramoni, 2006; Dini and Tozzi, 2005; Tomasso, 2014; Tozzi and Dini, 2007). Rarer technological studies were applied to Central-Southern Italian lithic assemblages such as Campo delle Piane (Olive and Valentin 2005), Grotta Continenza (Serradimigni, 2009; Tomasso et al., 2020), Grotta della Serratura (Ricci et al., 2019) and Grotta del Cavallo (Ricci, 2018; Tomasso et al., 2020).

In his Ph.D. dissertation C. Montoya (2004) analysed the lithic industries of Saint Antoine (Vitrolles, Hautes Alpes, France) and some main sites of the Venetian Pre-Alps (Riparo Dalmeri, Riparo Villabruna, Val Lastari and Riparo Tagliente) and defined a new chronological framework of the Late Epigravettian based on specific changes in technical traditions. He identified three different phases:

- *Ensemble* 1 - Oldest Dryas
- *Ensemble* 2 - Bølling/ beginning of the Allerød
- *Ensemble* 3 - End of the Allerød/beginning of the Younger Dryas

A few years later A. Tomasso (Tomasso, 2014) compared his results in the Liguro-Provençal arc and Northern Tuscany with those of previous studies (Bassetti et al., 2009; Cusinato et al., 2004; Esu et al., 2006; Fontana et al., 2009a; Montoya, 2008a, 2004; Olive and Valentin, 2005; Peresani et al., 2000; Serradimigni, 2013) and designed a chronological subdivision of the Late Epigravettian in 4 phases: ER1, ER2, ER3, which correspond to the *Ensemble* 1, 2 and 3 of C. Montoya, and Terminal Epigravettian (re-using the term previously proposed by Binder in 1980). ER3 was divided into two sub-phases ER3a (13300-12900 cal BP) and ER3b (12900-11700 cal BP). In Table 1.1 all the sites considered by A. Tomasso (2014) are designed. Moreover, the similarities in lithic production between the EA3 and ER1 rather than between the ER1 and ER2, led A. Tomasso to shift the beginning of the Late Epigravettian at the onset of the GI-1 (Fig 2.47). Technological features of the lithic industry of each phase are presented in detail in chapter 2.4.2 and 2.4.3.

Table 1.1 - Late Epigravettian sites employed by A. Tomasso to define each phase.

Phase	Sites
ER 1	-Riparo Tagliente, layer 17-12 -Campo delle Piane
ER 2	-Riparo Tagliente layers 11-6 -Val Lastari -Villabruna layers 17-6 and the burial -Riparo Dalmeri layer 15a-65
ER 3a	-Riparo Dalmeri, layers 26c and 14b/26b -Grotta dei Fanciulli, layer 1 -Monte Frignone II
ER 3b	-Saint-Antoine -Isola Santa, layer 5 -Bus de la Lum -La Cogola, layer 19 -Riparo Soman, phase II -Palu Echen -Grotta del Romito
ER Terminal	-Abri Martin -La Cogola, layer 18 -Grotta Continenza

2.2.4. The case study of the North-Eastern Italy

The north-eastern is one of the most studied areas of the Italian scenario concerning the Late Epigravettian. Several "local" scholars rapidly espoused the chrono-typological approach and defined regional sequences on a typological basis with respect to climatic and environmental changes (Broglio, 1997; Guerreschi, 1984). Among the multitude of Epigravettian sites discovered in this area those referred to the Early Epigravettian are extremely rare and located only on the Berici Hills (Grotta Paina and Grotta Trene). On the contrary, this zone has a great potential for the analysis of the Late Epigravettian.

The intense field research in the area allowed to identify and explore numerous sites and to start reconstructing the rhythms of human penetrations into the southern Alpine fringe during the Late Glacial and the ways in which this territory was exploited (Bertola et al., 2007). Evidence indicates a close relationship between timing of glaciers' retreat, reforestation of the Alpine range and human occupations (Ravazzi et al., 2007). The re-colonization started from the low altitudes in the last phase of GS-2 with the first evidence brought to light at Riparo Tagliente (VR). At the beginning of the Bølling-Allerød interstadial, thanks to the reforestation at altitudes up to 1700 m a.s.l., human occupation achieved around 500 m a.s.l. (Riparo Villabruna, Clusantin and Grotte Verdi di Pradis). This process become progressively more intensive during both the Allerød (Val Lastari and Riparo Dalmeri) and the Younger Dryas (Bus de la Lum, La Cagola, Le regole, Palu Echen), reaching altitudes up to 1000 - 1200 m a.s.l, or even more (e.g., Malga Staulanza, Riparo Tschonstoan) (Fig. 2.10). To these latter must be added other undated middle altitude sites which were referred, based on lithic artefacts typology, to the last part of the Late Epigravettian (e.g., Piancavallo, Andalo, Viotte, Palughetto). It is interesting to note how the colder phase related to the GS-1 did not stop human re-colonization in the Alps (Mussi and Peresani, 2011; Ravazzi et al., 2007). During the interstadial and the Younger Dryas other valley bottom sites were occupied (Riparo Biarzo, Riparo Soman and Terlago) designing a clear settlement system divided between valley bottom and medium altitude occupations. This particular sites distribution associated with archaeozoological data allowed to propose a seasonal exploitation of the territory (Bertola et al., 2007; Broglio, 1994): valley bottoms were occupied during both cold and hot seasons (e.g., Riparo Tagliente, Riparo Soman, Riparo Biarzo), while medium altitude areas were frequented during the spring and summer (e.g., Riparo Dalmeri and Riparo La Cogola).

As regards the function of these sites, in relation to the surrounding environment, it is difficult to delineate a clear and universal model. At a general level it seems possible to distinguish open-air sites from caves and rock-shelters. The former are more specialised and extemporaneous, the latter, generally interpreted as "residential", are more intensively occupied and functionally articulated (Ziggiotti, 2007).

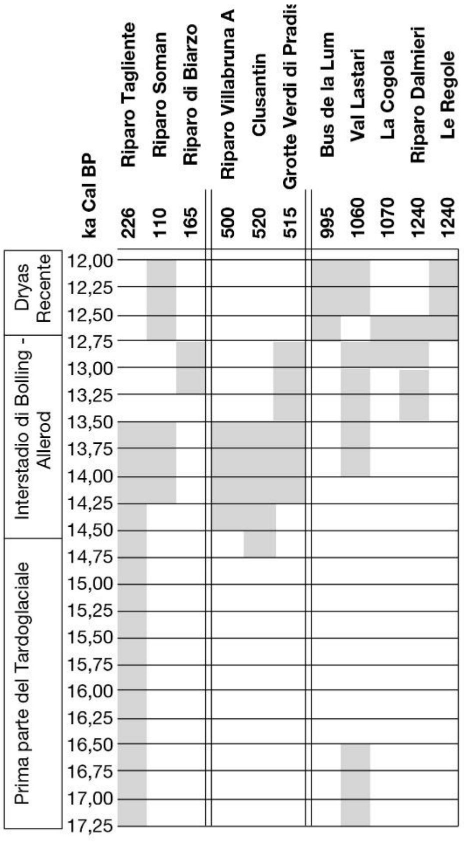


Fig. 2.10 - Altitudinal distribution of Late Epigravettian sites of North-Eastern Italy across the Late Glacial (from Ravazzi et al., 2007).

Recently, R. Duches and colleagues (2014) proposed for the GS-1 a settlement system characterised by higher mobility patterns compared to the previous period. According to the Authors, simplicity of spatial organisation, limited artefacts dispersion and spatio-temporal segmentation of chaine opératoires show a settlement system articulated around numerous small camps frequented for short periods, rather than a few sites located in strategic positions and periodically re-occupied.

2.2.5. Towards the West

Although the similarity between the Italian and Provençal lithic industries have been underlined by Laplace since 1964, the Provençal Late Palaeolithic was for a long time studied according to a different methodology leading to a completely different cultural division. The first studies carried out by M. Escalon de Fonton since 1950s' (and then by G. Onoratini) allowed identifying a specific cultural sequence of the Provençal area composed by several regional facies: the *Salpêtrièn, Arénien*, *Bouvérien* and *Valorguien* (Escalon de Fonton, 1984, 1972, 1966, 1954; Escalon de Fonton and Daumas, 1951). In the following years this plurality of cultural traditions was strongly criticised and related either to the western Atlantic sequence or the Italian one.

Three sites yielded artefacts referred to the *Salpêtrièn* (Escalon de Fonton, 1964, 1963): Salpêtrière, Rouvière and Cadenet. All of them are located on the right bank of the Rhone (Gard). More recent studies (Boccaccio, 2006, 2005; Onoratini, 1982) argue in favour of a strong convergence between the Early *Salpêtrièn* and the Late Solutrean and the Late *Salpêtrièn* and the Upper Magdalenian.

The *Arénien* was defined by M. Escalon de Fonton (1966) based on the analysis of artefacts from the eponymous site of Arene Candide. This facies, characterised by the presence of unifacial foliate points, shouldered points and microgravettes, was associated to the Early Epigravettian by G. Onoratini in 1982. Also the *Bouvérien,* which was proposed by G. Onoratini after the study of the lithic industries of Grotte Rainaudes and Bouverie, was rejected by Palma di Cesnola (Palma di Cesnola, 2001) and associated to the Epigravettian.

The analysis of several sites dated to the Allerød, such as Abri Cornille, Abri Capeau (Istres, Bouches-du-Rhône), Abri Arnoux (Saint-Chamas, Bouches-du-Rhône), Abri de la Marcouline (Cassis, Bouches-du-Rhone) and Baume de Valorgues (Saint-Quentin-la-Poterie) allowed M. Escalon de Fonton to define the *Valorguien* (1972) (Fig. 2.11). These assemblages present, along with *microgravettes*, a type of backed point called *Point d'Istres* (Escalon de Fonton, 1972; Onoratini, 1982). The similarities in armatures production with Saint-Antoine-Vitrolles (Hautes-Alpes, France) prompted C. Montoya (2002, 2004) to attribute these sites to the Late Epigravettian thus placing the western border of the Late Epigravettian expansion along the Rhone Valley.

Recently, through the analysis of the lithic assemblages of several sites of the Jura and of the Northern side of Alps, S. Fornage-Bontemps and L. Mevel (e.g., Rochedane, layer A4 and

Mannlefelsen I, layer R; Fornage-Bontemps, 2013; Mevel et al., 2014) noted comparable features with the Late Epigravettian industries of Saint-Antoine-Vitrolles (Hautes-Alpes, France) suggesting Late Epigravettian penetrations during the Younger Dryas in territories previously occupied by Azilian groups. The role of cultural crossroad played by this region seems to be confirmed also by the discovery of sites referring to the Laborian (Jallet and Bouvier, 2012; Monin, 2000; Pasty, 2017). A similar situation was observed in the rockshelter of Château-d'Œx (Swiss Prealps) where to a Late Azilian occupation dated to around 13.000 cal BP follows a Late Epigravettian occupation dated to the Younger Dryas-Preboreal transition (Crotti et al., 2016).

Actually, S. Fornage-Bontemps (2013) identified Late Epigravettian-like backed points also in Abri de Gigot layer D2 (Bretonvillers, Doubs), northwards of Altwasser-Höhle 1 (Rüle, Appenzell, Switzerland) and Gönnersdorf (Feldkirchen, Kreis Neuwied, Germany) and eastwards of river Rhône in the sites of Baume d'Oullins (Ardèche), Fontaine Pila Saint-Gelly (Montpellier), Grage des Merveilles (Rochefort-du-Gard), Mas de Mayan (plaine du Nimes) and Usclades (Nant).

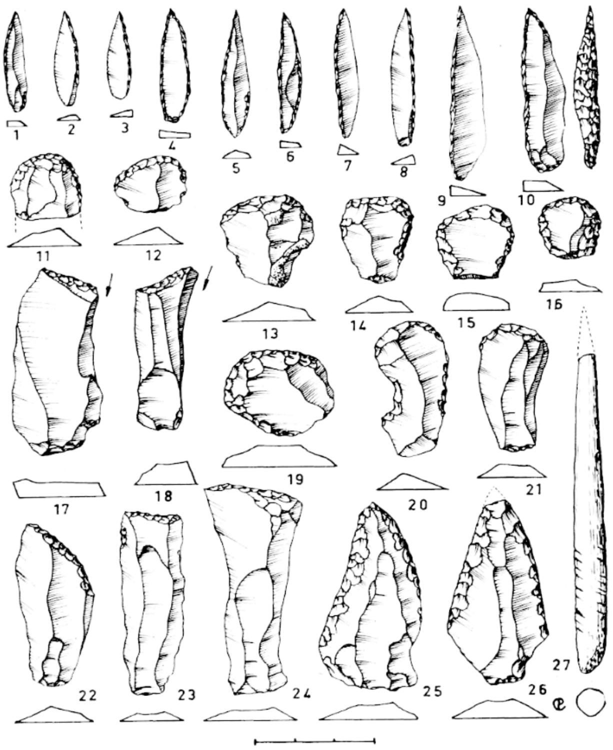


Figure 2.11 – La Baume de Valorgues layers 9-8 (from Escalon de Fonton 1966).

2.3. The Italian "Sauveterriano"

While in France the Sauvetterian was defined during the first half of the 20th century, in Italy the first discoveries date back between 1968 and 1975 when three main Mesolithic sequences were brought to light in the Adige Valley (N-E Italy) (Broglio, 2016, 1980, 1976, 1971): Vatte di Zambana, Romagnano Loc III and Pradestel. At the same time several Mesolithic sites were found also in the Dolomites (North-Eastern Italy) between 1900 and 2400 m a.s.l. (Bagolini et al., 1984; Bagolini, 1972; Bagolini et al., 1975; Bagolini and Dalmeri, 1987; Broglio and Lanzinger, 2000; Broglio and Lunz, 1978). The most important evidence are the sites of Mondeval de Sora (Fontana et al., 2009b), Colbricon (Bagolini and Dalmeri, 1994), Lago delle Buse (Dalmeri and Lanzinger, 1994), Pian dei Laghetti (Bagolini et al., 1984) and Plan de Frea (Angelucci, 1996).

The typological analysis of lithic assemblages (especially those of the Adige Valley sites) led A. Broglio to identify both the Sauveterrian and the Castelnovian in this region and to relate these assemblages to those of Southern France sequence: *« è possibile avanzare l'ipotesi dell'esistenza di una vasta area culturale che abbraccerebbe la Francia meridionale, la Valle Padana e il Carso Triestino, dove l'Epipaleolitico è rappresentato da complessi di questo tipo [Sauveterrian and Castelnovian] »* (Broglio, 1971, p. 232). Thus, a cultural homogeneity between Northern Italy and Southern France was already proposed in 1971. Recently D. Visentin (2017) observed similar lithic technical systems between these two regions, although numerous "stylistic" differences concerning domestic tools and armatures are still recognisable.

The richness and chronology of the multi-layered sites of Romagnano III, Vatte di Zambana, and Pradestel allowed A. Broglio and S.K. Kozłowski to define a typological list for both the Sauveterrian and the Castelnovian (Broglio, 1980; Broglio and Kozlowski, 1984).These studies have considered not only retouched artefacts but also cores. Regarding the Sauveterrian three phases were identified on the base of armatures variability and radiocarbon dates:

- Early Sauveterrian (approximately 11500-10500 cal BP)
- Middle Sauveterrian (approximately 10500-9500 cal BP)
- Late Sauveterrian (approximately 9500-9000 cal BP)
- Final Sauveterrian (approximately 9000-8500 cal BP)

The typological similarities between the Terminal Epigravettian and the Early Sauveterrian (spread of geometrics produced by the microburin blow technique) led several authors to consider the transition between Upper Palaeolithic and Mesolithic as continuous (Broglio, 1973; Guerreschi, 1984a; Martini and Tozzi, 1996). Recently, technological studies seem to confirm this hypothesis (Bassetti et al., 2009; Cusinato et al., 2004; Ricci, 2018; Tomasso et al., 2020).

The definition of a Sauveterrian-like assemblage led to a rapid increase of research enlarging the "Sauveterriano" region. In North-Eastern Italy sites referred to Sauveterrian amount to some hundreds spanning from the he Pre-Alpine belt (Bertola and Cusinato, 2005; Broglio et al., 2006; Cusinato et al., 2004; Fiore and Tagliacozzo, 2004; Frigo and Martello, 1994; Peresani, 2009; Peresani et al., 2009; Peresani and Angelini, 2002; Peresani and Bertola, 2010; Visentin et al., 2016b) and the Venetian-Friulian plain, especially along the springs line and towards the Venetian lagoon (Corazza et al., 2009; Fontana et al., 2016; Fontana and Visentin, 2016). Several sites were discovered also in the southern Po Plain (Farabegoli et al., 1994;

Fontana and Cremona, 2008; Fontana and Guerreschi, 2009; Marchesini et al., 2016; Visentin et al., 2016a, 2014) and northern Apennines (Fontana et al., 2013).

In the Western Alpine range the most important evidence is represented by the sites of Mount Fallère (AO; Raiteri, 2013) and Alpe Veglia (VB, Gambari et al., 1991), while in the central sector of the southern Alps (Lombardy) research by F. G. Fedele, P. Biagi and more recently F. Martini brought to light several Early Mesolithic sites (e.g. Biagi, 1997; Biagi and Starnini, 2015; Fedele, 1990; F. Martini et al., 2016; Fabio Martini et al., 2016). In Liguria several open-air sites were discovered but all of them are surface collections and with uncertain chronology (Maggi and Negrino, 2016).

Moving to the south, the density of Sauveterrian occupations decreases and lithic assemblages show higher variability from a typological and structural viewpoint, which has been interpreted as the reflection of a more fragmented cultural framework (Lo Vetro and Martini, 2016; Martini and Tozzi, 1996). According to these Authors the lithic industry variability designs four different contemporaneous facies: Sauveterrian-like facies (11600 and 8600 cal BP), Undifferentiated Epipalaeolithic (11200 and 8000 cal. BP), Epiromanellian (11700 and 9900 cal. BP) and Epigravettian Tradition facies (11000 and 9100 cal. BP). These presumed cultural facies are interpreted as the result of a strong regionalization process attested in central and southern Italy since the Late Epigravettian (Palma di Cesnola, 1993, 1983). The Sauveterrian-like facies is sporadically attested in the Fucino Basin, Low Tirennian area, Apulia and Sicily.

2.4. Between the Atlantic and Mediterranean: a focus on lithic production

After a general presentation of the main cultural traditions characterising the South-Western European Late Glacial and Early Holocene, we will analyse the lithic assemblages attested in Southern France and Northern Italy by presenting the objective of reduction, reduction schemes and armatures variability for each cultural tradition between the end of the GS-2 and the Early Holocene. The wide territory analysed has been divided into three main areas which are discussed individually:

- South-Western France
- North-Eastern Italy
- North-Western Italy and South-Eastern France

2.4.1. South-Western France

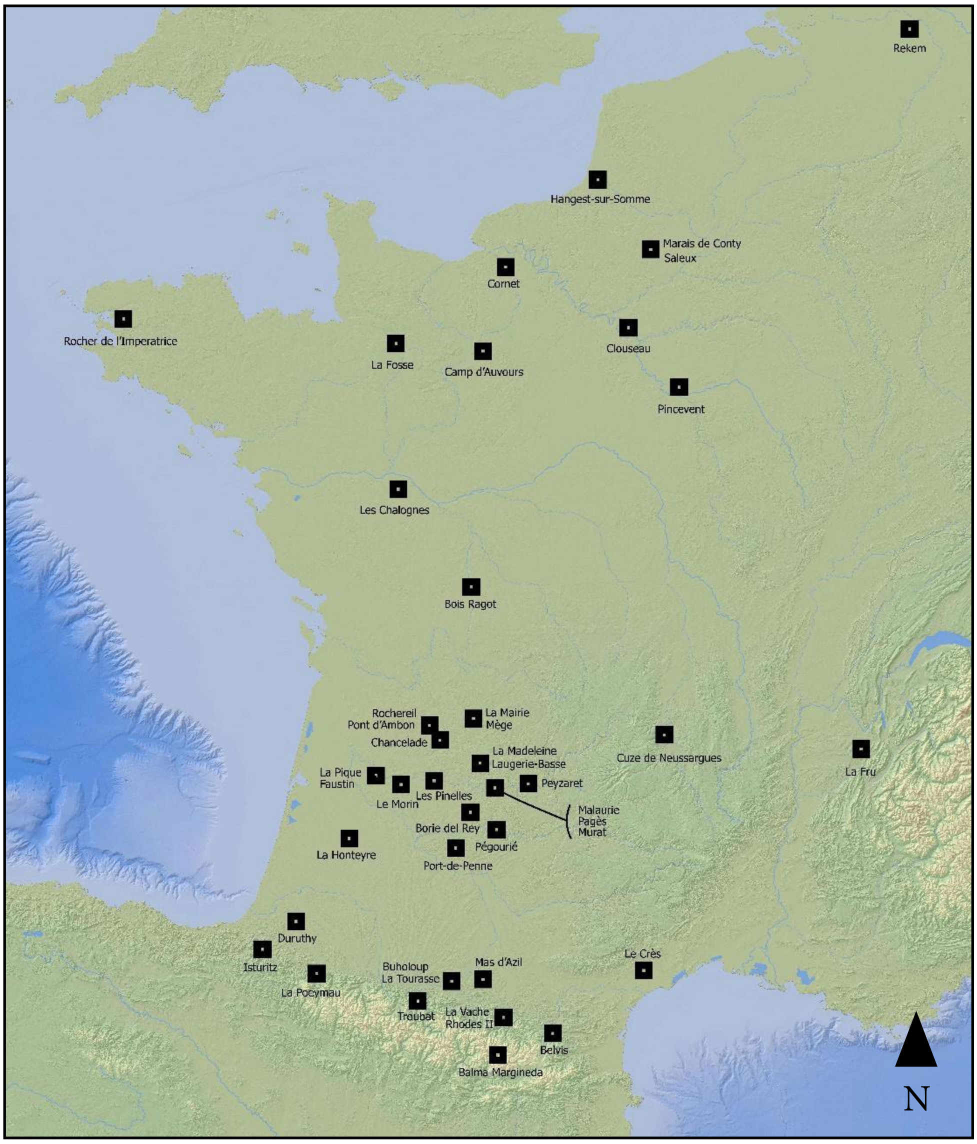


Figure 2.12 - Location of Late Glacial sites of France cited in the text.

2.4.1.1. Upper Magdalenian

South-Western France has long been one of the main regions for Magdalenian research. Several chronological models have been established across time on the basis of techno-typological markers and radiocarbon dating thanks to several collective projects (e.g., MAGDATIS, MAGDAQUI and PAVO) and doctoral dissertations (e.g., Dachary, 2002; Lacombe, 1998; Langlais, 2007; Sécher, 2017). Up to now our knowledge on lithic technical systems of the Upper Magdalenian in the South-West is still mainly based on results of M. Langlais Ph.D. (2007) and to the synthesis proposed by the Author in the following years (Langlais, 2010; Langlais et al., 2016, 2014c, 2012) together with other few studies (e.g., Angevin, 2012; Taylor, 2012). In one of the last publications the Upper Magdalenian has been divided in two main chrono-cultural phases (Langlais et al., 2016): Early Upper Magdalenian (16500-15000 cal BP) and Late Upper Magdalenian (15000-14000 cal BP).

2.4.1.1.1. Objectives and production schemes

During both the Early and Late Upper Magdalenian the knapping activity was aimed at obtaining standardised blades and bladelets (Fig. 2.13). Two main *chaine opératoires* were identified. The former is a "mixed scheme" which testifies the transition from blades to bladelets starting from the same block. Cores are systematically prepared through a frontal crest that often also involves flanks and sometimes even the back (posterior crest as during the Middle Magdalenian). The debitage rhyme is unidirectional and semi-tournant. The debitage surface is narrow and orientated following the greatest length of the volume suggesting the intention to produce narrow and elongated blanks. The gradual core reduction through the detachment of *tablettes* and striking platform maintenance flakes allows the transition from blades to bladelets. In the Pyrenean this specific reduction scheme is less attested compared to the rest of the South-West. The second production scheme consists of an independent bladelets/microbladelets production. The reduction sequence can develop through two different unidirectional modalities:

- Burin-like exploitation of thick flakes
- Frontal or semi-tournant debitage from pyramidal or prismatic cores

Upper Magdalenian cores have an angle between the striking platform and the debitage surface fairly closed (45°-70°). Regarding the knapping techniques, a tangential direct percussion was applied both by an organic and soft-stone hummer (Lacombe, 1998; Langlais, 2007; Mallye et al., 2018). According to what M. Langlais (2007) observed in the sites of Balvis and Parco the organic hummer was employed for detaching blades, whereas the soft stone one for bladelets. The coexistence of these two knapping techniques was documented also in other Magdalenian regions (e.g., Valentin, 2006, 1995).

Blades are used to produce domestic tools which are mainly composed by burins, long end-scrapers, and retouched blades. Armatures are manufactured on bladelets and microbladelets.

As far as raw material provisioning is concerned, although there is a clear reduction of the supply area compared to Middle Magdalenian (Angevin and Surmely, 2013; Fontana et al., 2003; Lacombe, 2005, 1998; Langlais, 2010; Langlais and Sacchi, 2006; Pétillon et al., 2014; Primault et al., 2010; Sànchez, 2015; Sécher and Caux, 2017) several evidence still attests to a wide network of exchange (Langlais et al., 2016). On the northern slopes of the Pyrenees, lithic assemblages were flaked on both local and allochthonous flint (Lacombe, 1998; Langlais, 2007; Langlais et al., 2016; Simonnet, 2007). For example Lacombe (1998) identified at Troubat (layer 8) several artefacts made from raw material outcropping in the Aquitania (e.g., Chalosse, Grain de mil, Bergeracois) and Aude (Charophytes). Both regions are more than 100 km away from Troubat. Also at the Sable des Landes, a region quite rich of good quality raw material, a block of Charentais flint imported from over 100 km has been recorded in the site of La Honteyre (Gourc, 2015).

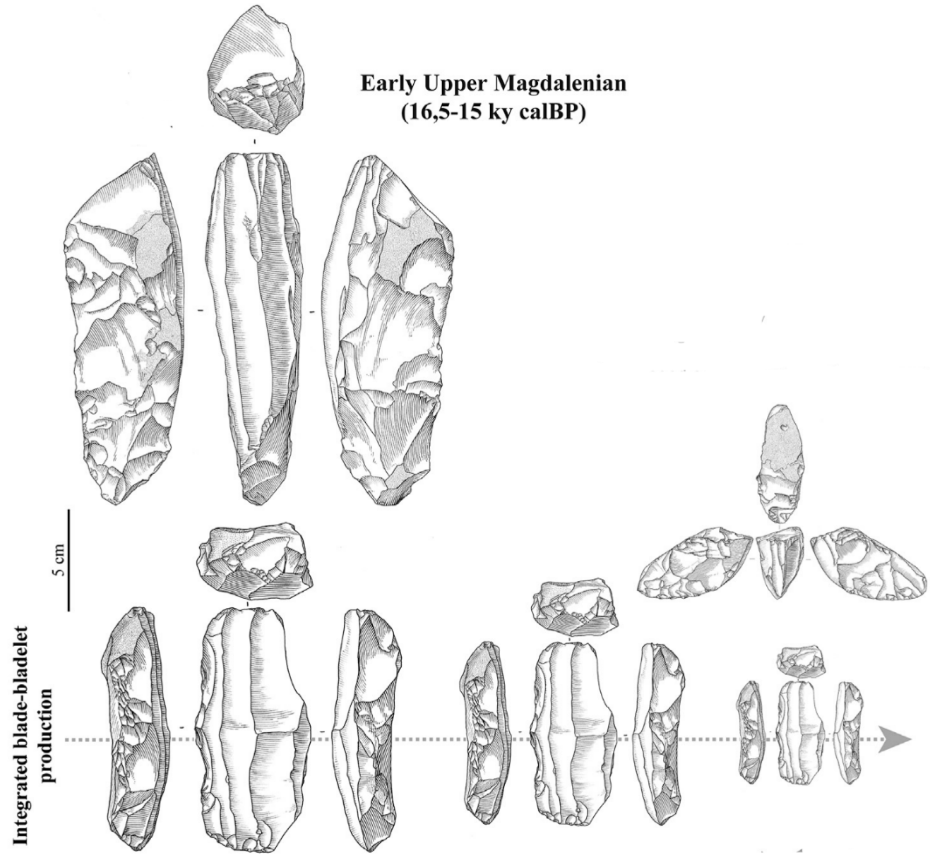


Figure 2.13 - Lithic production during the Erly Upper Magdalenian (from Langlais et al., 2016 modified).

2.4.1.1.2. Armatures

The design of projectile weapons represents the main difference between the Early Upper Magdalenian (EUM) and the Late Upper Magdalenian (LUM). Next to the persistence of certain morpho-types, such as backed bladelets (often naturally pointed) and backed truncated bladelets, new armatures developed. During the EUM shouldered points and *Gravette*-like backed points are attested in several sites of the Aquitaine basin (Arambourou et al., 1978; Dachary, 2006; de Sonneville-Bordes, 1960; Langlais, 2018, 2008). The former are documented in the Le Morin B, Faustin, La Pique and La Madeleine and sporadically also in the Atlantic Pyrenees (e.g., Duruthy). The latter were mainly found in Dordogne (e.g., La Madeleine, La Mairie and Abri Mège). At the same time, this first phase of the Upper Magdalenian is characterised by the development of scalene triangles. This morpho-type is produced either with (rare) or without (frequent) the microburin technique. It spreads in the Pyrenees region (e.g., Belvis, Parco level II, Troubat level 8 and 7, and La Vache) as well as in the Aquitaine Basin assuming in the latter area an extremely elongated shape (cf. *pointes à troncature oblique*). A pointed backed bladelet characterised by a basal inverse or direct truncation appears in several assemblages (Langlais, 2018, 2008).

At the onset of the LUM, shouldered points and *Gravette*-like backed points are replaced by Teyjat and Laugerie-Basse points. A good amount of these morpho-types were documented in the Aquitaine Basin (e.g., Le Morin A, Faustin, La Honteyre, Laugerie-Basse, Chancelade, uppermost layers of La Mairie, Rochereil, La Madeleine, Pont d'Ambon layer 5), while it seems absent in the Pyrenees. By contrast, backed bladelets, backed truncated bladelets and scalene triangles do not disappear. As claimed by M. Langlais (2018) the geographical distribution of lithic points during the Upper Magdalenian seems to indicate a clear distinction in the way of conceiving projectile implements between the groups inhabiting the Aquitaine plains and the foothills of Quercy (with lithic points) and those situated on the Pyrenees and the Languedoc (without lithic points).

Focusing on blank selection, two main categories were identified. Small blades/ bladelets used for the production of lithic points and narrow and thin microbladelets transformed into backed bladelets, backed truncated bladelets and scalene triangles (Langlais, 2007; Langlais et al., 2016). In the site of Le Crès M. Langlais observed a high exploitation of microbladelets extracted from flake-cores (Langlais, 2004). This difference in blank selection may be ascribed to a separate function of projectile implements: perforating for lithic points vs. tearing/slashing for backed bladelets, backed truncated bladelets and scalene triangles. The hypothesis of an axial position on the shaft for Upper Magdalenian lithics points is based exclusively on their morphology, since use-wear analysis and dedicated experimental programs are still missing. On the contrary, the use as lateral implements of the other morpho-types (especially backed bladelets) was confirmed by several archaeological findings (e.g., antler projectile points armed with backed bladelets from Pincevent and the Blanchard cave; Allain and Descouts, 1957; Leroi-Gourhan, 1983), experimental activities (Pétillon et al., 2011; Roux et al., 2020) and several analyses of impact damages (Christensen and Valentin, 2004; Clemente Conte et al., 2017; Roux et al., 2020; Sano, 2009; Symens, 1986; Taller et al., 2012).

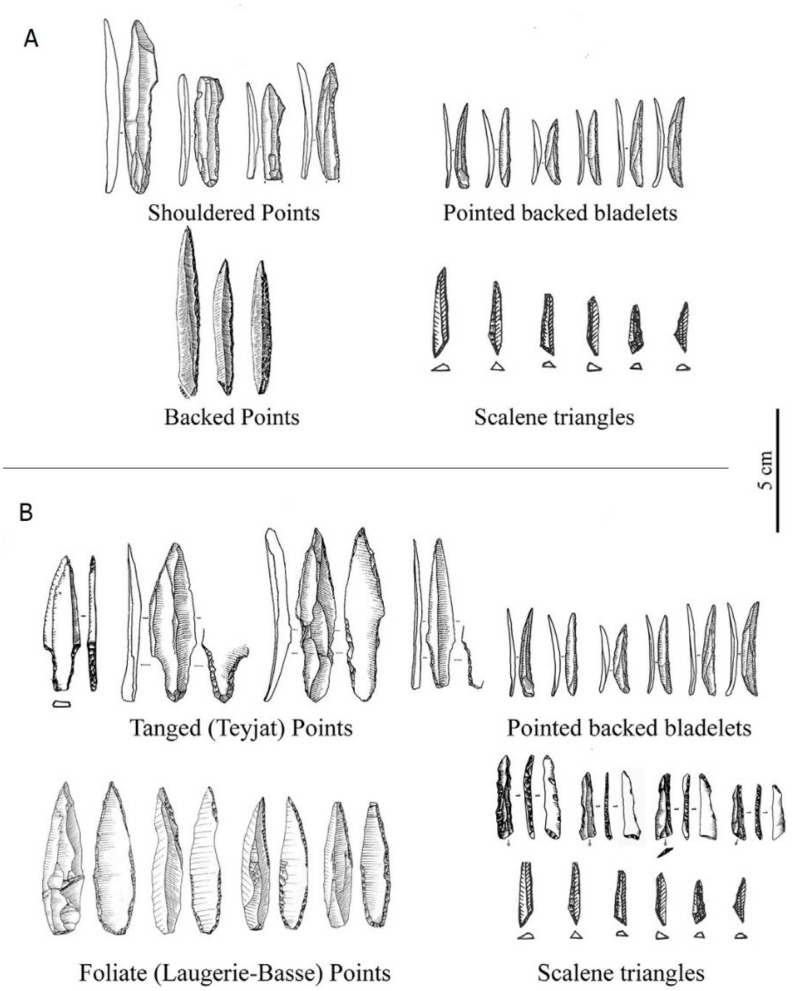


Figure 2.14 – Armatures variability during the Early Upper Magdalenian (A) and the Late Upper Magdalenian (B) (from Langlais et al., 2016 modified)

2.4.1.2. Early Azilian

South-Western France has been central (mainly Dordogne) to the debate on the Azilianization process. It is here that Bordes and D. de Sonneville Bordes analysing the stratigraphic sequences of Morin and Gare-de-Couze proposed the progressive Azilianization of Upper Magdalenian lithic assemblages (Bordes and de Sonneville-Bordes, 1979). Few years later, this model was rejected thanks to excavations in the sites of Pont d'Ambon by G. Célérier and Boit Ragot by A. Challot. The limited post-depositional process that took place in both sites allowed the identification of an Early Azilian phase with no Magdalenian elements (Célérier et al., 1997). Nevertheless, Early Azilian lithic production is not homogeneous throughout this wide region. Two distinct areas can be identified (Fat Cheung et al., 2014): Aquitaine, where the Early Azilian assemblages present features shared with the rest of France (Mevel, 2013; Naudinot et al., 2017a; Valentin, 2006), and the Pyrenees which attests to a different lithic industry (Fat-Cheung, 2020, 2015; Fat Cheung et al., 2014).

Despite the richness of lithic assemblages in this period detailed analysis aimed at reconstructing raw material provisioning and reduction schemes is still missing with the exception of G. Célérier's works (1993, 1998) at Pont d'Ambon. For this reason in order to briefly present the main features of Early Azilian technical systems we also referred to more exhaustive studies conducted outside the examined area (e.g., Clouseau, Bodu, 2000; Bodu and Mevel, 2008; Bodu and Valentin, 1997; La Fru, Mevel, 2013, 2010; Rocher de l'Impératrice, Naudinot et al., 2017a; Bois-Ragot, Valentin, 2006).

2.4.1.2.1. Objectives and production schemes

Early Azilian groups are clearly oriented toward the production of standardised blades (Bodu, 2000; Bodu and Mevel, 2008; Célérier, 1998, 1993; Mevel, 2013, 2010; Naudinot et al., 2017a) (Fig. 2.15). These blades are regular, with parallel edges and a flat cross-section suggesting the removal from cores with low transverse convexities. Their profile is straight or at least slightly convex. Two distinct production objectives can be identified: long (>70 mm) and large (>15mm) blades used unretouched or retouched in various domestic tools (burins, long endscapers, typical lateral flat scalar retouch blades) and short (50-70 mm) and narrow ones produced in a second step of the reduction process. The latter are transformed into projectile points. An independent short blades production was hypothesised at La Fru (Mevel, 2013). Bladelets/microbladelets were not a target. Short endscrapers on flakes are attested.

Even though the preparation of a crest is well documented, the shaping-out phase is less elaborate compared to the Upper Magdalenian. Two opposed platforms are frequently created. At Pont d'Ambon G. Célérier noted «*…des changements fréquent du sens d'extraction dans le dessein de s'affranchir des accidents de débitage pour des produits au profil aussi peu arqué que possible. »* (Célérier 1998 p. 243). On the contrary, at Rocher de l'Impératrice Naudinot et al. (1017) observed a more frequent unidirectional debitage. The same was reported in the open-air site of Clouseau in the Paris Basin (Bodu and Valentin, 1997). The angle between the striking platform and the debitage surface is around 80°-90° (Célérier, 1998). Soft hammerstone direct percussion is systematically used after meticulous abrasion of the overhang which is an essential point for this knapping technique (Pelegrin, 2000). The raw material exploited by Early Azilian groups is mainly local, although allochthonous flint was observed in several sites (Célérier, 1993a; Naudinot et al., 2017a).

The Pyrenean site of Rhodes II (Arignac, Ariège) was analysed by C. Fat-Cheung (2015) during her Ph.D. The lithic industry of *foyer* 5 (13800-13400 cal BP) shows a completely different technical behaviour compared to the usual norms of the Early Azilian production. This diversity is represented by a less normalised production of short and large blades, a higher importance of flakes for manufacturing domestic tools (short endscraper and *pièces esquillées*) and the exclusive presence of curved backed monopoints analogous to those attested during the Late Azilian. The same tools variability is attested at Balma Margineda layer 10, (Guilaine et al., 2008; Guilaine and Évin, 2007; Martzluff et al., 2019). Another specificity of the Pyrenean area is the high exploitation of local raw material different from flint, such as quartzite, quartz, schist and volcanic rocks (Fat-Cheung, 2020, 2015; Martzluff et al., 2019).

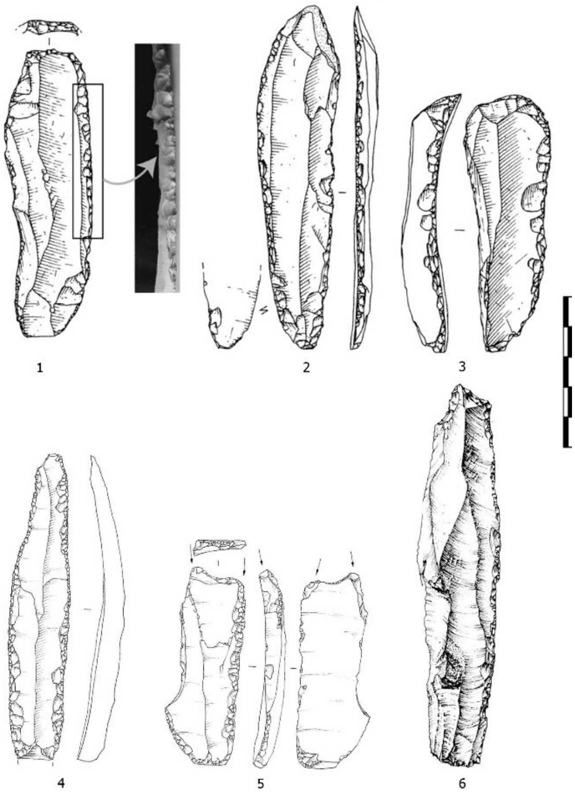


Figure 2.15 - 1-3: Closeau (Bodu and Mevel, 2008; 4-5: Rocher de l'Impératrice (Naudinot et al., 2018); 6: Pont d'Ambon (Célérier 1993).

2.4.1.2.2. Armatures

The Early Azilian is characterised by an extremely low armatures variability. The hunting equipment is mainly composed of two distinct morpho-types of curved backed points: monopoints and bipoints. The co-occurrence of these two morphologies was highlighted in several sites (e.g., Bois-Ragot, Pont d'Ambon, Murat, Morin, Rochereil). Their shape is fairly homogeneous throughout the Early Azilian territory with just few variants (Célérier, 1979; Mevel, 2013) (Fig. 2.16). To the West the Pyrenees seems to have represented a barrier for the diffusion of such points (Fat Cheung et al., 2014). Only Isturitz layer Ia (Langlais, 2010), and perhaps Rhodes II foyer 5 and 6 (Fat-Cheung, 2015 p.126) yielded few specimens.

This strong backed points standardisation is the result of both a normalised backing process and blank selection. Backs have a curved delineation opposite to a rectilinear cutting edge. The backed retouch is invasive in order to obtain pointed apexes, and it is more marginal on the mesial portion (Célérier, 1993a; Mevel, 2013b; Naudinot et al., 2017a; Valentin, 2006) (Fig. 2.17). At La Fru L. Mevel (2013) observed the selection of blades with one naturally convex edge with the aim to minimise the retouching phase. N. Naudinot suggests the use of percussion with a hammerstone to retouch backed points at Rocher de l'Impératrice (Naudinot et al., 2017). The same result was obtained by Mevel et al (2014) for the Late Azilian curved-backed monopoints from l'abri de La Fru layer 2 aire

H. Plisson (2005) - by analysing lithic points from layer 4 of Bois Ragot - suggested a latero-distal position of bipoints with a perforating apex on axis with the shaft and a lateral apex playing both a retentive and cutting role (Fig. 2.17). This hypothesis is mainly based on MLIT's (microscopic linear impact traces) orientation. The same hafting method was confirmed by other Authors in other Early Azilian sites (Naudinot et al., 2017). B. Valentin (2006) claims that this double function of bipoints (namely perforating and tearing/slashing) might be the reason for the disappearance of backed bladelets and in general barbs during the Early Azilian.

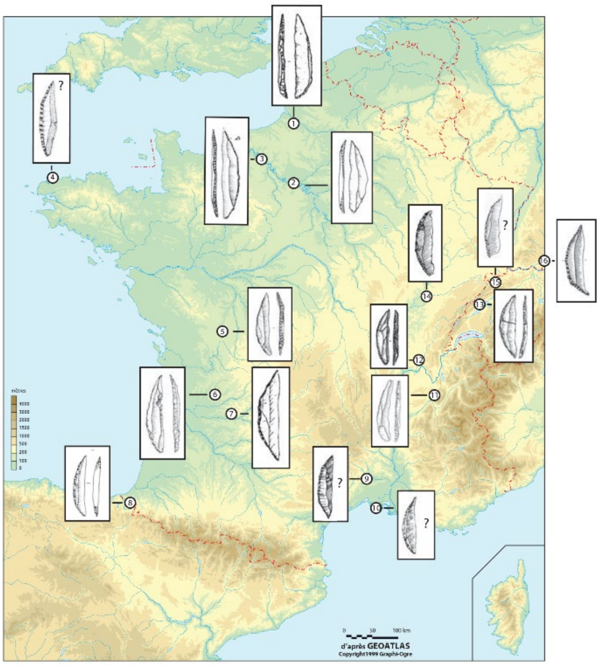


Fig. 2.16 Diffusion of Early Azilian curved backed points. 1: Hangest; 2: Le Closeau; 3: Grotte du Cheval; 4: Roc'h Toul; 5: Bois Ragot; 6: Pont d'Ambon; 7: Villepin; 8: Isturitz; 9: Baume de Valorgues; 10: Abri Cornille; 11: Abri de la Fru; 12: Abri Gay; 13: Monruz; 14: Rochedane; 15: Neumuhle; 16: Peterdfels (from Mevel, 2013).

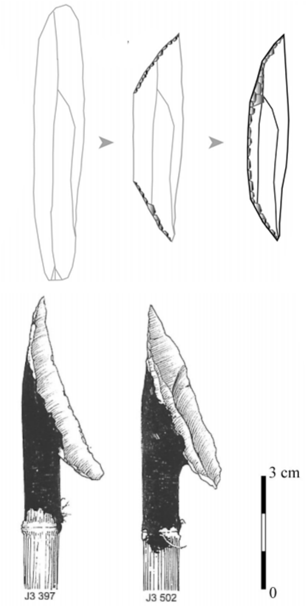


Figure 2.17 – Reduction process of Early Azilian bipoints (from Valentin, 2006 modified) (above). Hafting modality reconstruction of two Early Azilian bipoints from Bois Ragot (from Plisson, 2005 modified).

2.4.1.3 Late Azilian

The Late Azilian develops throughout the GI1d-c-b-a and at least until the first half of the GS1 in the Pyrenees (Fat-Cheung, 2015; Fat Cheung et al., 2014, 2020). As seen for the Early Azilian detailed technological studies are few in the Aquitania Basin. Pagès, (Fat Cheung, 2014), Pont d'Ambon layer 3A and 3 (Célérier, 1998, 1993a), Pégourié (Seronie-Vivien, 1995) and Pinelles, (Mevel et al., 2017) are the best studied from a technological viewpoint. The

Pyrenees area is better known thanks to a recent Ph.D. project conducted by C. Fat-Cheung (2015) and dedicated to production modalities of lithic artefacts on several sites: Troubat, La Tourasse, Le Poeymau and Rhodes II.

2.4.1.3.1. Objectives and production schemes

At a general level the lithic industry from this recent phase of the Azilian are produced on raw materials collected from limited procurement. The reduction schemes are extremely simplified compared to the Early Azilian and aimed at obtaining poorly standardised, irregular and thick products which are often large blades and elongated flakes. After opening a striking platform, the debitage surface was arranged following the natural round surfaces of the exploited nodules. Preparation of a crest is rare and frequently unilateral. The debitage surfaces are open and flat and the production sequence follows a unidirectional and semi-tournant rhythm. The opening of an opposite striking platform is only occasionally attested. The knapping technique changes with respect to the previous Azilian phase: full debitage products were extracted through direct percussion with a hard (or less frequently soft) stone used with a linear motion aimed at striking inwards with respect to the overhang which is never trimmed. In this regards G. Célérier wrote (about lithic artefacts from Pont d'Ambon layer 3A): « *La proportion des talons ayant conservé un aspect denticulé, c'est-à-dire n'ayant subi aucune réduction des surplombs par abrasion ou grattage, dépasse 70 %.* » (Célérier, 1993a, p. 42) or even « *La quasi-absence de traces de préparation des plans de frappe est un des caractères qui séparent le plus radicalement l'aspect technique de l'ensemble 3A [Late Azilian]de celui de 3B [Early Azilian].* » (Célérier, 1993a, p. 44). The use of flakes as blanks for the production of domestic tool (especially endscrapers, Fig. 2.18 n. 4-6) sharply increases together with the selection of numerous by-products coming from the initialisation and/or maintenance phase (Fig. 2.18 n. 1-2): « *La présence de plages corticales sur plus de 60 % des supports suggère que cette caractéristique n'a pas eu d'influence discriminante dans leur sélection.* » (Célérier 1993 p. 43). Among domestic tools several backed knives appear (e.g., Pinelles).

A burin-like exploitation of thick flakes is documented in Pont d'Ambon layer 3 (Célérier, 1993a), Pagès (Fat-Cheung, 2014) and Pinelles Locus B (Mevel et al., 2017) (Fig. 2.18 n.7). A flakes production (perhaps related to a final reduction phase of cores) is attested in layer 3A of Pont d'Ambon (Célérier, 1993a), layers I-III of Abri Murat (Fat Cheung et al., 2014) and Pinelles Locus B (Mevel et al., 2017). Cores can be strongly reduced in size before their abandonment and sometimes it is even impossible understand the production aim as claimed by Mevel and colleagues for the site of Pinelles « *…ils (cores) sont à ce point détériorés par les dernières opérations de débitage qu'il est impossible de déterminer quelles* étaient *les dernières intentions de production des tailleures.* » (Mevel et al., 2017 p. 329).

Differences between the Aquitania and the Pyrenean area continue even during the Late Azilian as suggested by C. Fat-Cheung (2014) after comparing lithic assemblages of Pagès (Rocamadeur, Lot) and layer 6 of Troubat (Troubat-en-Barousse, Hautes-Pyrénées). The former attests two reduction schemes: one aims at obtaining blades and in a second phase bladelets through frequent core re-orientations (Fig. 2.18 n.8), while the other one shows an independent bladelets production from thick flakes. By contrast, Troubat documents an intensive use of bipolar percussion next to a flaking activity orientated towards the production of flakes, elongated flakes and thick bladelets (both as independent and mixed schemes). Blades are almost absent. The morphology (small blocks) and nature of Pyrenean raw material (low-quality flint, quartzite, quartz and various volcanic rocks) represent other main differences between these two sites. Even domestic tools present several divergences: a different blank selection (blades in Pagès, flakes and elongated flakes in Troubat) and an high number of *pièces esquillées* next to an evident microlithization of endscrepers in Troubat.

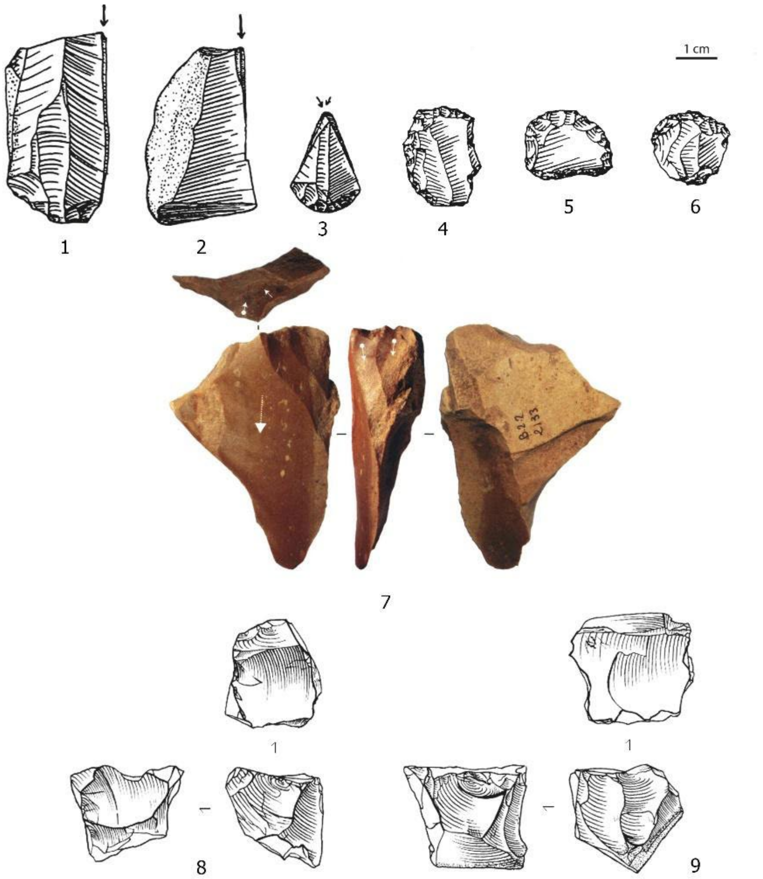


Figure 2.18 – 1-3: Burins from Pagès (Fat-Cheung, 2014); 4-5: short endscrapers from Troubat layer 6 (Fat-Cheung 2014). 7: flake-core from Pinelles (Mevel et al., 2017); 8-9: cores from Pagès (Fat-Cheung, 2014).

2.4.1.3.2. Armatures

During Allerød Late Azilian bipoints and monopoints gave way to a progressive diffusion of curved backed monopoints obtained from variable, thick and wide blanks and normalised by an invasive backing process (Fat Cheung et al., 2014; N. Naudinot et al., 2019; Thévenin, 1997). Compared to the previous Azilian phase, backed points are characterised by a higher morphological and morpho-metrical variability. The long typological list established by C. Célérier (Célérier, 1993b, 1979) at Pont d'Ambon is explicit of this variability. The Author identifies at least 6 different morpho-types belong to Late Azilian levels 3A and 3:

- *Pointe Azilienne banale* (unretouched base)
- *Pointe symétrique*
- *Pointe venture*
- *Pointe à base arrondie*
- *Pointe à base rétrécie*
- *Pointe courte*

Among them the *Pointe à base rétrécie* (also called penknife points ou *pointes de Grundy*) is the most attested type (Fig. 2.19 n.1-13). A similar backed points variability is mentioned also in several neighbouring sites, such as Abri Murat, Rochereil, Pégourié, Morin, Pagès and Bois Ragot (Fat Cheung, 2014; Fat Cheung et al., 2014; Valentin, 2006) or even in Chalognes, (Naudinot, 2008, Marchand et al., 2009) and Closeau *phase tardive* (Bodu and Valentin, 1997). In the Pyrenean context the situation is completely different. Although selected blanks are still irregular, Late Azilian armatures are smaller (their length rarely overpasses 30 mm) and present along with curved backed monopoints without an additional basal retouch, a more symmetric type called *Pointe fusiforme: «…c'est-à-dire à bords symétriques de part et d'autre de leur axe longitudinal…»* (Barbaza and Lacombe, 2005, p. 426) (Fig. 2.19 n.19-23). *Pointe à base rétrécie* are absent within the Pyrenean area (Fat Cheung, 2014; Fat-Cheung, 2015). Excluding some sporadic and uncertain specimens, such as in Pont d'Ambon layer 3 (Célérier, 1998) and Troubat layer 6 (Fat-Cheung, 2015), backed bladelets and more generally lateral projectile implements are absent in South-Western France during the Late Azilian.

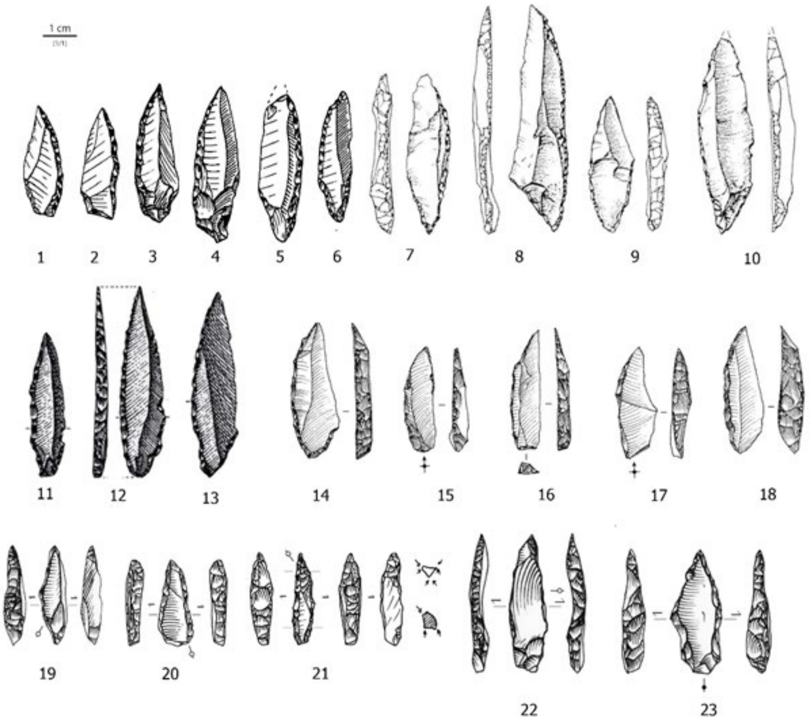


Figure 2.19 – Late Azilian backed points: 1-6 Pagès (Fat-Cheung 2014); 7-10 Pont d'Ambon (Célérier, 1993b); 11-13 Rochereil (Fat-Cheung et al ., 2014); 14-18: Bois Ragot (Valentin, 2006); 19-21 Rhodes II; 22-23 Troubat.

2.4.1.4. Laborian

The Laborian has been discovered for the first time in the Aquitania Basin at the eponymous site of Borie del Rey during 60's (Lot-et-Garonne, Coulonges, 1963). Few years earlier Niederland and colleagues (Niederlender et al., 1956) had identified a new type of backed truncated point in the Malaurie rock-shelter, namely *pointes de la Malaurie* (which today is considered as the *fossile directeurs* of the Early Laborian), but at the time it was referred to an « *Azilien original* ». In fact, initially the Laborian was perceived as part of the azilianization process. The re-valuation of the stratigraphic sequence of Borie del Rey by J.-M. Le Tensorer (1979), resulting in the identification of three diachronic phases (Prelaborian, Laborian and Epilaborian), and the discovery of an «*Azilien terminal à affinités Laboriennes*» at Pont d'Ambon (Célérier and Delpech, 1978) allowed to consider the Laborian as an independent cultural tradition. Recently, M. Langlais et al (2014) divided the Laborian in only two phases: Early Laborian (comprising both the *Laborien* and the *Prélaborien sensu* Le Tensorer 1979) and Late Laborian (Épilaborien *sensu* Le Tensorer 1979).

In South-Western France the Early Laborian covers a span of time between approximately 12700 cal BP and 11500 cal BP. This chronology is based on radiocarbon dates from several sites (layer 5 of Borie del Rey, layer 2 of Port-de-Penne, Malaurie rock-shelter and layer 2 of Pont d'Ambon). On the contrary, the Late Laborian is referred to the beginning of the Preboreal thanks to the only South-Western France site directly dated to this period, namely Peyrazet layer 2 (1266-11145 cal BP and 10513-10251 cal BP). Even if the chrono-cultural sequence of the Laborian needs to be better defined, this timetable seems to be confirmed by other sites outside the examined area (Langlais et al., 2020). In the Pyrenees, Laborian evidence is rare. The only dated site is Buholoup (11996-11393 cal BP).

The studies focusing on lithic industry in South-Western France are far from being exhaustive and the Laborian remains poorly studied compared to Northen (Bodu, 2000a; Fagnart, 2009; J.-P. Fagnart, 1997; B. Valentin, 2008; Valentin, 1995) and Western areas (Michel and Naudinot, 2014; Naudinot, 2013, 2010, 2008; Naudinot and Jacquier, 2014) of the country. A general framework is reported in several synthesis works (Langlais et al., 2020, 2014a, 2014b; Naudinot et al., 2019) mainly based on analysis conducted in La Borie del Rey, Port-de-Penne (Detrain et al., 2018; Langlais et al., 2014b), Peyrazet (Langlais et al., 2015) and Pont d'Ambon layer 2 (Célérier, 1998, 1993a).

2.4.1.4.1. Objectives and production schemes

Blades/bladelets production become extremely sophisticated using high quality raw material. The shaping out phase involves the entire volume of the core which is prepared through frontal and posterior/latero-posterior crests. Full lamino/lamellar products are characterised by a rectilinear profile, a flat cross-section and extremely acute and parallel cutting edges. To obtain such a morphology the debitage surface has a low transverse convexity and it is flaked following a facial modality alternating two opposite striking platforms (Fig. 2.20 n.1-2). The maintenance of the convexities was achieved by detaching orthogonal flakes from the back of the core and by creating neo-crests and partial neo-crests. The reduction process aimed at obtaining two blanks categories: blades (rarely longer than 10 mm) and bladelets. They can be produced through both independent *chaine opératoires* and mixed schemes by reducing core length through the detachment of *tablettes.* Striking platforms are plain or sometimes prepared by removing short flakes from the debitage surface before extracting full debitage lamino/lamellar products. According to several Authors (Célérier, 1998, 1993a; Langlais et al., 2014b, 2014a) the knapping technique adopted by Laborian groups is the soft stone direct percussion applied through a tangential gesture after a local overhang abrasion. The latter can be applied both from the striking platform towards the debitage surface or vice versa as observed by G. Célérier in layer 2 of Pont d'Ambon: «*…pour la première fois* [along the stratigraphic sequence of Pont d'Ambon]*, nous avons rencontré une abrasion vers l'intérieur du plan de frappe…»* (Célérier 1993 p. 61). The Author claims that such a technical solution is effective to control the width and thickness of products. Any precise information about the angles between the striking platform and the debitage surface is available, but looking at cores' drawings and pictures illustrated on several publications (Detrain et al., 2018; Langlais et al., 2015, 2014b, 2014a) it appears to be systematically lower than 80°. Blades not necessarily of *plein débitage* were transformed into endscapers, burins, truncations, backed knives and retouched blades (Fig. 2.20 n.4-6). The latter were also used unretouched (cf. *lame mâchurée*). Armatures were produced from short blades and bladelets.

Renewed interest for regular blades production results in a new change in raw material acquisition strategies with a significant extension of lithic procurement areas up to 250 km (Briois and Vaquer, 2009; Langlais et al., 2015, 2014b). More generally, we can note the transportation of blades already flaked. Furthermore, at Peyrazet Laborian groups had flaked raw material other than flint, such as quartzite by bipolar percussion (Langlais et al., 2015).

From a diachronic perspective the only significant change highlighted by M. Langlais and colleagues (2014a, 2014b, 2015) between the Early and Late Laborian is an increase of interest in bladelets production (Fig. 2.20 n.3) mainly extracted by unidirectional sequence, probably due to the appearance of *Blanchères* points (i.e. rectilinear backed points), which are manufactured on this specific blank class.

2.4.1.4.2. Armatures

The reason that led archaeologists to divide the Laborian in two phases is the important transformation in hunting lithic equipment (Langlais et al., 2020): an Early Laborian with backed truncated points (cf. *Pointes de la Malaurie*) and backed bi-truncated bladelets (cf. *rectangles*) and a Late Laborian with bi-truncations (cf. *Bitroncatures trapéziformes*) and *Microgravette*-like backed points (cf. *Blanchères*) (Fig. 2.21). This diachronic pattern is well documented at the Borie de Rey sequence (Langlais et al., 2014b) and seems to be validated by

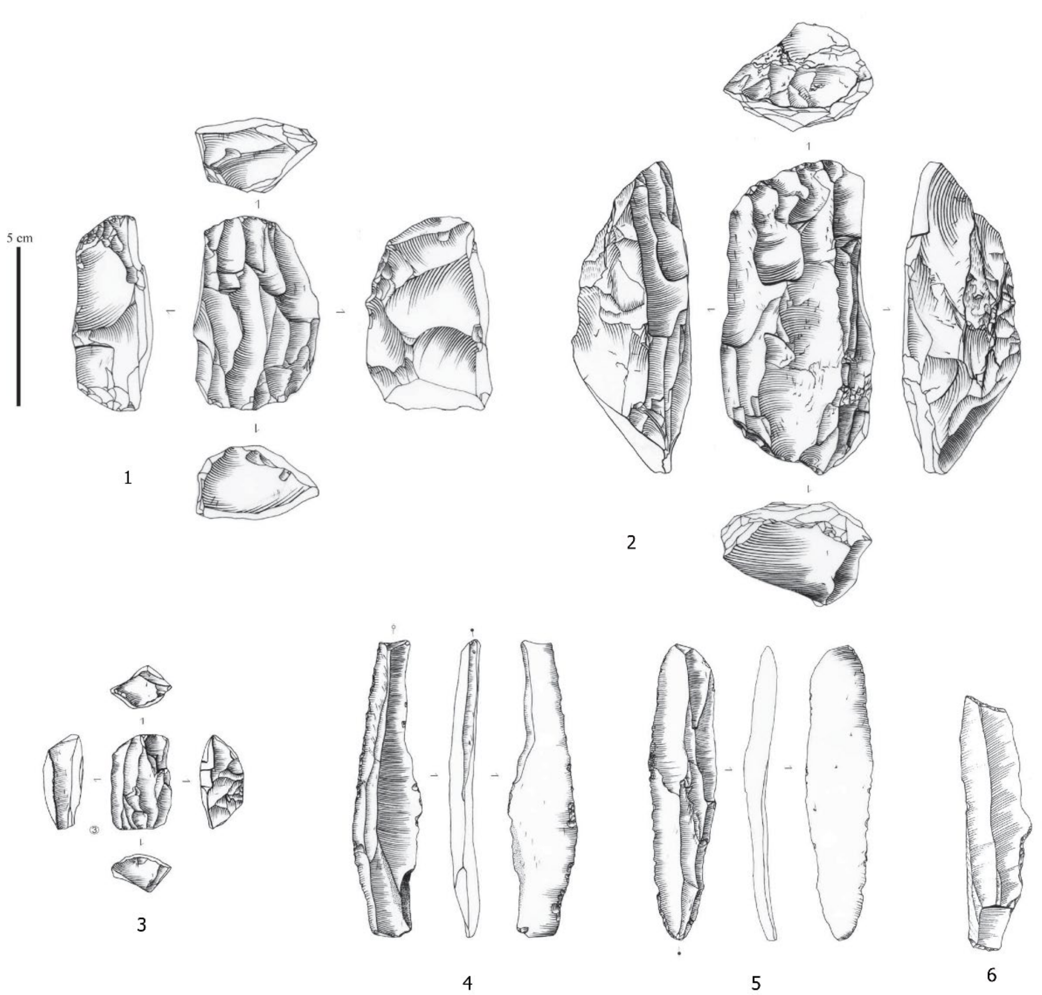


Figure 2.20 – Borie del Rey. 1-3: cores; 4: burin; 5: retouched blade; 6: truncation (Langlais et al., 2014b modified).

some extra-regional sites. For example, Cuze de Neussargues yielded several *Malaurie* points in layer 5A base and *Blanchères* in layer 5A top-4D (Delpuech et al., 1983) while at Closeau P. Bodu (2000b) brought to light a locus "25" with *Malaurie* points and a locus "sud RN13" with *Blanchères.* For Pays de la Loire N. Naudinot proposed a diachronic succession from a Final Azilian characterised by *Malaurie* points to an *industrie de type Auvours* (from the eponymous site of Auvours Camp in Saint-Marsla-Brière) displaying *Blanchères* and bi-truncations (Naudinot, 2013, 2008). However, this trend is not always clear. As a matter of fact, in Peyrazet these four morpho-types were found with similar percentages in the same stratigraphic unit (Langlais et al., 2015). The association between *Malaurie* points and *Blanchères* is also recorded at Port-de Penne (Langlais et al., 2015), Auberoche (Langlais and Fat-Cheung, 2019), La Fosse (Naudinot and Jacquier, 2014) and La Guichaumerie (Naudinot, 2008). The latter evidence points to the risk of multiple successive phases of occupation unrecognised during field works or a more gradual and less abrupt transformation of weapons equipment throughout the Laborian.

Malaurie points and *réctangles* were preferably shaped on small blades. Backs are rectilinear or slightly curved and shaped by a direct (rarely crossed) and abrupt retouch. Any lateralization was observed. Recycling of fractured *Malaurie* points into *rectangles* has also been proposed (Langlais, 2007 p. 393; Langlais et al., 2015, 2014b, 2014a). On the other hand, *Blanchères* were manufactured starting from thin and narrow bladelets. The backing process occurs by a total or partial direct or crossed retouch. Its delineation is rectilinear on the basal and mesial portion while it becomes slightly oblique in the apex. Functional studies indicate a lateral position on the shaft of *Blanchères.*

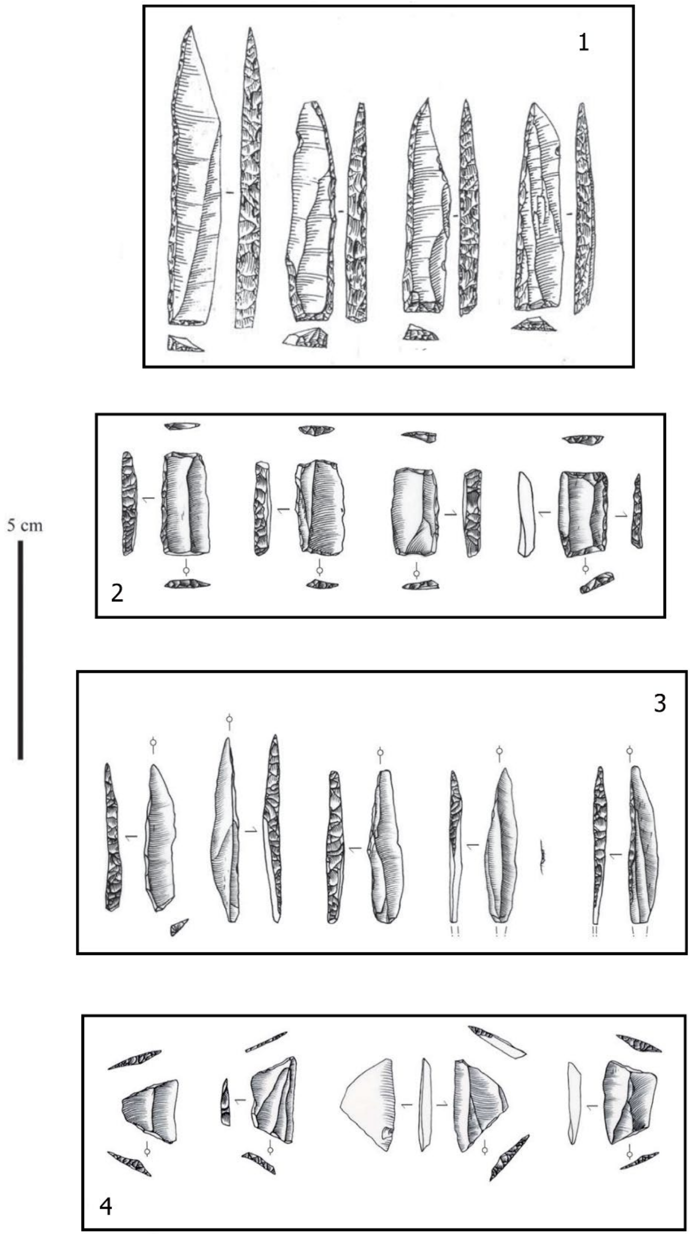


Figure 2.21 – Borie del Rey. 1: *Malaurie* points; 2: *Réctangles*; 3: *Blanchères*; 4 *Bitroncatures trapéziformes* (Langlais et al., 2014b modified).

As far as bi-truncations are concerned, small blades and less frequently bladelets were exploited. The use of the microburin blow technique is not attested (Jacquier et al., 2020), but truncations occasionally cover previous (intentional?) bending fractures. Use-wear analysis conducted by Jacquier et al. (2020) indicates the use of these implements as transverse projectile tips.

In the Pyrenean context Laborian evidence corresponds to the sporadic presence of *Malaurie* points and *rectangles*. *Blanchères* and bi-truncations were not discovered. This could indicate that the Late Laborian did not reach the Pyrenees (Fat-Cheung, 2020; Fat Cheung et al., 2014).

2.4.1.5. Sauveterrian

South-Western France has been part of the Sauveterrian research history since its first discovery. The main evidence of the region refers to plateaus located to the South-West of the Massif Central, where the two eponymous sites (Coulonges, 1928) and some of the most famous Sauveterrian sequences are attested (Fig. 2.22). Sites located in the Quercy are certainly those better investigated (Valdeyron et al., 2008). Among them the most important are Fontfaurès (Barbaza et al., 1991; Valdeyron, 1994; Visentin, 2017), Les Fieux (Valdeyron et al., 2011), Cuzoul de Gramat (Valdeyron et al., 2014) Escabasses Cave (Lorblanchet, 1974) and Trigues (Valdeyron et al., 2005) along with Rouffignac (Visentin, 2017) and Saint-Lizier (Chesnaux et al., 2018). Numerous caves and rock-shelters with Sauveterrian levels were identified also along the northern slope of the Pyrenees. The best preserved are Bourouilla (Dachary et al., 2013), Poeymaü, Troubat (Barbaza and Heinz, 1992), Buholoup (Briois and Vaquer, 2009) and Balma de l'Abreuador (Vaquer and Ruas, 2009). In Andorra the site of Balma Margineda yielded Sauveterrian artefacts too (Philibert, 2002).

2.4.1.5.1. Objectives and production schemes

During the Sauveterrian the exclusive use of local raw materials is reported (Briois, 1991; Briois and Vaquer, 2009; Valdeyron et al., 2008; Visentin, 2017). These correspond to small/medium sized alluvial cobbles, blocks and thick flakes oriented to the production of thin, narrow and elongated blanks such as short bladelets and small laminar flakes whose length is generally no longer than 40 mm. These blanks are mainly aimed to the production of microliths. In Rouffignac the exploitation of large nodules (15-20 cm) for the production of blades and bladelets by a unidirectional rhythm is also attested. This is certainly related to the presence of rich outcrops of chert directly inside the cave (Barrière, 1973, 1972; Visentin, 2017).

The initialisation of the debitage was generally direct and natural ridges and convexities were exploited with absolutely no shaping-out phase. Small blocks/nodules and cobbles are reduced through short unidirectional sequences. The orthogonal reorientation of the cores is often documented (reorientation blanks extracted along the overhang) resulting in a multidirectional exploitation. Sometimes the debitage surface and the striking platform were swi-

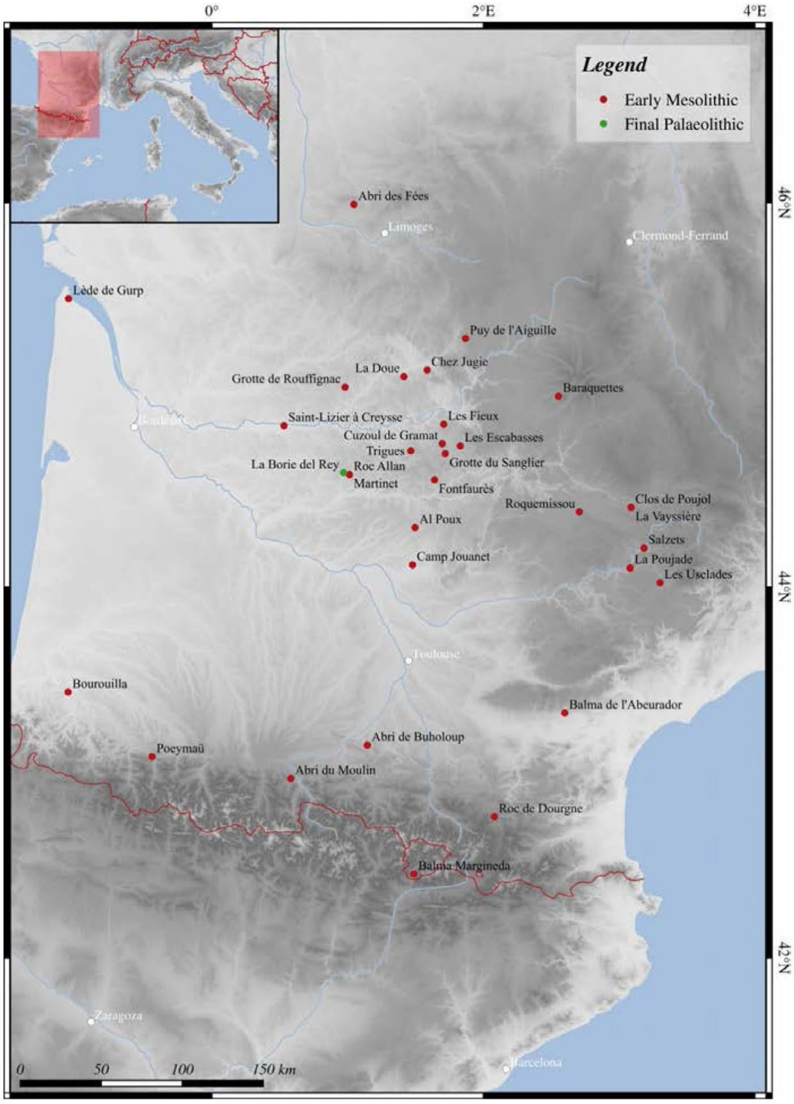


Figure 2.22 - Location of some of the main Sauveterrian sites of South-Western France (from Visentin, 2017).

tched. Domestic tools (burin, short endscrapers, backed knives) are produced on a wide variability of by-products together with full debitage elongated blanks and flakes.

In case of flake-cores the striking platform was mostly located in correspondence of the ventral surface and the debitage started from the distal end of the flake (i.e. endscraper-like morphology).

The knapping technique is consistent with a soft stone hammer percussion applied with a tangential gesture. The adoption of the bipolar technique was also proposed (e.g., Fontfaurès). After preliminary experimental sessions, D. Visentin (2017) identified in the site of Rouffignac the use of heat treatment aimed at splitting large volumes of flint into small blocks.

2.4.1.5.2. Armatures

The technical and typological characteristics of armatures throughout the Sauveterrian were investigated by N. Valdeyron and colleagues on several Quercy sites (Valdeyron et al., 2008). Projectile implements were manufactured on the most regular blanks, in particular those with straight edges, and a rectilinear or slightly curved profile. A thickness of 2-2.5 mm was preferred. Important changes in armatures morphology were identified along the Sauveterrian: by plotting morpho-metric values of geometrics, N. Valdeyron and collaborators (2008) highlighted a shift from symmetric and short geometrics (isosceles triangles, crescents and short scalene triangles) towards more elongated scalene triangles (cf. *Montclus triangles*). This transition marked the shift from the Early to the Middle phase of the Mesolithic (Fig. 2.23). An increase of triangles with three retouched sides is also attested. Such a trend has been observed outside the Quercy area e.g., Fontfarès, (Valdeyron, 1994; Visentin, 2017) and Abeurandor (Vaquer and Ruas, 2009). In addition to triangles, other morpho-types seem to change over time. Sauveterrian points clearly increase during the Middle Mesolithic, while obliquely truncated points strongly decrease. On the other hand, backed bladelets, backed points, points with a retouched base do not present diachronic variations. A further important change involves the gradual disappearance of the microburin blow technique. It is important to note that compared to South-Eastern France and Northern Italy, geometrics do not attest to a strong microlithisation process being rarely shorter than 10 mm. L. Chesnaux (2014) suggested the use of abrasion and pressure with an organic tool as retouch techniques for the production of geometric armatures in several Sauveterrian sites.

Use-wear analysis carried out on armatures from Rouffignac, Fontfaurès, Les Fieux and Saint-Lizier showed that both geometric and non-geometric armatures were used as perforating elements, while only the former were used as lateral implements (Chesnaux, 2014; Philibert, 2002, 2000, 1991; Visentin, 2017).

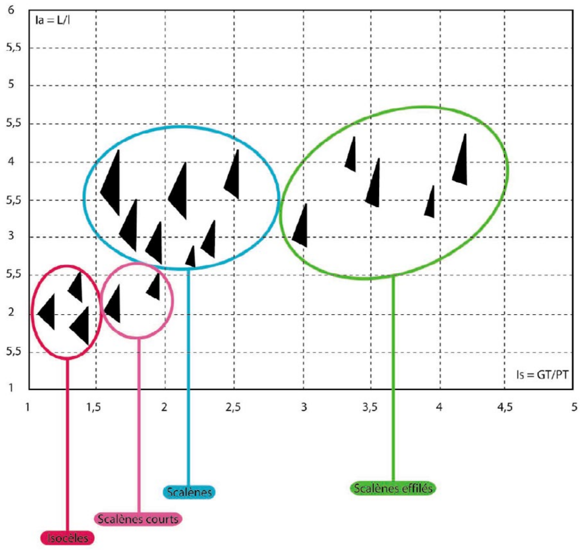


Figure 2.23 – The four dimensional categories of triangles identified in the Quercy by Valdeyron et al. (2008).

2.4.2. North-Eastern Italy

2.4.2.1. Late Epigravettian

As far as Late Epigravettian lithic technology is concerned North-Eastern Italy is one of the best-known territories. Several sites have been discovered since the second half of the 20th century and up to now a good number of them has been studied both from a typological and technological perspective. The main lithic assemblages allowing to reconstruct Late Epigravettian technical systems are: Riparo Tagliente (Cremona, 2008; Falceri, 2014; Fontana et al., 2015; Gajardo, 2014; Montoya, 2008b, 2004), Val Lastari (Montoya, 2008b, 2004), Villabruna A (Montoya, 2008b, 2004), Riparo Dalmeri (Montoya, 2008b, 2004), La Cogola (Cusinato et al., 2004), Casera Staulanza (Cecchetti, 2020; Soncin, 2017), Palu Echen (Duches et al., 2014) and Palughetto (Peresani et al., 2011). Preliminary data were obtained also from Bus de la Lum (Peresani et al., 2000), Pian delle More (Duches et al 2007) and Riparo Biarzo (Fasser et al., 2020). Other sites, such as Riparo Tschonstoan (Avanzini et al., 2001), Riparo Soman (Broglio and Lanzinger, 1986), Piancavallo (Guerreschi, 1975), Andalo (Guerreschi, 1984b), Terlago (Bagolini and Dalmeri, 1984), Riparo Battaglia (Broglio, 1964), Fiorentini (Guerrreschi and Pasquali, n.d.), Viotte di Bondone (Bagolini and Guerreschi, 1978) and Le Regole (Dalmeri et al., 2004) have been analysed only from a typological viewpoint (Bertola et al., 2007). The location of all sites cited in the text is illustrated in Figure 2.24.

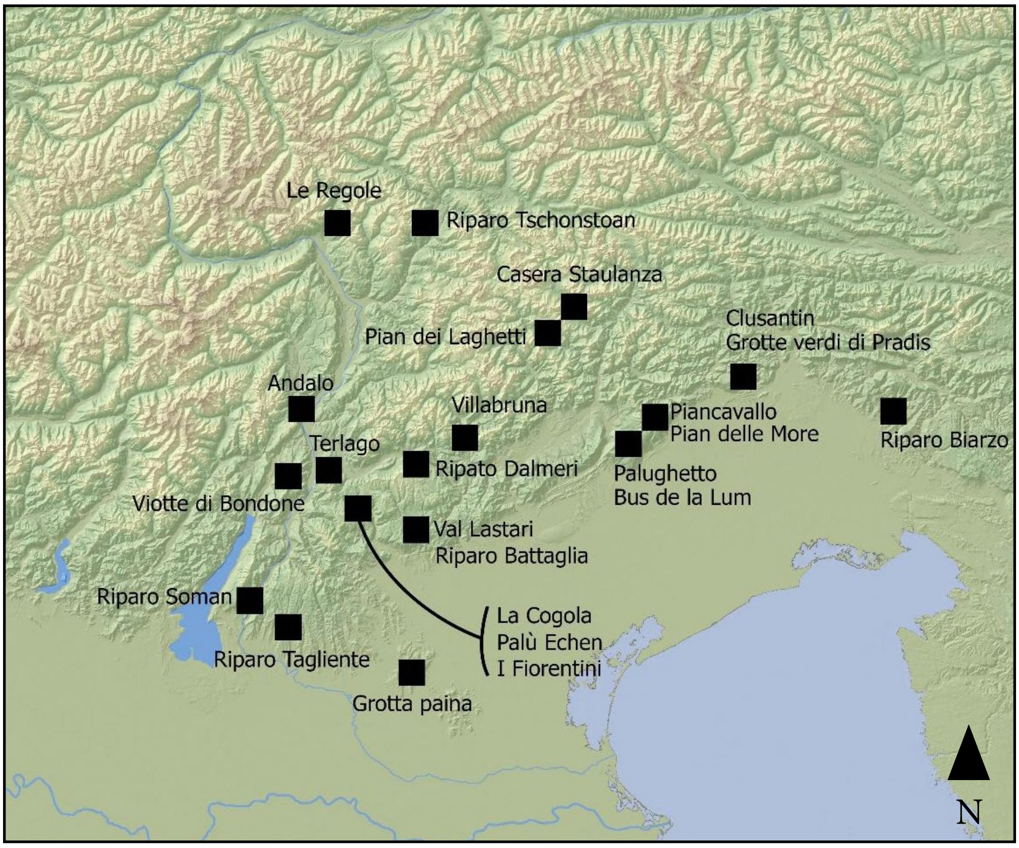


Figure 2.24 - Location of Late Epigravettian sites of North-Eastern Italy mentioned in the text.

2.4.2.1.1. ER 1 (Last part of GS-2 – Oldest Dryas/Beginning of the Bølling)

2.4.2.1.1.1. Objectives and production schemes

In Northern-Eastern Italy the only evidence related to ER 1 (*Ensamble 1* according to C. Montoya 2004) comes from the deepest layers (17-12) of Riparo Tagliente which are dated between 17000 cal BP and 14000 cal BP. Several Ph.D. projects (Cremona, 2008; Falceri, 2014; Gajardo, 2014; Montoya, 2008b, 2004) were focused on lithic artefacts from the oldest occupations phases. All these works agree on several aspects: initialisation blanks indicate the selection of blocks, nodules as well as thick flakes. The opening of the debitage surface could either be direct and based on the extraction of cortical blades and naturally crested blades or (much less frequently) preceded by a shaping out phase aimed at preparing a frontal crest. This shaping out phase rarely involved the flanks and back of the core. In case of blades production, at the beginning of the production phase, narrow debitage surfaces are exploited by a unidirectional and frontal debitage. Sometimes the transition to a semi-tournant modality is attested. The flaking angle is around 80°. The opening of an opposite striking platform is infrequent, as well as the reorientation of the core in order to exploit a new striking platform and a new debitage surface.

According to Montoya (Montoya, 2008b, 2004) this phase is characterised by three main objectives: blades, bladelets and microbladelets. Each category of product is fairly regular and normalised with a rectilinear profile (except for blades that can be slightly curved) and it was obtained through an independent reduction scheme and debitage method:

- **Microbladelets** (*petites lamelles*). Length 20-30 mm; width 5-9 mm; thickness 1-3 mm. They were produced from small blocks or flakes by exploiting narrower surfaces. Flakes were reduced as burin-like cores.
- **Bladelets** (*grandes lamelles).* Length 60-80 mm; width 8-15 mm; thickness 2-6 mm. They were flaked from nodules. The *citrange* of the debitage surface is more open. The retouch platform was located on the largest dimension of the exploitable volume.
- **Blades** (*lames*). Length hardly ever exceeds 100 mm; width ranging between 20-30 mm. Nodules are orientated oppositely with respect to the bladelets production with the striking platform positioned on the smaller dimension of the block. The narrowest side corresponds to the debitage surface which is generally slightly convex (Fig. 2.25). The angle between the retouch planform and debitage surface is fairly closed ranging between 65° and 85°.

However, successively studies on lithic assemblages from the northern sector (Cremona, 2008; Falceri, 2014; Fontana et al., 2015; Gajardo, 2014) did not entirely agree with data collected by C. Montoya. The reduction sequences did not seem as independent as C. Montoya claims. In fact, some “mixed schemes” which testify the transition from blades (length > 60 mm) to bladelets (length: 36-59 mm) and from bladelets to microbladelets (length: 10-35 mm) were recognized, as well as an independent project for flakes extraction. The raw material is mainly local but some tools and cores from the Umbria-Marche Apennines attest to displacements of more than 250 km (Bertola et al., 2018).

Features observable on full debitage lamino/lamellar blanks (plain butts with an overhang highly abraded) suggest the use of a tangential organic percussion as knapping technique especially in layers 17-15, whereas in layers 14-12 butts characterised by multiple impact points and a frequent *esquillement du bulbe* indicate the use of a soft stone hammer (Montoya and Peresani, 2005; Visentin, 2009).

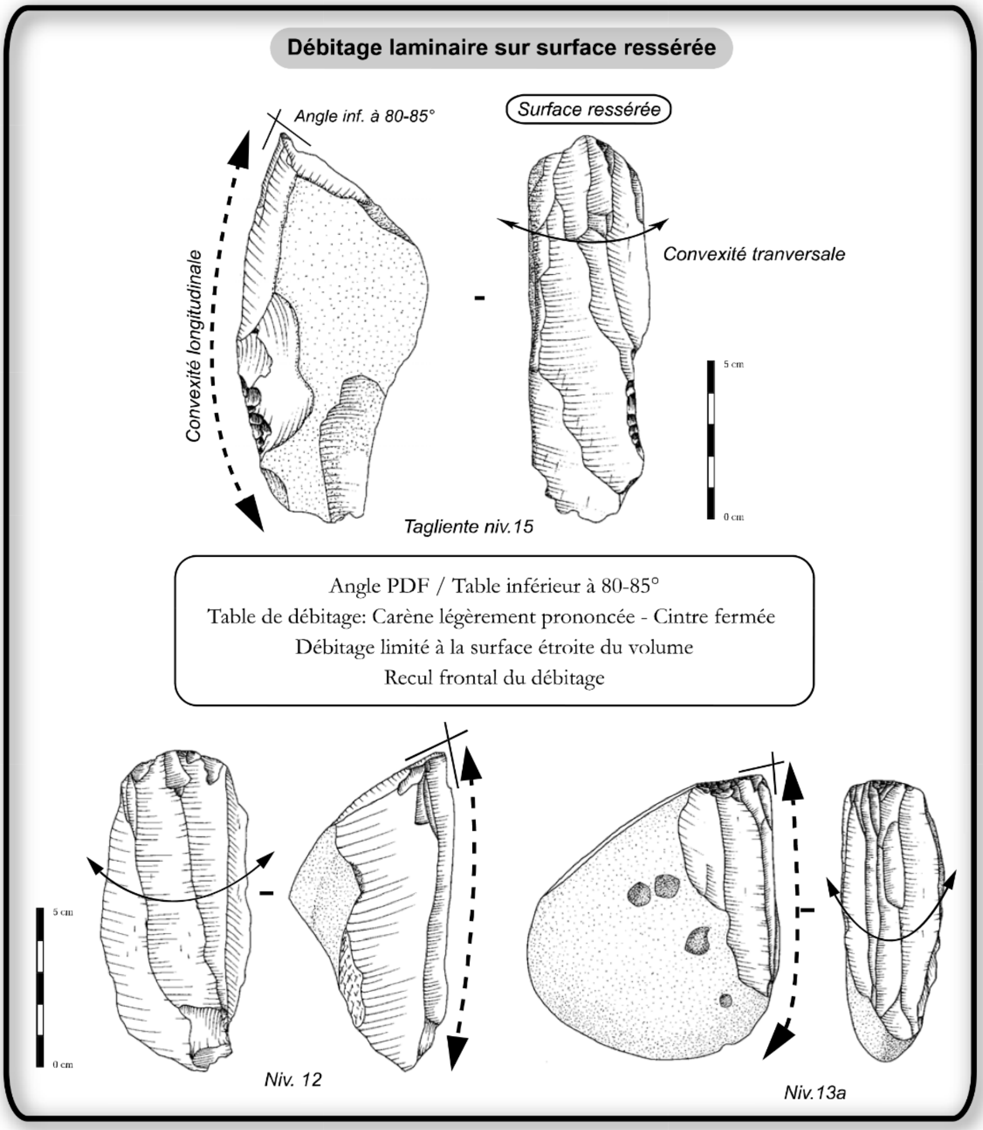


Figure 2.25 – Blades cores from the lower levels of Riparo Tagliente (Montoya, 2004).

2.4.2.1.1.2. Armatures

The typological study developed by A. Guerreschi (Bartolomei et al., 1982) allowed us to divide the Late Epigravettian sequence of Riparo Tagliente into two main phases. The oldest one (layers 17 to 11) includes backed points, backed bladelets and some blacked truncated bladelets. Following Laplace (1964a) typology, backed points are mainly attributed to the PD4 group (i.e. total backed points) and they are perfectly attributable to *microgravettes* ("*pointe de la Gravette de petites dimensions*" according to Sonneville-Bordes and Perrot 1956). Few shouldered points were also recorded. From a more strictly technological viewpoint, Fontana et al. (2015) observed the exploitation of all three blank dimensional classes: blades, bladelets and microbladelets, with the latter being the best represented. C. Montoya (2004) highlights the strong regularity of these blanks.

2.4.2.1.2. ER 2 (first part of GI-1 – Bølling/beginning of the Allerød)

2.4.2.1.2.1. Objectives and production schemes

The technical systems of the ER2 (*Ensamble 2 sensu C. Montoya*) was firstly defined by C. Montoya (2004) based on the analysis of three sites: layer 11-4 of Riparo Tagliente, layer 17-6 of Villabruna A and Unit 3 of Val Lastari (Montoya, 2004). Although dates from the latter site refer to a very wide range (approximately from 16250 to 10300 cal BP) the Late Epigravettian occupation is referred to the Allerød period. According to C. Montoya this phase is marked by a simplification of the flaking process with two production methods respectively dedicated to the manufacture of straight blades/laminar flakes and bladelets/microbladelets. An increase in width and thickness of the lamino-lamellar categories and a lower degree of standardisation compared to the previous phase is attested. The opening of the debitage surface is based on the exploitation of natural round or sub-angular surface. Products were obtained from more open and larger debitage surfaces. The striking platform is plain and the flaking angle is around 80°-90°. The organic hammer direct percussion disappeared in favour of soft stone applied with a tangential gesture (Montoya 2008; Visentin 2009). The overhang is generally highly abraded.

- **Bladelets** (*grandes lamelles,* length: 30-70 mm; width: 9-15 mm) and **microbladelets** (*lamelles,* length:15-45 mm; width: 3-9 mm) were flaked by a unidirectional and semi-tournant debitage or as claimed by C. Montoya (2004 p. 377) it occurs « *par superposition partielle de tables adjacentes* ».
- **Blades** are wide (18-30 mm) and short (< 100 mm), becoming sometimes **elongated flakes**. They are relatively thick (>7 mm) in their median part becoming progressively thinner towards the edges as seen from the cross-section. This morphology allows a high cutting power of edges with a certain robustness of the blank. The reduction process is unidirectional, with a debitage surface particularly open, large and almost flat (i.e. *schéma facial laminaire,* according to C. Montoya). Interesting to note the use of *cadrage* blades in order to prepare a local and pronounced *cintrage* for then removing a central and fairly regular blade (Fig. 2.26).

An additional site located in North-Eastern Italy that was not taken into consideration by C. Montoya and dated to the same span of time is Grotta del Clusantin (PN). Lithic artefacts come from the Layer 4 and 4/2 which yielded three radiocarbon dates ranging between 14500 and 13500 cal BP (Bertola et al., 2007; Duches and Peresani, 2010). One main reduction scheme has been identified for the production of two sizes of elongated blanks (microbladelets and bladelets) from small blocks and thick flakes. The debitage rhythm tends to be unidirectional and semi-tournant. An independent reduction scheme dedicated to blades is absent. The raw material was collected within a distance of 50 km (Duches and Peresani, 2010).

Based on several technological similarities both the undated open-air sites of Pian delle More (Piancavallo Plateau, PN; Duches et al., 2007) and Casera Staulanza (BL; Cecchetti, 2020; Soncin, 2017) are likely to be referred to this specific span of time. At Casera Staulanza it is interesting to note an unusual preparation of the striking platform by removing short flakes starting from the debitage surface ("facettage") before extracting thick lamino/lamellar products. In this case the hammerstone was used with a linear motion and aimed at striking inwards with respect to the overhang. C. Montoya included in this phase also layer 15-65 of Riparo Dalmeri (Montoya, 2008b). During this period the importation of long-distance raw material ceases and the sites of the Venetian area undergo a "regionalization" process marked by the exclusive exploitation of local resources (Bertola et al., 2018).

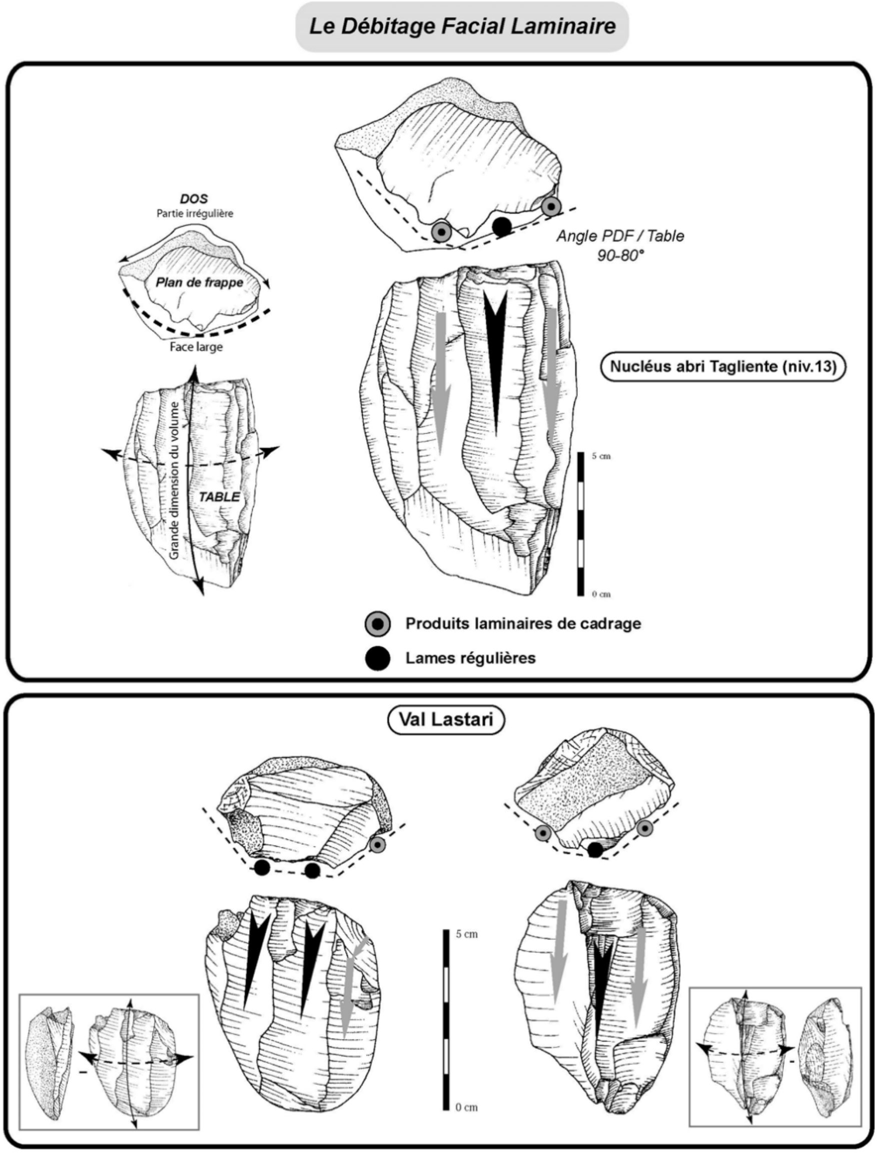


Figure 2.26 – The blade production scheme (Montoya, 2004).

2.4.2.1.2.2. Armatures

All sites dated to this period (e.g., Riparo Tagliente, Val Lastari, Grotta del Clusantin, Riparo Soman, Villabruna A) or simply referred to it based on the typological variability of lithic artefacts (e.g., Fiorentini and Riparo Battaglia) are characterised by four types of armatures: backed points, backed bladelets, backed truncated bladelets and occasionally geometrics (e.g., Bartolomei et al., 1982; Battaglia et al., 1994; Broglio, 1964; Broglio et al., 1993; Duches and Peresani, 2010) (Fig. 2.27). Concerning Riparo Tagliente, few changes from a typological perspective compared to the previous phase have been pointed out by A. Guerreschi (Bartolomei et al., 1982): the disappearance of shouldered points starting from layer 13, the increase of backed truncated bladelets in the uppermost layers as well as the appearance of few geometrics such as crescents, triangles, and trapezoids (bi-truncations) (Bartolomei et al. 1982; Fontana et al. 2015). Moreover, C. Montoya (2004) emphasised an increase of width and thickness of backed points. Such a trend is also visible in the sites of Val Lastari (Fig. 2.27) and Villabruna A, (Montoya, 2004). Both microbladelets (*petites lamelles*) and bladelets (*grandes lamelles*) were exploited as well as blanks that do not systematically come from the full debitage phase. Additional technological notes are reported below:

- backs are rectilinear and the reduction process occurs by direct or crossed retouches
- apexes are mainly positioned in the distal portion.
- occasionally complementary retouches were applied on the opposite edge in correspondence of the basal and/or the apical extremity. Such a retouch can be either inverse and flat or direct and abrupt.

On the contrary, R. Duches and M. Peresani (Duches and Peresani, 2010) described backed points from Grotta del Clusantin as thin (1-2 mm), narrow (average width of 4.7 mm) and produced from regular blanks (both microbladelets and bladelets) with an even thickness along the morphological axis. The apex is equally located in the proximal and distal portion and back delineation can be both rectilinear and slightly convex (Duches and Peresani, 2010).

As far as backed bladelets are concerned, a similar production scheme is attested in Val Lastari, Villabruna A and Clusantin (Duches and Peresani, 2010; Montoya, 2004). These items were systematically shaped by a rectilinear back that occurs through direct retouches. Any complementary retouch was applied. The selection of both microbladelets (more frequently) and bladelets (less frequently) is related to a certain size variability. The same type of blanks are exploited to produce backed truncated bladelets. From a general viewpoint the only difference between these two categories (backed bladelets and backed truncated bladelets) is the presence of one or less frequently two truncations located in the proximal and/or distal portion (Duches and Peresani, 2010; Montoya, 2004). Truncation delineation tends to be rectilinear in Grotta del Clusantin and Villabruna A, while it is more often oblique in Val Lastari. C. Montoya noted the use of both microbaldelets and bladelets for producing backed bladelets and backed truncated bladelets also in Riparo Soman (Phase 1) and in Riparo Battaglia (Montoya, 2004). Symmetric backed bi-truncated bladeletes begin to appear (e.g., Val Lastari Fig. 2.27

and layers 6-5 of Villabruna A).

Crescents and triangles are attested in Grotta del Clusantin (n=5), in the upper layer of Villabruna A (n=2; layers 9 to 5 are undated) and in phase II of Riparo Soman (n=10). Few bi-truncations were recorded in Grotta del Clusantin (n=1), Val Lastari (n=3) and Riparo Soman phase I (Aimar et al., 1994; Battaglia et al., 1994; Broglio et al., 1994; Duches and Peresani, 2010). Also Villabruna A yielded 5 bi-truncations from the uppermost layer (layer 5). This latter is probably more recent (ER3?).

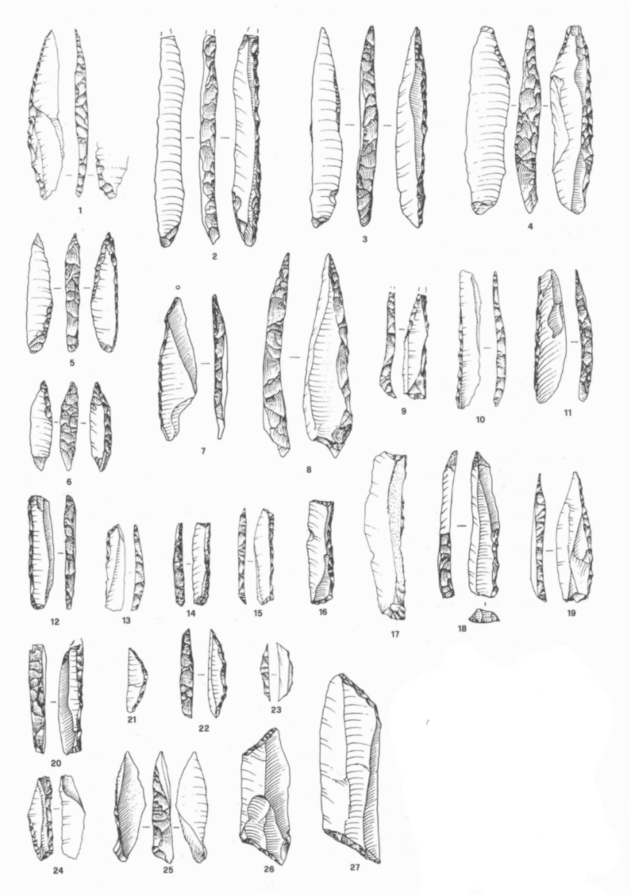


Figure 2.27 – Val Lastari. 1-8: backed points; 10-11: backed bladelets; 12-18 backed truncated bladelets; 9,19,20: backed truncated points; 21-23: crescents; 24-25: Krukowski microburins; 26-27 bi-truncations (Broglio et al.,1994 modified).

2.4.2.1.3. ER 3 (end of the GI-1 and GS-1 – end of Allerød and Younger Dryas)

2.4.2.1.3.1. Objectives and production schemes

The ER 3 partially corresponds to *Ensemble 3* defined by C. Montoya based on the technological analysis of lithic artefacts from Riparo Dalmeri (layers 26c and 14b/26b) and Saint-Antoine-Vitrolles (Hautes-Alpes, France) which was discussed in Chapter 2.4.3. Actually layer 26c has been previously analysed by Cusinato (1998). Both sites are dated to the transition between the Allerød and the Younger Dryas. In Riparo Dalmeri one main reduction scheme has been identified aimed at producing a unique class of poorly normalised and fairly irregular bladelets from small nodules, blocks and flakes. Width varies between 5 and 20 mm, while length between 14 and 60 mm. These products are quite thin and weakly elongated. Edges are straight, convex and/or irregular. Blades are rare and their production is integrated into the bladelets reduction process in case of the exploitation of bigger nodules.

After opening a striking platform, few cortical or partially cortical elongated blanks were extracted following the natural round or sub-angular surfaces. The transverse convexity of cores can be closed aimed at producing narrow bladelets with rectilinear edges or more open aimed at manufacturing larger bladelets with convex edges. The debitage proceeds through unidirectional and semi-tournant sequences with sometimes a switch to a bidirectional debitage or to orthogonal reorientations : «*Le tailleur profite ainsi du cintre fournit par le dièdre créé par l'intersection de l'ancienne table avec un flanc du nucléus.*» (Montoya 2004, p.357.

Similar lithic production was observed in other sites referred to the end of the Allerød and Younger Dryas, such as Riparo Biarzo (Fig. 2.28 and 2.29) (Fasser et al., 2020), Palu Echen (Duches et al., 2014), Bus de la Lum (Peresani et al., 2000) and La Cogola, layer 19 (Cusinato et al., 2004). All these sites share several technical aspects:

- a single *chaine opératoire* aimed at producing unstandardized microbladelets/bladelets. Blades are rare and often produced outside the site
- exploitation of small blocks, nodules and flakes (except for Palu Echen where any flakes-core is attested)
- no shaping-out phase
- unidirectional and semi-tournant debitage (bidirectional debitage or orthogonal reorientations are less frequent but anyway documented)
- percussion with a soft stone hammer applied with a tangential gesture
- blanks butts are plain, linear and only rarely facetted. The overhang is often abraded

It is important to highlight the gradual decrease of length of endscrapers between 14000 cal BP and 11000 cal BP. According to Peresani et al. (2014), this shorting process is related to a change in blank selection from long blades to short flakes.

2.4.2.1.3.2 Armatures

During the second part of the Allerød period backed points continue to be characterised by a certain flexibility in blanks selection (bladelets and microbladelets) and size as provided by the technological analysis of armatures from Riparo Dalmeri conducted by R. Duches and colleagues (2018). Authors identified three main backed points categories according to size and retouching modes (Fig. 2.30).

Moving to the sites dated to the Younger Dryas that yielded a significant amount of backed points, such as Bus de la Lum (Peresani et al., 2000) and Riparo Cogola SU 19 (Cusinato et al., 2004), some remarkable elongated specimens are still present (e.g. a backed point from La Cogola layer 19 measures 56 mm of length), although a major production of short (20-30 mm) and narrow backed points was recorded.

The end of the Allerød period and the Younger Dryas marked several important innovations

Figure 2.28 - Artefacts from SU 5 of Riparo Biarzo. 1-3: bladelets; 4-6: microbladelets; 7-10: endscrapers; 11: retouched blade; 12: truncation (Fasser et al., 2020).

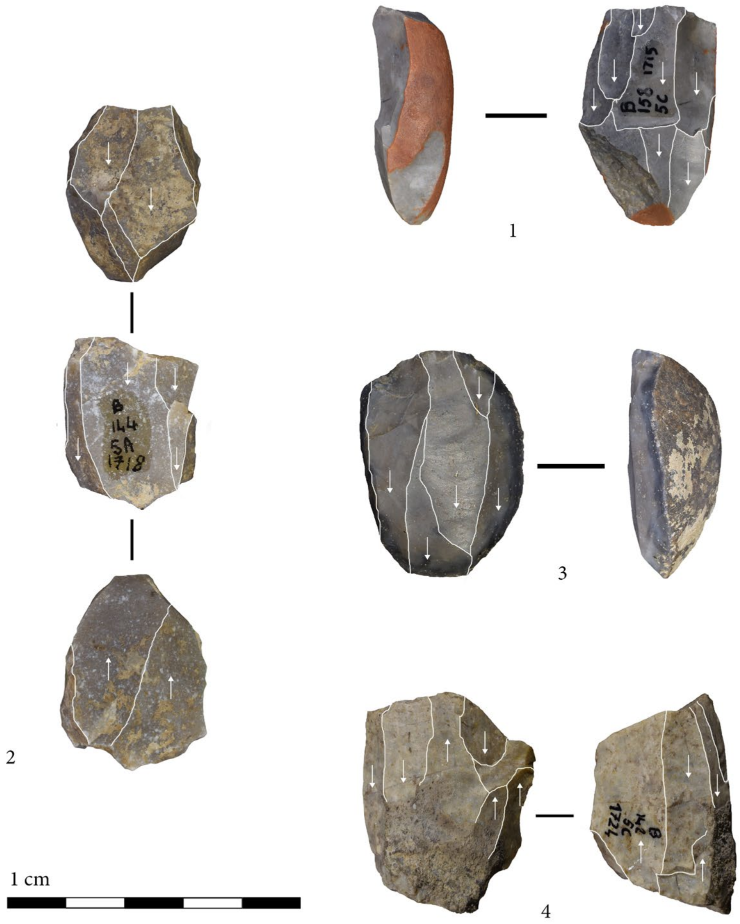


Figure 2.29 - Cores from SU 5 of Riparo Biarzo. 1: core attesting to a reorientation phase; 2-3: cores exploited through a unidirectional debitage; 4: core exploited through a bidirectional debitage (Fasser et al., 2020).

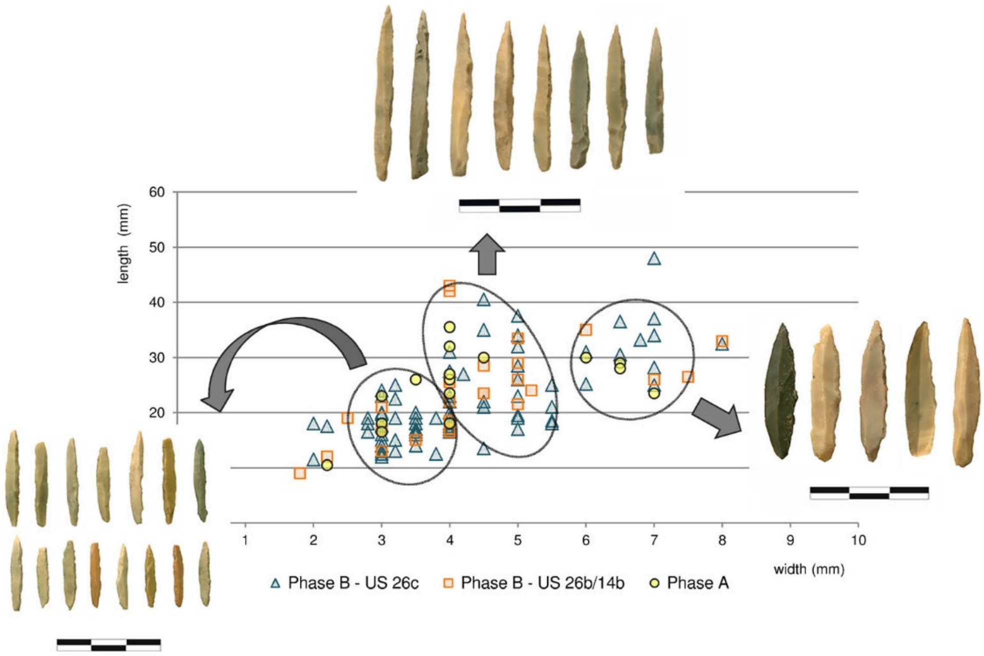


Figure 2.30 – Riparo Dalmeri. Backed points categories (Duches et al., 2018).

in armatures variability:

- the appearance of a type of *microgravette* characterised by a basal transverse or oblique direct truncation as attested in the rock-shelter of La Cogola layer 19 (n=10; Cusinato et al., 2004) and Bus de la Lum (n=13; Peresani et al., 2000)
- a remarkable decrease of backed bladelets that almost disappear among projectile weapons
- an important increase of symmetric and standardised backed bi-truncated bladelets becoming gradually the most attested type of gear in armatures assemblages (Fig. 2.31 A-D)
- the spread of bi-truncations (Fig. 2.31 E)

As far as the backed truncated bladelets are concerned, R. Duches and colleagues (Duches et al., 2018) by analysing Riparo Dalmeri armatures observed a strong homogeneity from both a dimensional (width < 5 mm, length < 20 mm and thick of 2 mm) and morphological viewpoint (in 60% of the cases both truncations are oblique and form an obtuse angle with respect to the back) (Fig. 2.31 A). Riparo Biarzo (Guerreschi, 1996) (Fig. 2.31 C), La Cogola layer 19 (Fig. 2.31 B) (Cusinato et al., 2004) and Bus de la Lum (Peresani et al., 2000) show a similar trend, even if in La Cogola backed truncated bladelets are slightly longer (30-20 mm) and wider (3-7 mm), whereas in Bus de la Lum truncations tend to be more transverse rather than oblique. Backed truncated bladelets are frequently characterized by a marginal direct retouch opposite to the back. Functional studies suggested a lateral positioning of this type of armature on the shaft (Duches et al 2018; Ziggiotti and Dalmeri, 2008).

The extremely high number of this type of backed bi-truncated bladelets has allowed the undated open-air site of Viotte di Bondone (Bagolini and Guerreschi, 1978) to be referred to ER3 (Fig. 2.31 D). Several publications (e.g., Bagolini and Dalmeri, 1984; Bagolini and Guerreschi, 1978; Guerreschi, 1996) associate backed bi-truncated bladelets with two oblique symmetric truncations forming an obtuse angle with respect to the back to Gm2 Laplace's type (under the name of *segmenti trapezoidali*) thus including them in the geometric group.

Bi-truncations (or trapezes) appear for the first time during the ER 2. However the few specimens from this phase have a fairly irregular morphology due to a not normalized retouch process and/or blank selection (Ferrari and Peresani, 2003). Some pieces are also recorded during the end of the Allerød (e.g., Riparo Biarzo and Riparo Dalmeri), but it is during the Younger Dryas that the number of such items strongly increases within armatures assemblages. Two sites yielded the richest collection of bi-truncations: Bus de la Lum (n=21) and La Cogola, layer 19 (Fig. 2.31 E; n=13). Such an item is generally produced on the mesial portion of a straight lamino/lamellar blank by two symmetric truncations (more frequently oblique rather than transverse) applied by a direct, deep and abrupt retouch. The use of the microburin blow technique to split blanks is not attested (Ferrari and Peresani, 2003). The only functional analysis conducted by S. Ziggiotti on this type of gear indicates both a lateral position on the shaft and the use as a transverse point (Ziggiotti and Dalmeri, 2008).

Crescents and triangles are occasionally recorded. For example, La Cogola layer 19 counts a total of 8 geometrics divided between 1 isosceles triangle, 2 scalene triangles and 5 crescents, whereas Bus de la Lum yielded 2 scalene triangles and 1 crescent. Few geometrics were recorded also in Palu Echen (4 crescents), Riparo Dalmeri (7 generic geometrics), Riparo Biarzo (4 scalene triangles) and Riparo Soman phase 2 (2 scalene triangles).

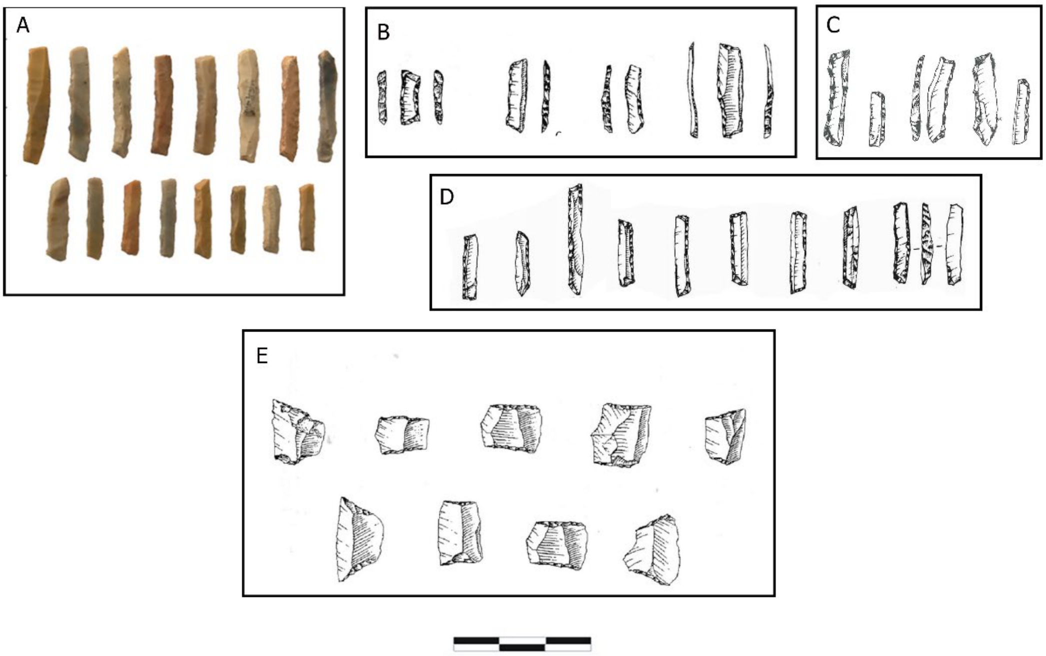


Figure 2.31 – A: backed truncated bladelets from Riparo Dalmeri (Duches et al., 2018 modified); B: backed truncated bladelets from Riparo La Cogola layer 19 (Ziggiotti and Dalmeri, 2008 modified); C: backed truncated bladelets from Riparo Biarzo layer 5 (Guerreschi, 1996); D: backed truncated bladelets from Viotte di Bondeno (Bagolini and Guerreschi, 1978 modified); E: bi-truncations from Riparo La Cogola layer 19 (Ziggiotti and Dalmeri, 2008 modified).

2.4.2.1.4. Terminal Epigravettian (Younger Dryas – Preboreal transition)

2.4.2.1.4.1. Objectives and production schemes

The term “Terminal Epigravettian” was proposed for the first time by D. Binder in 1980 and then re-used by A. Tomasso (2014) to indicate the industries dated at the transition between the Younger Dryas and Preboreal and characterised by a clear “Epigravettian” technical tradition. Riparo La Cogola layer 18 (Bassetti et al., 2009; Cusinato et al., 2004) and Le Regole 3 (Dalmeri et al., 2004) are the only sites certainly dated to this span of time (La Cogola layer 18: 11390-11140 cal BP; Le Regole 3: 11245-11084 cal PB). To a final phase of the Late Epigravettian were attributed also several undated mountains sites due to their Epigravettian-Sauveterrian mix features, such as Andalo (TN), Terlago (TN), Piancavallo (PN), Pian dei Laghetti (PN) and Palughetto (Cansiglio Plateau) (Broglio, 1994; Guerreschi, 1984a; Peresani et al., 2011). Among them only Palughetto has been analysed through a techno-economical approach (Peresani et al., 2011).

Production systems related to this phase are still poorly known. Few data were reported by Bassetti et al. (2009) and Cusinato et al. (2004) about layer 18 of Riparo La Cogola that can be summarised as follows: the flaking process is oriented towards the production of variable elongated blanks that show a clear size reduction compared to layer 19. An increase of flake-cores is also attested together with an independent flakes production.

At Palughetto four independent reduction schemes were documented according to the morphology and volume of blocks of raw material for the production of microbladelets, bladelets and laminar flakes (Peresani et al., 2011). The debitage rhythm can vary from unidirectional to bidirectional and from facial to semi-tournant attesting to a certain flexibility of flaking modalities.

2.4.2.1.4.2 Armatures

Riparo La Cogola is a perfect site to evaluate armatures production during the end of the Late Epigravettian. M. Bassetti and colleagues (2009) pointed out several variations from layer 19 to layer 18:

- a decrease in backed points frequency
- a decrease in backed points length, width and thickness (average values are 24,2 mm; 5,4 mm; 2,5 mm)
- a decrease of crossed back retouch
- an increase of geometrics (mainly crescents and isosceles triangles)
- a considerable increase of the microburin blow technique for the production of both geometrics and backed points

Backed truncated bladelets and bi-truncations remain stable in their morphology, size and frequency.

Palughetto (*morena nord*) shows the same hunting equipment variability. Backed points are equally orientated on the distal and proximal portion and the manufacture process occurs by deep, direct and abrupt retouches. One double backed point and five backed truncated points are attested. Complete backed truncated bladelets present a double and symmetric truncation and frequently an additional complementary retouch along the cutting edge. Crescents are well documented (n=10) as well as triangles (n=10), especially isosceles. Only one trapezoid was recorded. The microburin blow technique is largely employed (ordinary microburin = 59).

The combination between backed (bi)truncated bladelets, backed points, geometrics (crescents and triangles) and microburins is characteristic also of the undated sites of Pian dei Laghetti (B. Bagolini et al., 1984), Piancavallo (Guerreschi, 1975), Andalo (Guerreschi, 1984b) and Terlago (Bagolini and Dalmeri, 1984). All of them yielded both isosceles and scalene triangles. For these sites the possibility of a mixing process between two independent occupation phases respectively referred to the Late Epigravettian and to the Sauveterrian should be considered, especially for Andalo where Sauveterrian-like points were found.

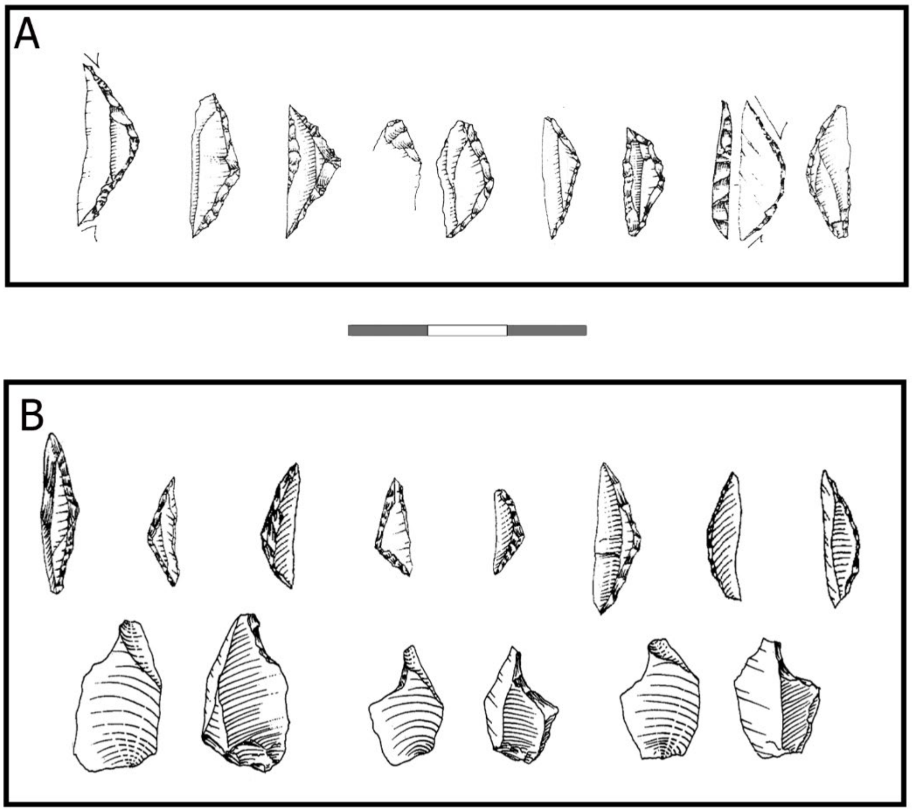


Figure 2.32 – A: Palughetto (Peresani et al., 2011); B: La Cogola layer 18 (Cusinato et al., 2004).

2.4.2.2. Sauveterrian

Despite the high number of sites discovered (Fig. 2.33) over time only few have been the object of techno-economical studies, while the adoption of a typological approach has prevailed. Information on the technical systems for each chrono-typological phase proposed by A. Broglio and S. Kozlowski (1984) were collected from the following sites: Mondeval de Sora (Fontana et al., 2009b), Romagnano Loc III (Flor et al., 2011), La Cogola layer 16 (Cusinato et al., 2004), Galgenbühel/Dos de la Forca (Wierer, 2008), Cassera Lissandri (Visentin et al., 2016b), Cima XII, Grottina de Covoloni (Visentin, 2017), I.N.F.S. (Fontana and Guerreschi, 2009), Le Mose (Fontana et al., 2016; Visentin, 2017) and Collecchio (Visentin et al., 2016a).

2.4.2.2.1. Objectives and production schemes

Lithic assemblages of North-Eastern Italy seem to respond to the same conceptual scheme and the lithic technical systems present numerous common traits from both a spatial and diachronic perspective. Lithic raw material provisioning was essentially local and extremely variable, from flint to rock crystal and even silicified siltstone and limestones according to the geographic location of the sites. Production process was aimed at obtaining two main sets of products: poorly normalised microbladelets/bladelets (mainly shorter than 35-45 mm) and

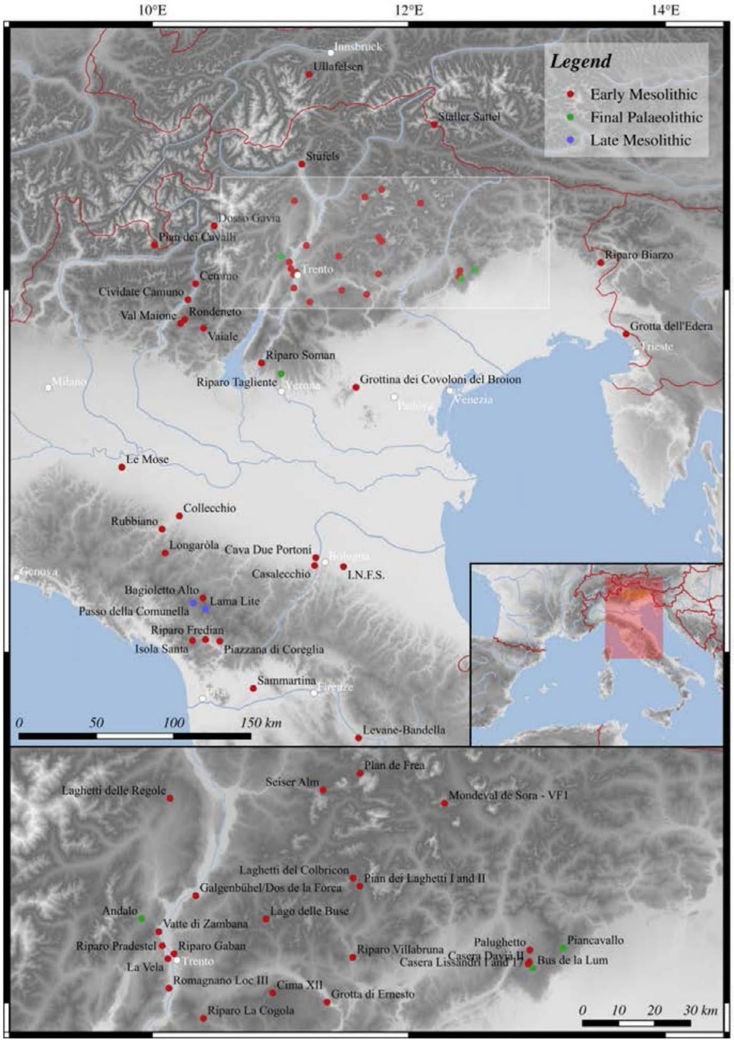


Figure 2.33 - Location of some of the main Sauveterrian sites of North-Eastern Italy (from Visentin, 2017).

flakes/laminar flakes through an independent reduction sequence starting from nodules, small blocks or thick flakes. Elongated blanks are obtained through several flaking methods:

- by exploiting narrow/large surfaces with a unidirectional and facial debitage
- by shifting from a facial to a semi-tournant debitage or (alternatively) by reorienting cores both orthogonally or bidirectionally either on the same (peripheral exploitation) or on new surfaces (multidirectional exploitation)

On the other side, flakes and laminar flakes were often obtained by a centripetal reduction sequence on thick flakes by using as debitage surface the ventral (e.g. Romagnano Loc III; Flor et al., 2011) or the dorsal face (e.g. Galgenbühel/Dos de la Forca; Wierer, 2008) of flake-cores while Collecchio attests to an original and independent reduction scheme aimed at obtaining large naturally backed flakes on coarse grained raw materials (Visentin et al., 2016a).

Generally the opening of the debitage surface is direct and any shaping out phase is attested with the exception of the site of Galgenbühel/Dos de la Forca in which a preparation of a crest was observed in burin-like cores (Wierer, 2008). At the occurrence of knapping errors, generally consisting of hinged removals, cores were turned and not maintained. At a general level larger and thicker blanks were used as domestic tools (with or without previous retouching phase) and small (mostly but not exclusively) lamellar blanks for the manufacture of microliths. As regards percussion techniques all sites attest to the use of direct percussion with a soft hammerstone. Variable was the type of gesture adopted. For larger and thicker products the hammerstone was used with a linear motion and aimed at striking inwards with respect to the overhang. On the other hand, for the production of full debitage and thinner bladelets, microbalelets, laminar flakes and flakes, hammerstones were used with a more tangential gesture striking closer to an abraded overhang. In the final stage of the reduction process cores could be flakes by a bipolar percussion technique.

By comparing the Late Epigravettian layers 19 and 18 of La Cogola with the Sauveterrian layer 16 of the same site and of Galgenbühel/Dos de la Forca, M. Bassetti and colleagues (2009) highlighted several changes, such as an increase of flakes-cores, a decrease in the size of cores and a more frequent opening of a striking platform orthogonal to the principal flaking axis. Also the Sauveterrian sequence of Romagnano Loc III attests to few variations from a diachronic viewpoint, such as a decrease of bidirectional debitage, a decrease of flake-cores and an increase of semi-tournant debitage from the bottom to the top layers of the Sauveterrian sequence (Flor et al., 2011). Furthermore, D. Visentin (2017) pointed out that during the Boreal the maintenance of striking platforms became more important and more carefully curated

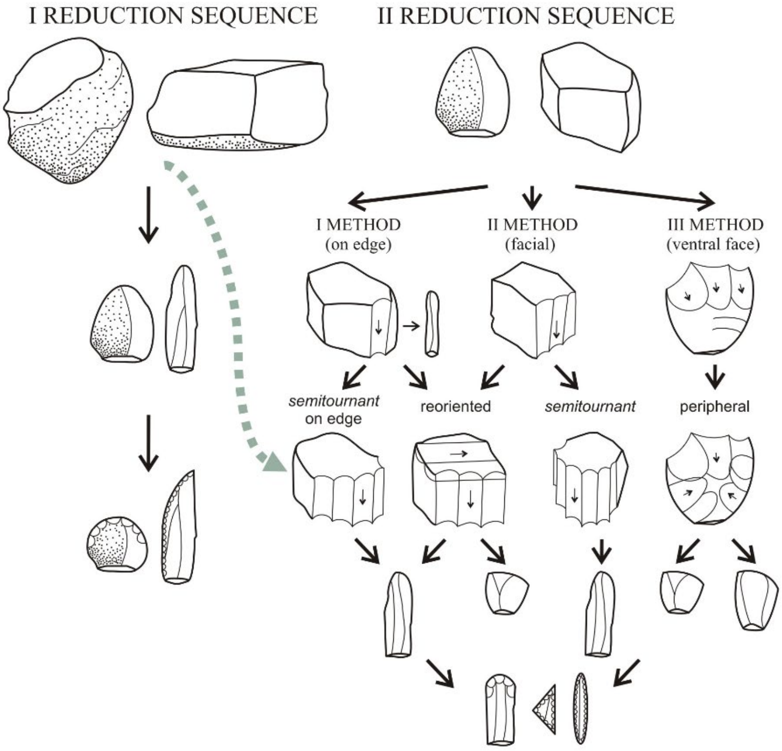


Figure 2.34 – Reduction scheme identified at Romagnano Loc III (Flor et al., 2011).

compared to the Preboreal period.

2.4.2.2.2 Armatures

The variability in armatures production of Adige Valley sites was one of the main aspects that allowed A. Broglio and S. Kozlowski (1984) to propose a phasing within the Sauveterrian. The main typo-morphological features for each phase are presented below:

- The **Early Sauveterrian** is characterised by the presence of triangles, mainly isosceles with three retouched sides, crescents, double backed points (c.f. Sauveterrian points), backed (bi)truncated bladelets and rare single backed points. In some Emilian (e.g. Collecchio and I.N.F.S.) and Trentino (e.g. La Cogola 16) assemblages crescents are more abundant than triangles. Compared to the previous Late Epigravettian layers, La Cogola SU 16 attests to a decrease of backed (bi)truncated bladelets and the appearance of double backed points. The presence or the absence of this latter, especially if produced transversally on flakes, seems to be one of the most significant parameters to distinguish the Early Sauveterrian assemblage from the Terminal Epigravettian ones, together with the disappearance of bi-truncations and the significant decrease of *Microgravettes*.
- The **Middle Sauveterrian** is characterised by a higher percentage of long and narrow crescents rather than short and wide and a decrease of isosceles triangles in favour of elongated and scalene ones. Backed (bi)truncated bladelets are less frequent compared to the previous phase. Sauveterre points are well documented.
- The **Late and Final Sauveterrian** are characterised by the increase of elongated scalene triangles with three retouched sides (cf. *Montclus* triangles) and among double backed points short types with large bases are more frequent. Crescents decrease.

In the Emilian and Venetian sites the tendency of triangles to become more elongated (with shorter bases) together with a gradual decrease in the presence of crescents and isosceles triangles was confirmed also by D. Visentin (2017). M. Bassetti and colleagues (2009) observed the same trend in the Trentino region. Some examples are presented in Figure 2.35.

As regards blanks selection, the smallest classes (microbladelets and small flakes or laminar flakes) were systematically selected to produce microliths. Several Authors highlighted differences in blanks selection according to the type of armature (Flor et al., 2011; Fontana et al., 2009; Bassetti et al., 2009). Thinner elements were used for triangles (1-2 mm), whereas thicker ones for backed points (2-3 mm). Furthermore, the refitting of a proximal microburin on a core in Galgenbühel/Dos de la Forca demonstrated that length of the original blank does not need to be very high for the production of geometric armatures (Fig. 2.35 C, n.30). As suggested by F. Fontana and A. Guerreschi (Fontana and Guerreschi, 2009) the production of irregular blanks was balanced by higher investment in the phase of transformation of standardised microliths. The blank thickness was probably the most controlled parameter (Wierer, 2008).

For Collecchio and Cassera Lissandri 17 D. Visentin (2017) mentions an armatures shaping applied by direct retouch (more rarely crossed) associated with an extensive use of the microburin technique. The same retouching modality was noted in La Cogola SU 16 and Galgenbühel/Dos de la Forca assemblages (Bassetti et al., 2009; Cusinato et al., 2004; Wierer, 2008). Microburins are more frequently proximal rather than distal according to the sites for which such information was reported (e.g Le Mose, Collecchio, Cima XII, Cassera Lissandri 17, La Cogola).

As concerns microliths functioning and hafting modality, data are weak for the time being. However, it seems that there is a unanimous consensus in attributing to these artefacts a primary function as projectile implements. Few data came from Mondeval de Sora (Fontana et al., 2009) and Collecchio (Visentin et al., 2016a). In both cases backed points have a perforating function and an axial hafting modality while geometrics can be hafted laterally (barbs) or latero-distally.

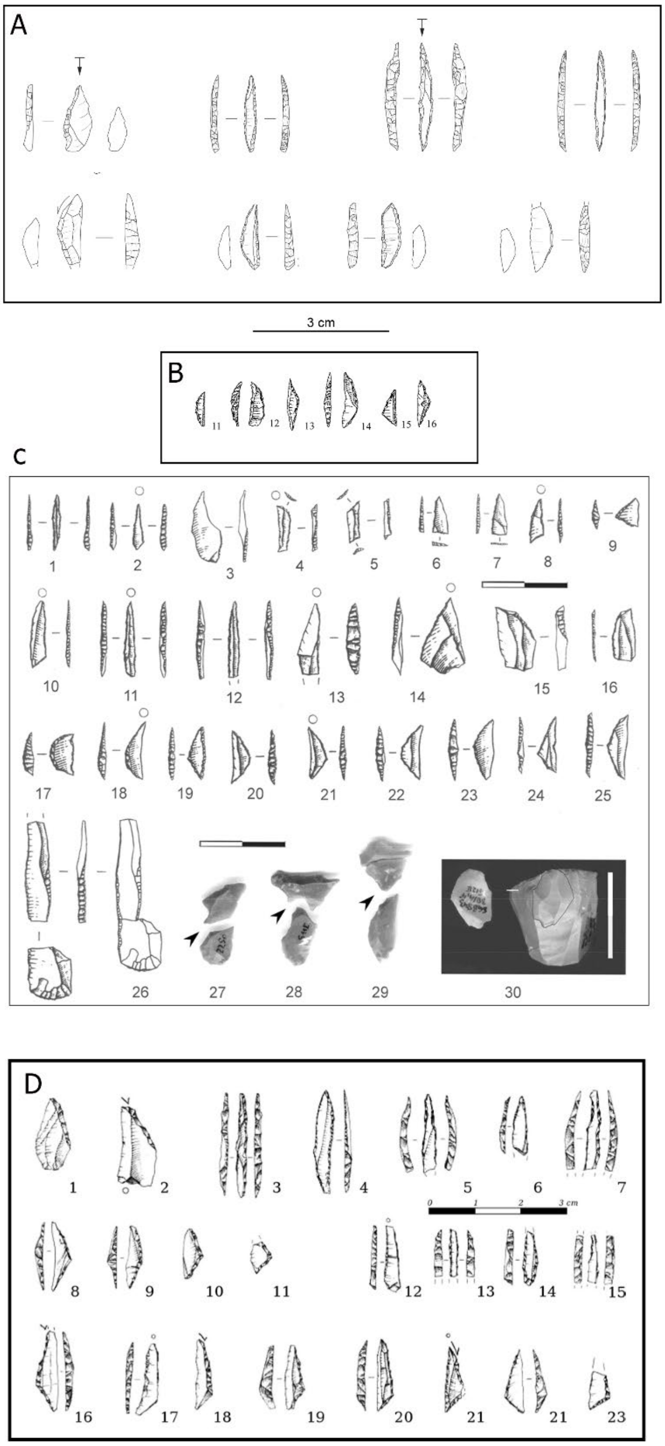


Figure 2.35 – A: Collechio (Visentin et al., 2016a); B: La Cogola layer 16 (Cusinato et al., 2004); C: Galgenbühel/Dos de la Forca (Wierer, 2008); D: Cima XII (Broglio et al., 2006).

2.4.3 North-Western Italy and South-Eastern France

2.4.3.1 Late Epigravettian

Late Epigravettian sites of North-Western Italy and South-Eastern France do not cover the entire span of time between the end of the GS-2 and the Younger Dryas-Preboreal transition. An important hiatus concerns the first part of the Late Epigravettian at least until the second half of the interstadial (Allerød). The only exception is layer 2 - foyer D of Grotta dei Fanciulli, the integrity of which has been recently questioned (Tomasso, 2014).

For the Liguro-Provençal arc our knowledge on technical systems is thus referred to ER3 and the Terminal Epigravettian and it is mainly based on the works of A. Tomasso (Tomasso, 2014; Tomasso et al., 2014) and C. Montoya (2004, 2002). Grotta dei Fanciulli (layer 1), Riparo Mochi layer A, Pié Lombard and Saint-Antoine-Vitrolles (Montoya, 2004, 2002; Tomasso, 2016, 2014; Tomasso et al 2014) are the best-known sites ascribed to ER3. Among them only Saint-Antoine-Vitrolles and Grotta dei Fanciulli (layer 1) yielded radiocarbon dates. The former is dated to 12807-12669 cal BP and 12887-12251 cal BP, while the latter is slightly older: 13243-12732 cal BP. The Terminal Epigravettian is represented only by Abri Martin which is dated to the transition between the Younger Dryas and Preboreal.

Other exhaustive technological data come from the studies of S. Fornage-Bontemps (2013) and L. Mevel et al., (2014) in the Jura and the Western Alps. Authors attributed the sites of Rochedane (layer A4) and Mannlefelsen I (layer R) to the Late Epigravettian through a comparison with Saint-Antoine-Vitrolles. Radiocarbon dates cover a span of time between the end of the Allerød and the Younger Dryas (Rochedane, layer A4: 12910-12618 cal BP and 12895-12585 cal BP; Mannlefelsen I, layer 3: 12796-12564 cal BP).

Further important research was conducted in Northern Tuscany, especially in the Arno and Serchio valleys. In this area several Late Epigravettian sites have been analysed through a techno-typological approach (Baills et al., 2020; Dini and Sagramoni, 2006; Dini and Tozzi, 2005; Tomasso, 2014; Tomasso et al., 2014; Tozzi and Dini, 2007). Almost all of them refer to a final Late Epigravettian (end of Allerød-Younger Dryas). The only exception is the site of Castagnolo (PI) for which C. Tozzi and M. Dini (2007) proposed an older chronology (around 14000 cal BP) but any technological study has been published yet. Among them we decided to consider exclusively those certainly dated and for which it was possible to collect enough data concerning production modalities*,* namely Isola Santa layer 5 and Monte Frignone II SU2 (Dini and Tozzi, 2005; Tomasso, 2014). Other sites, such as Fredian layer 5, Piastricoli, Greppi Cupi II and I, La Mugella V, Farneta, Riparo Campane, La Greppia II, and Foce di Gello were cited in the text exclusively to summarise armatures variability because of the difficulty to interpret data on reduction schemes (Dini and Sagramoni, 2006; Tozzi and Dini, 2007).

The Val d'Aosta region lacks Late Epigravettian evidence. In Piemonte the only excavated site is Via del Maneggio, Castelletto sopra Ticino (NO). Any radiocarbon date is available, but G. Berruti and S. Viola (2009) referred the lithic assemblage to ER3 based on techno-typological comparisons. In Lombardy the only two known sites are located in the Valcamonica valley (BS): Cividate Camuno and Castello di Breno (Biagi and Starnini, 2015). The former is dated at 18067-15577 cal BP. Nevertheless, technological data are still missing. Just a few flint artefacts have been recovered from Castello di Breno (Biagi and Starnini, 2015).

The location of the sites considered for establishing the synthesis of reduction schemes and armatures variability are presented in Figure 2.36.

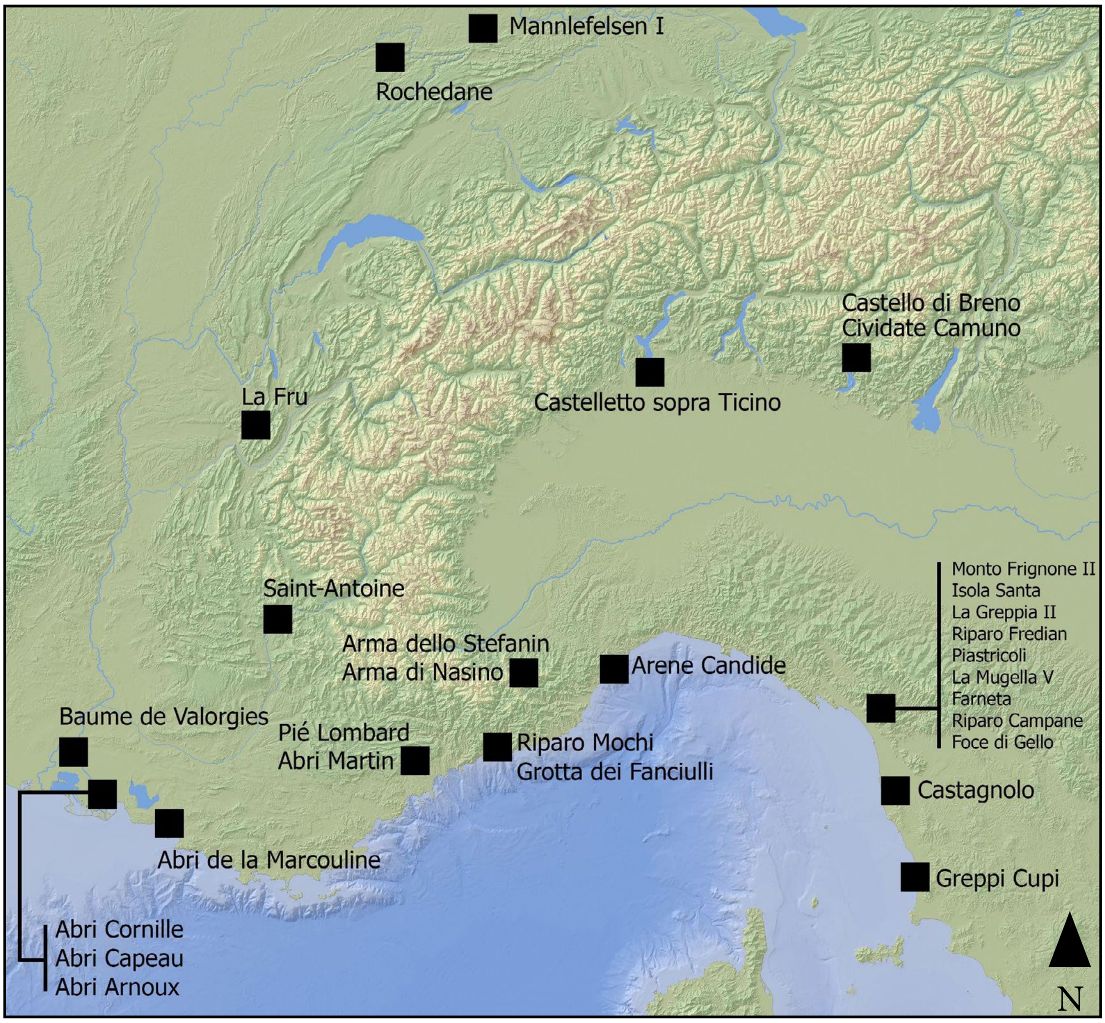


Figure 2.36 - Location of Late Epigravettian sites of North-Western Italy and South-Eastern France mentioned in the text.

2.4.3.1.1 ER 3 (end of the GI-1 and GS-1 – end of Allerød/Younger Dryas)

2.4.3.1.1.1 Objectives and production schemes

Sites of the Liguro-Provençal Arc analysed by A. Tomasso (Grotta dei Fanciulli layer 1, Riparo Mochi layer A and Pié Lombard) show homogeneous lithic assemblages (Tomasso, 2014; Tomasso et al., 2014). The production objective is a unique class of bladelets/microbladelets of variable morphology obtained through two independent reduction schemes (Fig. 2.37), one starting from blocks and nodules, the other one from thick flakes, blades or narrow slabs. The former reduction sequence rarely involves a shaping out phase. The debitage is unidirectional.

Occasionally, an opposite striking planform is opened during the final phase of the production and it is exploited independently from the previous one. The debitage surfaces are fairly flat and the *cintrage* is relatively open. The flaking angle is around 90°. The second reduction sequence occurs by exploiting the *tranchant* of the blank or the narrow surface of slabs. In case of flakes or blades, the back of the core is almost systematically modified by an abrupt retouch. This technical solution may help the prehension of the core during the flaking activity. The striking platform was prepared by truncation. From a general level the first production scheme tends to produce thinner and wider elongated blanks, whereas the second one thicker and narrower ones. In both cases the debitage technique adopted is a direct percussion by soft stone.

Moving to Northern Tuscany, Monte Frignone II (layer 2) is perfectly comparable with the other Liguro-Provençal sites analysed by A. Tomasso (2014), while Isola Santa (layer 5) presents some divergences. The latter concern:

- the angle between the striking platform and the debitage surfaces (lower than 80°)
- the morphology of products (thin and fragile)
- the absence of flake-cores
- the higher number of endscrapers produced on flakes

Also the site of Saint-Antoine-Vitrolles presents a comparable production system to the other Liguro-Provençal sites (Tomasso, 2014) with the exception of a lower variability of domestic tools (Tomasso, 2014). According to C. Montoya (Montoya, 2008b, 2004), besides the occasional exploitation of large blocks/nodules aimed at obtaining blades and large bladelets, the main production involved the exploitation of small blocks and flakes previously obtained from larger block/nodules. The debitage rhythm is mainly unidirectional, occurs through a facial or semi-tournant modality and any shaping out phase is attested. The knapping technique applied is a tangential direct percussion by soft stone.

As we have already mentioned, the similarities between Saint-Antoine-Vitrolles and the sites of Rochedane, (layer A4) and Mannlefelsen I (layer R), allowed L. Mevel and colleagues (2014) to propose a Late Epigravettian attribution for these assemblages. This hypothesis was based on several technical aspects that we generally observe in the Late Epigravettian of Northern Italy: a single production of a high arrays of poorly standardized elongated products (microbaldelets and bladelets with a rectilinear profile) from small blocks and sometimes thick flakes (burin-like exploitation). Longer products and flakes (mainly transformed into domestic tools, i.e. short endscrapers) belong to the initialisation and maintenance phase of the same reduction sequence. Any shaping out phase is attested and the debitage is mainly unidirectional from facial to semi-tournant or even occasionally tournant. An opposite striking platform was opened at the occurrence of knapping errors and the new reduction sequence partly overlaps the previous one and follows the same modality. Cores are highly exploited reaching even 20 mm of length. In both sites the use of direct percussion with soft stone applied by a tangential motion is attested.

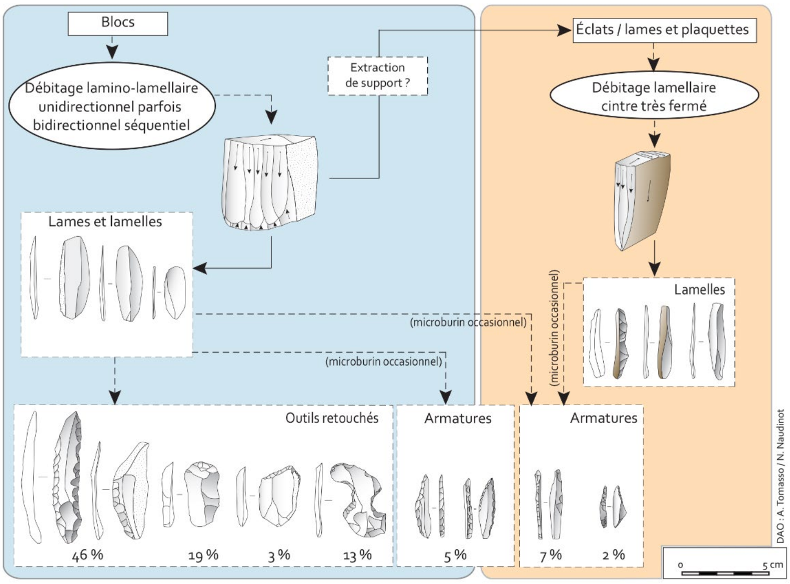


Figure 2.37 – Reduction sequences identified in Grotta dei Fanciulli layer 1 (Tomasso et al., 2014).

2.4.3.1.1.2 Armatures

Next to backed points other armatures were recorded, such as geometrics, backed truncated bladelets and backed bladelets. However, their frequency across this territory is not homogeneous and tends to change from one area to another. Backed truncated bladelets are numerous in few Northern Tuscany sites, especially in Greppi Cupi II and La Greppia II layer 1, but some specimens are recorded also in Farneta, Foce di Gello, Piastricoli and Fredian Layer 5 (Dini and Sagramoni, 2006; Tozzi and Dini, 2007). In the Liguro- Provençal Arc backed truncated bladelets are present at Arene Candide (CIII-I), Arma dello Sefanin (V-IV) and Arma di Nasino (XIII-XI), the latter two being undated, while they are almost absent at Riparo Mochi (layer A), Piè Lombard and Grotta dei Fanciulli (layer 1) as well as at Saint-Antoine-Vitrolles locus 1 and 2 (Palma di Cesnola, 1983 ; Montoya, 2004; Tomasso, 2014), Rochedane layer A4 and Mannlefelsen I layer R. This type of armature is mainly shaped by a single truncation, although there is no certainty on this because their integrity is often compromised. As written by Tozzi and Dini (2007) a few *segmenti trapezoidali* (*sensu* Bagolini and Guerreschi 1978) are documented at Riparo del Fredian and Riparo delle Campane.

Backed bladelets are highly attested in Saint-Antoine-Vitrolles locus 1 and 2 (Montoya, 2002) and Rochedane layer A4 (Fornage-Bontemps, 2013), whereas they are only sometimes mentioned at the sites of the Liguro-Provençal Arc, such as Arene Candide CIII-I, Arma dello Sefanin V-IV and Arma di Nasino XIII-XI (Palma di Cesnola, 1983). In Northern Tuscany they are almost absent (Tozzi and Dini, 2007). For example, Isola Santa layer 5 counts only 6 elements (Tomasso, 2014) and La Greppia II layer 1 a total of 2 (Dini and Sagramoni, 2006).

As far as geometrics are concerned, at Grotta dei Fanciulli layer 1 (n=7; 36% of armatures) and Riparo Mochi layer A (n=13; 21% of armatures) (Tomasso, 2016, 2014) they are produced by applying the microburin blow technique (Fig. 2.38 A and G). Among them isosceles triangles are the most attested type. Their dimension is remarkable at Grotta dei Fanciulli varying between 24 and 38 mm of length and 7-10 mm of width, whereas they are smaller (length: 16-22 mm; width: 5-9), although still far from Sauveterrian standards, in Riparo Mochi. On

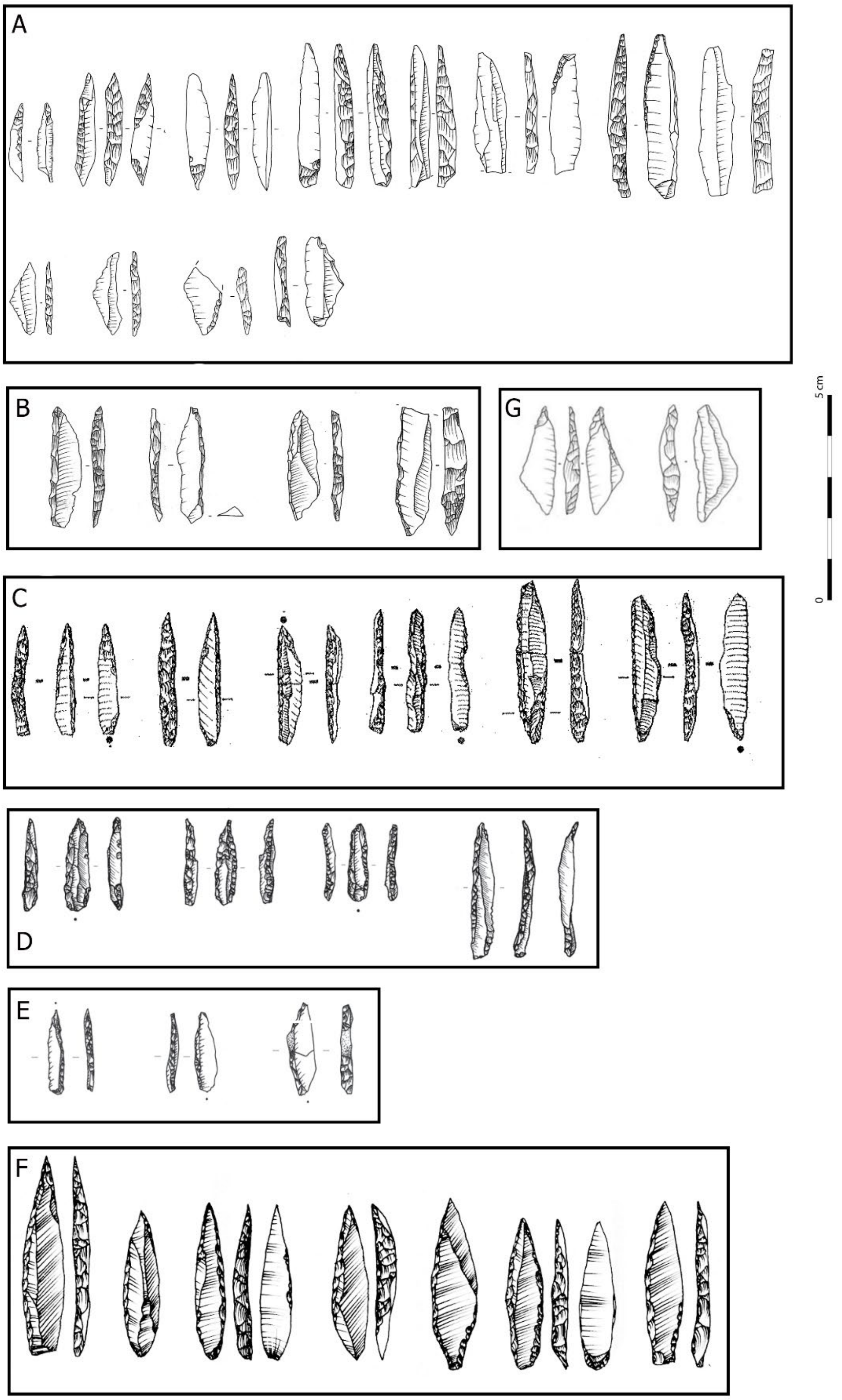


Figure 2.38 – A: backed points and geometrics from Riparo Mochi (Tomasso, 2014 modified); B: backed points from Isola Santa (Tomasso, 2014 modified); C: backed points from Saint Antoine (Montoya, 2002 modified); D: micropointes from Rochedane (Mevel et al., 2014 modified); E: micropointes from Mannlefelsen I (Mevel et al., 2014 modified); F: Point d'Istres (Escalon de Fonton 1972 modified); G: geometrics from Grotta dei Fanciulli (Tomasso, 2014).

the other hand, geometrics are extremely rare at Pié Lombard (n=1) and generally in Northern Tuscany (Dini and Sagramoni, 2006; Dini and Tozzi, 2005; Tomasso, 2014; Tozzi and Dini, 2007) and absent north of the Durance river (Saint-Antoine-Vitrolles, Mannlefelsen I layer R and Rochedane layer A4). Bi-truncations are sporadically attested only in Northern Tuscany (e.g. Piastricoli, Tozzi and Dini 2007). An ambiguous specimen is mentioned at Via del Maneggio, Castelletto sopra Ticino (NO, Piemonte; Berutti and Viola, 2009).

Taking into consideration those sites in which a significant number of backed points was recorded and analysed by a technological approach a certain variability is documented. At Riparo Mochi, blanks used to produce backed points are narrow and thick (*débitage sur tranches*) (Fig. 2.38 A). On the contrary, at Isola Santa they tend to be thinner and wider (debitage with an open *cintrage*) (Fig. 2.38 B). C. Montoya (2002) reports at Saint-Antoine-Vitrolles the exploitation of fairly regular full debitage lamino/lamellar blanks with a rectilinear profile and sub-parallel edges (Fig. 2.38 C). In all three sites the back is rectilinear and opposed to a slightly convex cutting edge. The backing process occurs generally by direct retouch, more rarely crossed. The apex is located in the distal portion and complementary retouches (direct and abrupt or inverse and flat) are used to modify both extremities in Saint-Antoine-Vitrolles while they are almost exclusively used to point the apex in Riparo Mochi and Isola Santa. Backed points with a functional edge entirely modified by a marginal retouch are also well documented. Backed points with a basal truncation are extremely rare. The average sizes of the points are presented below as described by A. Tomasso (2016, 2014) and by C. Montoya (2002).

- Riparo Mochi: length 21 mm (10-40 mm) and width 3.5 mm (2-8 mm)
- Isola Santa: length 23.5 mm (16-29 mm) and width 6.5 mm (4-9 mm)
- Saint-Antoine-Vitrolles length 29.5 mm (18-41 mm) and width 5.8 mm (4-10 mm) and thickness 2.7 mm (1-5 mm)

As regard retouch techniques, A. Tomasso and C. Montoya report the use of soft stone percussion on anvil at Layer A of Riparo Mochi, Grotta dei Fanciulli layer 1, Pié Lombard Unit A and Monte Frignone II, and of a pressure technique at Layer 5 of Isola Santa and Saint-Antoine-Vitrolles. This difference in backing technique allowed A. Tomasso to divide the ER3 into two independent chronological phases denominated as ER3a (dated between 13300 cal. BP and 12900 cal. BP) and ER3b (dated to the GS-1). According to A. Tomasso (2014 p. 474) other aspects vary from ER3a to ER3b, such as:

- a simplification in retouch tools variability
- a lower number of flake-cores
- an increase of endscrapes produced on flakes.

Microgravettes-like backed points were also identified in several sites (Abri Cornille, Abri Capeau, Abri Arnoux, Abri de la Marcouline and Baume de Valorgies) originally referred to the “*Valorguien*” by M. Escalon de Fonton (1972) and dated to the Allerød and Younger Dryas. These sites were successively attributed by C. Montoya (2002, 2004) to the Late Epigravettian. Armatures present along with *microgravettes* a type called “*Point d’Istres”* (Fig. 2.38 F) which is characterised by a slightly curved back and a more symmetric shape (Escalon de

Fonton, 1972).

Also Fornage-Bontemps (2013) in Rochedane layer A4 proposed a subdivision between *micropointes* (Fig. 2.38 D) and *pointes à borde abattu épais*. The former are narrow (4-8 mm) and thin (2-3.5mm), the latter are wide (8-11.5 mm) and thick (2.8-4.6 mm). In both cases the length rarely exceeds 30 mm (average 23.5 mm). The back (deep, abrupt and direct) is rectilinear in *micropointes*, more irregular in the *pointes à borde abattu épais*. Backed points orientation most frequently followed the morphological axis of the blank with the apex located on the distal portion and the base on the proximal one. Although several Authors (Fornage-Bontemps, 2013; Mevel et al., 2014; Tomasso et al., 2018) emphasise the similarity between these backed points and Epigravettian-like backed points, it is important to highlight the absence of one of the most recurrent aspects of Late Epigravettian armatures, namely inverse and flat complementary retouches.

2.4.3.1.2 Terminal Epigravettian (Younger Dryas – Preboreal transition)

2.4.3.1.2.1 Objectives and production schemes

Abri Martin (Gréolières, France) layer 2-3 displays important differences compared to the previous phase in both production aims and reduction schemes as well as in raw material acquisition that becomes restricted to the surrounding territory (Tomasso, 2014; Tomasso et al., 2014). Three independent production schemes were recorded. The first one aims at obtaining irregular and large bladelets and elongated flakes (< 50 mm of length) from blocks and nodules with flat and open debitage surfaces through a unidirectional sequence. A core reorientation (multidirectional exploitation) is often attested during the last production phase for flaking smaller bladelets and elongated flakes. The second reduction scheme involved small pebbles, nodules and thick flakes. The aim is the production of poorly normalized, flat, rectilinear and thin bladelets (interquartile range of length: 20-30 mm) from surfaces with an open *cintrage* used to manufacture armatures. Reorientations to exploit new surfaces are recurrent and cores are strongly reduced in size before their abandonment. Unlike the ER3, flake-cores were not only exploited with a burin-like. Last but not least, an independent small flakes production by a centripetal modality is recorded.

2.4.3.1.2.2 Armatures

The armatures assemblage of Abri Martin layer 2-3 includes backed points (n=81), backed truncated points (n=5) double backed points (n=5), backed bladelets (n=17), isosceles triangles (n=7) and crescents (n=32) showing an armatures variability near to Early Sauveterrian techno-complexes of the region (Guilbert, 2003, 2000). Two backed truncated bladelets are also recorded.

Backed points are characterised by a rectilinear back applied by direct retouches opposite to a cutting edge hardly ever modified. Occasionally direct abrupt, inverse flat or bifacial

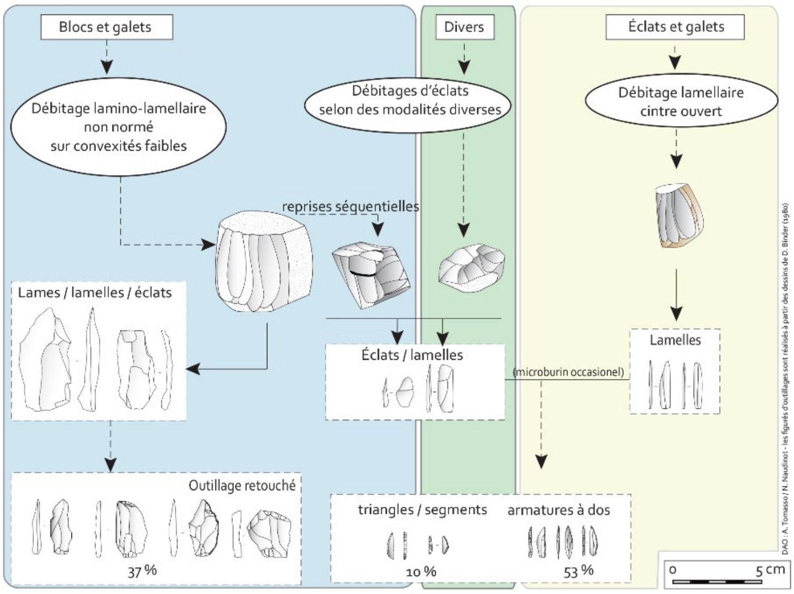


Figure 2.39 – Reduction sequences identified in the Epigravettian layer of Abri Martin (Tomasso et al., 2014)

complementary retouches were observed (Tomasso, 2014; Tomasso et al., 2014). Compared to ER3 the backing process is less invasive (exploitation of narrower blanks?) and back delineation is irregular. Apexes are systematically located in the distal portion. Their length is mainly shorter than 25 mm and width between 3-6 mm. The thickness is around 2-3 mm.

Geometrics strongly increase in number compared to ER 3 and the microburin technique is systematically applied for their production (actually *piquant-trièdres* were observed also on few backed points). Sizes are variable, especially for crescents (Fig. 2.40):

- Triangles: length 9-15 mm, width 3-6 mm, thickness 1-3 mm
- Crescents: length 9-21 mm, width 2-7 mm, thickness 1-4 mm

A. Tomasso suggests the use of the *égrisage* (*sensu* Pelegrin, 2004) or abrasion (*sensu* Fasser et al., 2019) to retouch armatures.

A clear increase of geometrics and microburins is also documented in Northern Tuscany in the site of Greppi Cupi I (Tozzi and Dini, 2007).

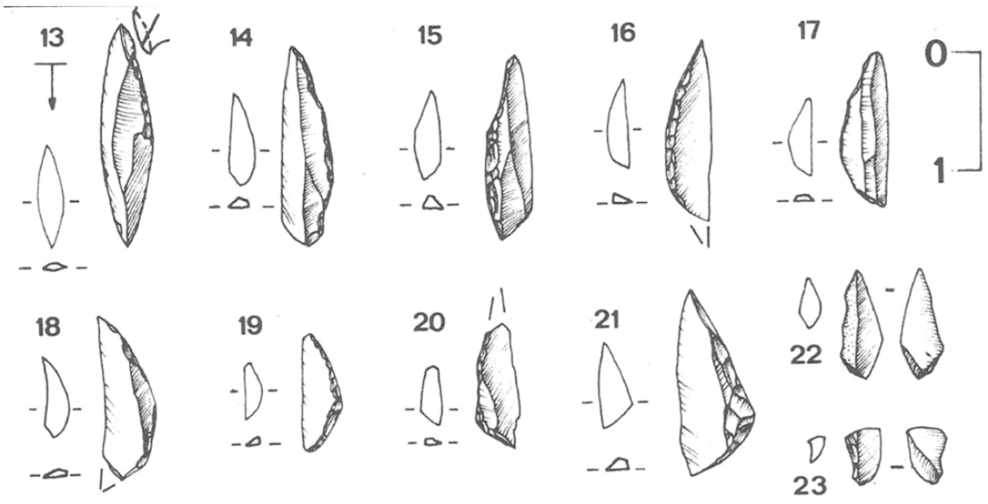


Figure 2.40 – Crescent from Epigravettian layers of Abri Martin (Binder, 1980).

2.4.3.2 Sauveterrian

Sauveterrian sites are rare in North-Western Italy and even less are those studied through a techno-economical approach. In Lombardy, only Cemmo (BS; Martini et al., 2016) provides some information. Moving to the west, both the Piemonte and Val d'Aosta are almost empty of Sauveterrian evidence. The only known sites are Alpe Veglia (Gambari et al., 1991) located in the Lepontine Alps and Mont Fallère in the Grand Combin Alps, near Aosta (Raiteri, 2013). The former yielded only preliminary data concerning debitage methods (Fontana, Guerreschi and Vullo, 2000), while the latter (in particular the site MF-1) has been the object of a Ph.D. dedicated to lithic production (Raiteri, 2013).

South-Eastern France is much richer in Sauveterrian sites as well as our knowledge on their technical traditions. In the western slope of the Rhône basin the most important evidence is represented by the Baume de Montclus, located along the narrow valley of Cèze and recently analysed by D. Visentin (2017). A series of radiocarbon dates allows the chronological attribution of Sauveterrian levels to the Boreal chronozone, encompassing approximately 9500 cal BP and 8500 cal BP. To the East of the Rhône river important data come from the lithic assemblages of Le Sansonnet, Les Agnels and Pey-de-Durance which have been part of a Ph.D project (Guilbert, 2000) and several publications (Guilbert, 2003, 2001). La Sansonnet is dated to the Early Sauveterrian (11816-11242 cal BP). Les Agnels includes multiple occupation levels and radiocarbon dates obtained from the middle and the top of the sequence fall within the Middle Sauveterrian (9495-8991 cal BP and 9309-8592 cal BP). Pey-de-Durance was attributed to a Late Sauveterrian based on the high number of *Monclus* triangles. Recently, the lithic industry belonging to the site of Baume de Monthiver, dated to the Middle and Late Sauveterrian, has been analysed through a technological approach (Ricci et al., 2021).

To the north, the mountain range of Vercors yielded several assemblages recently studied from a tecno-typological viewpoint (Angelin et al., 2020, 2016; Bintz et al., 2008; Bintz and Pelletier, 1999). The most important site is La Grande Rivoire which is a rock-shelter located in the northern part of the Vercors range. The long Sauveterrian sequence was recently divided into three phases (Angelin et al., 2020): an early phase (assemblage 1A/B; 10400-10150 cal BP), a middle phase (assemblage 2; 9900-9950 cal BP) and a late phase (assemblage 3A, 9250-9000 cal BP; assemblage 3B 8700-8550 cal BP). Location of sites cited in the text is illustrated in Figure 2.41.

2.4.4.2.1. Objectives and production schemes

By combining results of the aforementioned works a certain homogeneity can be observed across this territory. The exploited raw material is mainly local and extremely variable: from rock crystal in the Alpine region (e.g., Mont Fallère and Alpe Veglia), to chert both of good (e.g. Le Sansonnet, Les Agnels) and poor knapping quality (e.g., Pey-de-Durance and La Grande Rivoire) or even low silicified limestone and quartzite (e.g. Baume de Monclus).

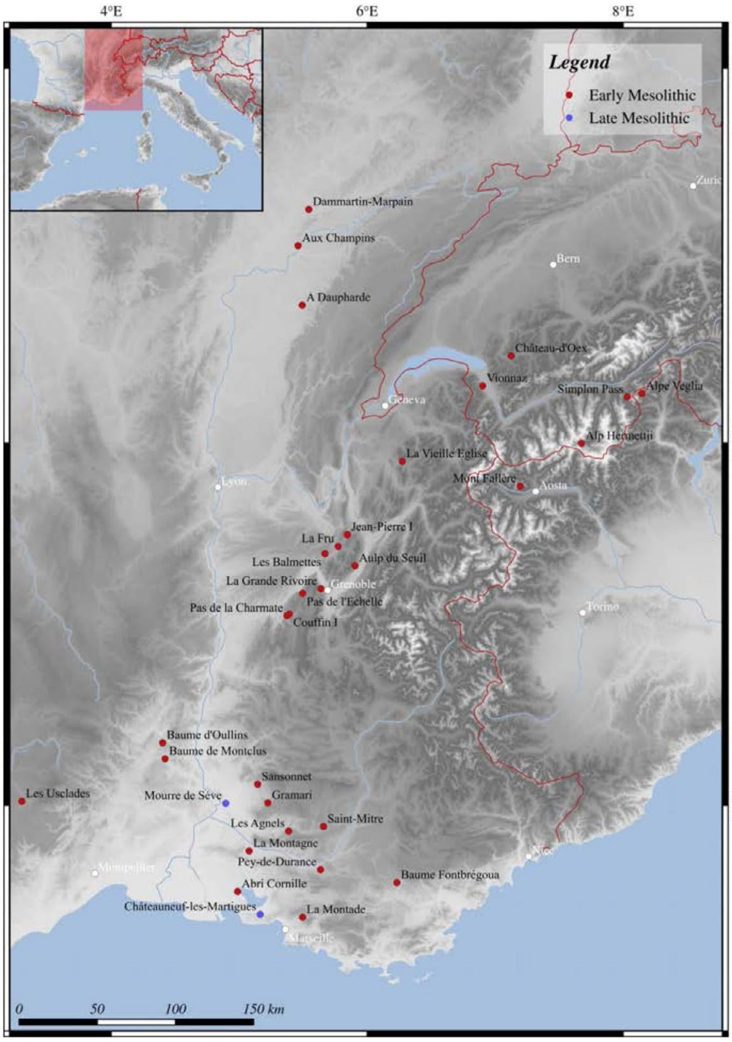


Figure 2.41 - Location of some of the main Sauveterrian sites of South-Eastern France (from Visentin, 2017).

Generally two main reduction schemes were detected. The first one concerns the exploitation of the largest volume for the debitage of a wide set of products used to manufacture domestic tools (retouched or not) or as cores for the second reduction scheme which involves smaller blocks. The latter can be obtained also from heat-fracturing (e.g., La Sansonnet and Agnels; Guilbert, 2001). The aim of the second reduction scheme was to obtain irregular bladelets and laminar flakes mainly shorter than 45 mm. Occasionally small flakes were produced during the last reduction phases. The debitage rhythm is mostly *semi-tournant* and unidirectional or facial with frequent core reorientations. Maintenance procedures are minimised and the shaping out phase is absent. Flake-cores are mostly exploited endscraper-like. Sometimes rejected cores are recycled and retouched as denticulates (e.g., La Grande Rivoire). Actually these assemblages are rich in this type of item. A third reduction sequence can involve an independent flakes production through a bifacial or centripetal exploitation (Guilbert, 2003). The knapping technique is the direct percussion by stone hummer. The overhang of the striking platform was not systematically trimmed. In both the most recent phases of Baume de Monclus (layer 19-17) and of several Vercors sites an increase of blanks regularity and standardisation is attested (Bintz and Pelletier, 1999 and Bintz et al.,2008; Angelin et al 2016; Visentin 2017).

2.4.4.2.1. Armatures

In South-Eastern France armatures variability marked important changes along the Early Holocene. In Provence the first phase of the Sauveterrian is characterised by the dominance of isosceles triangles and crescents, while during the second phase armatures assemblages included both scalene and isosceles triangles. The most recent phase attests to the dominance of elongated scalene ones (c.f. Monclus triangles) with often three retouched sides (Escalon de Fonton, 1966; Guilbert, 2003). Backed points are rare. In the Vercors range armatures follow a similar evolution: if the Early Sauveterrian is poorly documented in this area, the following phase (10500-9500 BP cal BP) attests to the presence of hypermicrolithic crescents, isosceles triangles and short scalene triangles (maximum length of 10-12 mm). Backed points and double backed points are also documented. The last phase (9500-8700/6500 cal BP) shows the development of elongated scalene triangles and Sauveterrian points (Angelin et al., 2020, 2016; Bintz, 1995; Bintz et al., 2008; Bintz and Pelletier, 1999).

Both an Early and Middle phase of the Mesolithic is documented in the Chartreuse Prealps, especially in the site of La Fru, aire III (Saint-Cristophe, Savoie). Again, the ancient layers dated to the Preboreal (4a, 4b and 4c) are dominated by short scalene triangles, isosceles triangles, crescents and single backed points. By contrast, recent layers (3 and 2) dated to the Boreal attest to a sharp increase of elongated scalene triangles together with Sauveterrian points (Fig. 2.42). Furthermore, according to several Authors (Guilbert 2003; Bintz and Pelletier, 1999 and Bintz et al., 2008) the microlithic characteristics of South-Eastern France assemblages tend to decrease towards the end of the Sauveterrian.

Next to this clear change in microliths morphology (and perhaps function?), important variations in production modalities were observed. In particular, the transition between the Early Mesolithic and the Middle Mesolithic marked the abandonment of the microburin blow technique (Visentin, 2017, Guilbert, 2003, Bintz, 1995). Geometrics are then produced by exploiting the entire length of the blanks or by using the fracturing technique called by Bintz (1995) "*bris de lamelle par flexion*". It consists of splitting in two the blank merely by a bending force thus permitting the creation of two microliths, one for each extremity. The fracture surface (snap terminating bending fracture) is replaced by the shorter truncation (Fig. 2.43). L. Chesnaux (2014) suggested the use of abrasion or pressure with an organic tool as a backing technique for the production of armatures at La Grande Rivoire.

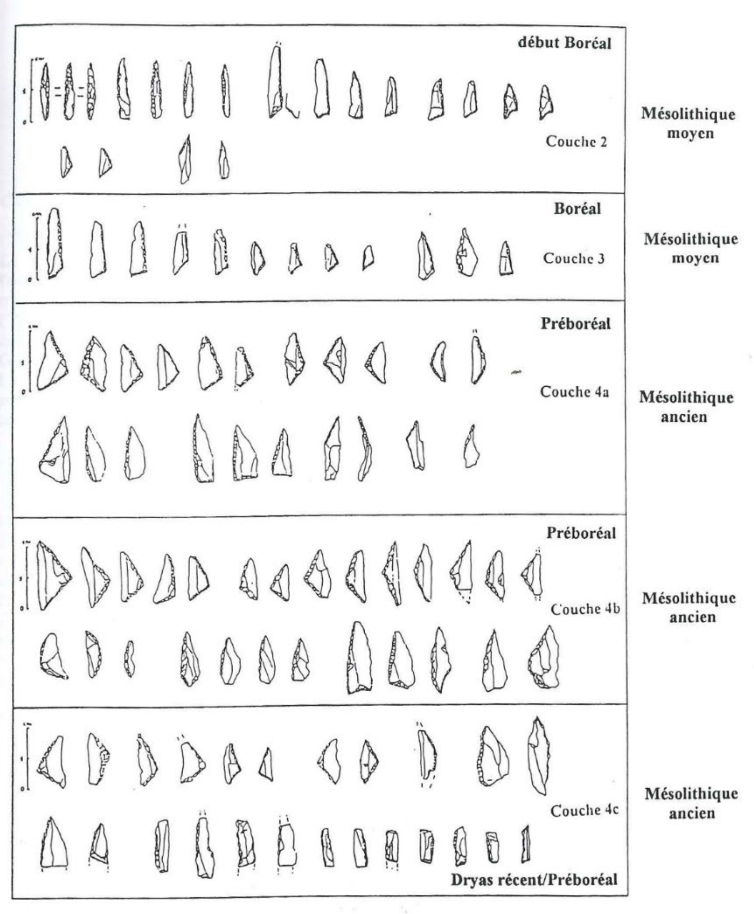


Figure 2.42 – Geometrics variability along the Mesolithic sequence of La Fru, aire III (Bintz 1995).

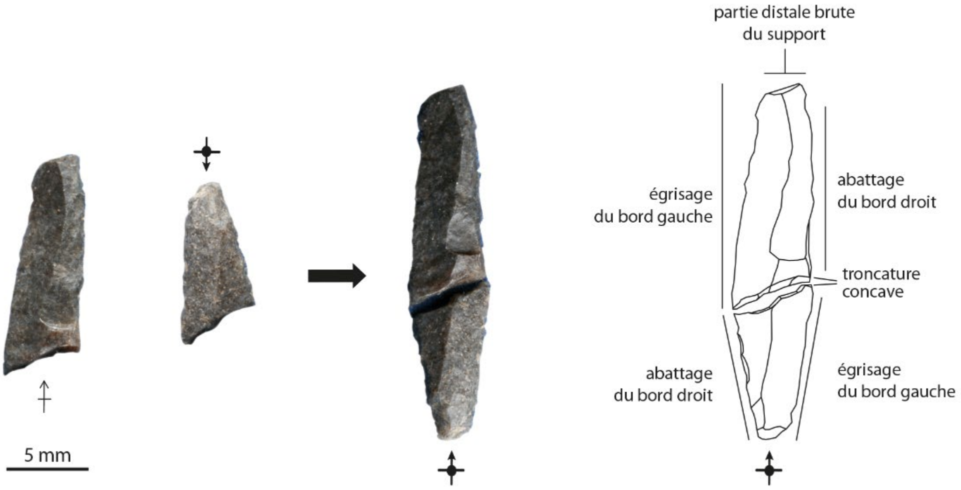


Figure 2.43 – Triangles production. La Grande Rivoire (Chesnaux, 2014).

2.5. Synthesis

The LGM brought about a cultural separation between the Western-Atlantic and the Mediterranean-Balcanic areas of Europe. This separation was originally defined by H. Breuil (1913) based on the morpho-typological variability of lithic artefacts. Later, the increase of research and the development of distinctive methodological approaches and schools of thought between the academic communities of these areas further emphasized such a division: the Italian context was strongly influenced by the "*typologie analytique*" of George Laplace (Laplace, 1964a), at least until the end of the 90s, while France was firstly affected by the Sonneville-Bordes and Bordes method (Sonneville-Bordes and Perrot, 1956; Sonneville-Bordes, 1966, 1959) and then on the early introduction of the concept of the *chaînes opératoires* (Leroi-Gourhan, 1965, 1964, 1945, 1943). Only in the last 20 years both regions started to adopt the same technological approach for the analysis of lithic artefacts (Arzarello et al., 2011; Inizan et al., 1999).

The French Western-Atlantic sequence

Between the end of the GS-2 and the Pleistocene-Holocene transition the French Western-Atlantic area saw the development of four main cultural traditions: the Upper Magdalenian, the Early and Late Azilian, followed by the Flat Blades Techno-complexes. This latter includes the so-called Laborian in Southern and Western France. The passage to one techno-complex to another is systematically marked by important changes in production objectives, reduction schemes and projectile implements.

The transition between the Upper Magdalenian and the Early Azilian (Bølling) is nowadays perceived as fairly gradual. Some features of the lithic production of the Early Azilian remind to those of Upper Magdalenian groups, such as an integrated regular blades/bladelets production through an important technical investment that involved a shaping out phase (preparation of one or more crests) and a meticulous preparation of the overhang. In both periods the allochthonous raw material circulation decreased compared to the Middle Magdalenian. On the other hand, several differences exist concerning the knapping technique (disappearance of organic hummer in favour of soft stone), the number of striking platforms (unidirectional debitage in the Upper Magdalenian vs. bidirectional during the Early Azilian) and morphology of hunting equipment. Antler and lithic points and a wide site of later implements (e.g., backed bladelets, backed truncated bladelets, scalene triangles) left the place to a unique type of curved backed point with one or two apexes. Furthermore only in the Upper Magdalenian an independent bladelets/microbladelets production is attested.

The beginning of the Late Azilian (GI-1c/b/a - beginning of the GS-1) coincides with an evident transformation of technical systems: the reduction schemes are extremely simplified (no shaping out phase) and aimed at obtaining poorly standardised, irregular and thick products (large blades and bladelets and elongated flakes) by a unidirectional sequence. Full debitage products were extracted through direct percussion with a hard stone used with a linear motion aimed at striking inwards with respect to the overhang which is never trimmed. Curved-backed monopoints are obtained by heterogeneous thick blanks and shaped by an invasive retouching process. Raw material collected attests to a restriction of the provisioning area.

During the GS-1 the extremely opportunistic and simplified flaking modalities of Late Azilian groups gave away to a highly sophisticated production of regular blades and bladelets using high quality raw material. The shaping out phase return involves the entire volume of the core (frontal and posterior/latero-posterior crests). Full debitage products are extracted by alternating two opposite striking platforms using a soft stone hummer. Also armatures completely change with the gradual appearance of first Malaurie points and *rectangles* and then *Blanchères* and transverse points (trapezes). An increase in mobility patterns is confirmed by the raw material circulation.

Throughout the Late Glacial, the Aquitaine Basin and the Pyrenean area, albeit they were systematically ascribed to the same cultural tradition, show several differences in armatures morphology and production schemes. The discussion on the meanings of such divergences (especially during the classic Azilian *sensu* M. Barbaza and the Early-Late Azilian *sensu* northern Aquitaine) and whether they are simply the result of an exploitation of different raw material by the same human groups/different sites functionality or rather a real cultural demarcation, is still open (Barbaza, 2011; Fat-Cheung, 2020; Fat Cheung et al., 2014).

The Late Epigravettian

During the same span of time the Italian peninsula and the South-Eastern France attest to the onset and the development of the Late Epigravettian. These facies show a certain similarity with respect to the Gravettian and it is characterised by a cultural continuity traced on the base of lithic artefacts typology, hard animal tissue items and artistic expressions. However, processes of regionalisation and divergences from a diachronic viewpoint have been highlighted and these variations were generally interpreted as an adaptation to local environment. Focusing on Northern Italy and South-Eastern France a progressive simplification of production methods starts at the beginning of the Interstadial B-A and a shift in objectives from normalised blades and bladelets to a wide set of irregular bladelets/microbladelets has been attested. Furthermore. The shaping phase becomes nearly nonexistent and the use of an organic hummer gives away to a soft stone one. The raw material acquired becomes more restricted to the surrounding territory. Both Northern Italy and South-Eastern France seem to share these patterns.

On the other hand, considering armature morpho-types a completely different situation comes to light. Their strong variability does not follow the same evolution throughout this wide territory, confirming the strong regional character of these items even within the same cultural facies. It is interesting to note that during the Terminal Epigravettian, although the main features of the previous phase are still present, several important innovations appear anticipating some of the main aspects of the Sauveterrian production.

Sauveterrian

After this long period in which these two macro regions seem to follow an independent evolution, both the Southern France and partially Italy present a similar lithic technical system and conceptual scheme referring to the Sauveterrian tradition: mixed production of small bladelets/microbladelets, laminar flaks and flakes through short unidirectional sequences with frequent core reorientations. The shaping-out phase is inexistent as well as maintenance procedures. Lithic raw material is local and extremely variable (flint, crystal rock, silicified siltstone, limestones etc.). As a matter of fact the most important success of Sauveterrian technology is the high suitability and flexibility and the almost complete independence from any constraints related to lithic raw materials (Fontana and Visentin 2016).

In Italy this cultural facies is considered as the result of a continuous transformation process directly related to the Late Epigravettian (Broglio, 1973; Guerreschi, 1984a; Martini and Tozzi, 1996). On the other hand, in Southern France modes of transition between the last Palaeolithic communities and the first Mesolithic ones are less clear, in particular in the South-West in which the Laborian do not present any sign of “Mesolithisation”.

Also armatures follow a similar trend in all the main Sauveterrian regions with crescents, isosceles triangles and short scalene triangles that gradually turn into elongated scalene ones. Nevertheless, as claimed by several Authors (Valdeyron et al., 2008; Visentin, 2017), numerous “stylistic” differences concerning domestic tools and armatures exist. In Southern France the microburin blow technique disappears during the boreal chronozone, whereas in Northern Italy continues to be highly employed and the strong microlithization that characterises lithic assemblages in South-Eastern France and Northern Italy did not occur in South-Western France. For an exhaustive synthesis of production systems between Northern Italy and Southern France refer to Visentin 2017.

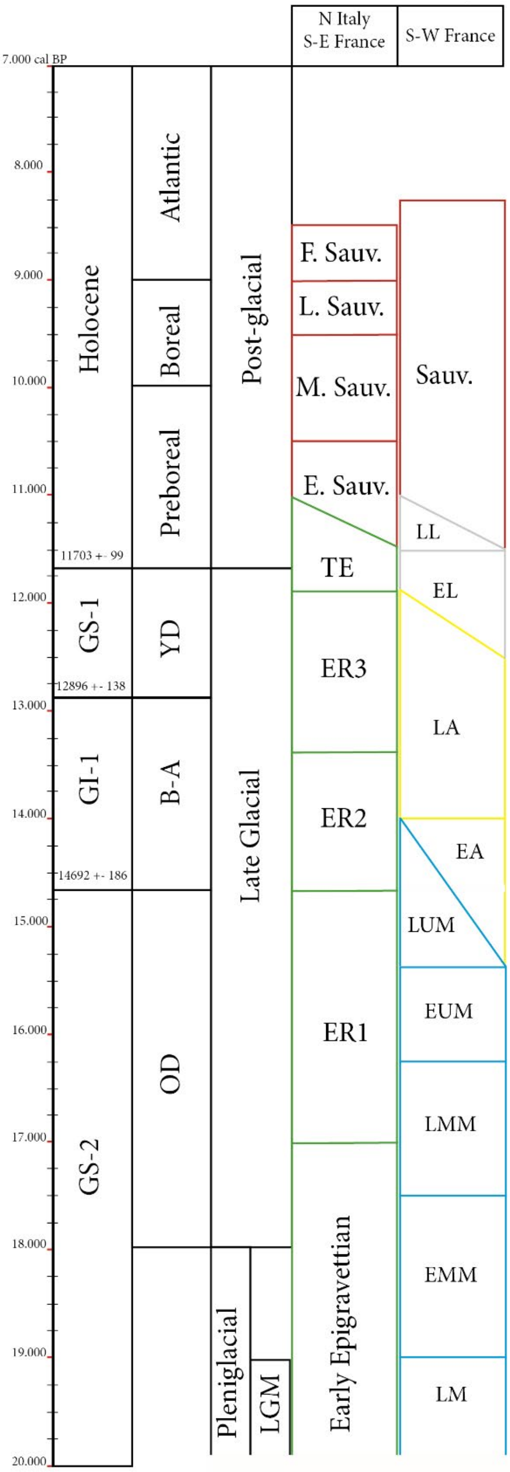


Figure 2.44 – Chrono-cultural sequence in Northern Italy and Southern France. TE: Terminal Epigravettian; LM: Lower Magdalenian; EMM: Early Middle Magdalenian; LMM: Late Middle Magdalenian; EUM: Early Upper Magdalenian; LUM: Late Upper Magdalenian; EA: Early Azilian; LA: Late Azilian; EL: Early Laborian; LL: Late Laborian.

Chapter 3 - Methods and experimentations

3.1. An overview of the methodologies developed for the analysis of lithic armatures

Projectile implements are one of the most represented categories of retouched blanks in Upper Palaeolithic assemblages. The frequency of these artefacts is mostly related to their relevant role in hunter-gatherers' daily life mostly in connection to cynegetic activities. Another aspect which reveals the importance of such tools is their high variability through time and space. Since the early stages of the development of prehistoric studies these tools have been attributed a key role (the so-called "*fossiles directeurs*") in the definition of specific cultural "techno-complexes" or "cultural facies". As suggested by several ethnographic studies, the reason for this variability is most probably to be searched in two main factors: the hunting techniques (e.g., spear thrower vs. bow) adopted in relation to different environments and the pursued preys along with the recognised role of these tools as elements for the identification of ethnic and personal identities (Cattelain, 2004, 1997, 1994; Churchill, 1993; Ellis, 1997; Lemonnier, 1991, 1986; Pétrequin and Pétrequin, 1990; Wiessner, 1983). All these considerations point out to the relevance of improving our knowledge on this category of gears which for many decades has been analysed only from a morphological viewpoint by adopting a mere typological approach. Since the early 1900s armatures types (especially projectile points) were named after the site where they were firstly identified. By coupling different types, multiple regional typologies were proposed (e.g., Célérier, 1979; de Sonneville-Bordes and Perrot, 1956; Broglio and Kozlowski 1983; G.E.E.M., 1972a, 1969; Laplace 1964a, 1964b; Onoratini, 1982; Rigaud, 1982; Schmider, 1971; Sonneville-Bordes, 1966, 1959). Among typological lists the one created by G. Laplace (Laplace, 1964a, 1964b) is peculiar since it is based on a hierarchical system. In his first version of "*Typologie analytique*" (Laplace 1964) the author elaborated several specific categories of armatures named "*Groupe des pointes à dos*" "*Groupe des lames à dos*" and "*Groupe des dos et troncatures*" in addition to the "*Groupe des géométriques*" each of which was divided into different classes and types according to specific morphological features such as invasiveness and extension of backed retouch, length and delineation of the back and the eventual presence and location of shoulders. In a certain sense his work represents a first attempt to analyse what are commonly defined "formal tools" based not only on morphology but also on the variability of specific technical features.

As of early 1970s, in order to try to fully exploit the potential information of projectile tools, morphological, morphometric (e.g., Ahler, 1971; Corliss, 1972; Falcucci et al., 2016; Greaves, 1982; Harrold, 1993) and functional (e.g., Chesnaux, 2014; Coppe and Rots, 2017; De Bie and Caspar, 1996; Fischer et al., 1984; Plisson, 2005; Rots and Plisson, 2014; Roux et al., 2020; Sano, 2009; Soriano, 1998; The Ho Ho Classification and Nomenclature Commitee, 1979; Yaroshevich et al., 2010) approaches started to be developed. The general goal of these latter was to understand whether artefacts classified as points on typological grounds had actually been used as projectile implements and in which way. The distinction between spear and arrow implements is another major topic of functional studies (Chadelle et al., 1997; De Bie and Caspar, 1996; Fischer et al., 1984; Geneste and Plisson, 1990).

As regards manufacturing techniques and methods, despite the considerable development of technological studies applied to lithic assemblages in the last decades (Arzarello et al., 2011; Boëda, 1994, 1986; Tixier et al., 1980), the analysis of retouched tools (or transformed blanks) is still not fully integrated in the *chaînes opératoires* reconstruction (Balfet, 1991; Karlin et al., 1986; Lemonnier, 1976; Pelegrin et al., 1988) and a shared methodology suitable for the analysis of retouched tools in its broader sense (including the methods and the techniques applied during the manufacturing process) is still lacking. The investigation on the processes of blanks transformation, in fact, involves the delineation of a different protocol of analysis with respect to the one applied in the reconstruction of knapping reduction sequences. Moreover, the study of different categories of tools requires the identification of specific criteria.

In opposition to the "classic" enumerative typology strictly focused on the definition of an inventory of types, Valentin (Valentin, 2008, 2006) has proposed an "interpretative" or "technological" typology which should be able to combine morpho-descriptive and techno-functional analyses with the aim of understanding the manufacturing methods and techniques and recognising the modalities of use. This involves the possibility of investigating whether the differences and affinities observed among backed tools on a typological/morphological level can also be recognised from a technological/manufacturing viewpoint. Following these two lines of research in the last fifteen years further studies were published aimed at identifying back retouch techniques (Baillet and Maury, 2018; De Wilde and De Bie, 2011; Duches et al., 2018; Fasser et al., 2019; Pelegrin, 2004) and manufacturing methods (Lorène Chesnaux, 2014; Christensen and Valentin, 2004; Fat Cheung, 2014; Langlais, 2004; Marder et al., 2007; Montoya, 2002; Montoya and Bracco, 2005; Naudinot, 2008; Soriano, 1998; Taylor, 2012; Valentin, 1995; Wierer, 2013).

Experimental studies aimed at identifying retouch techniques, which represent the most relevant technical aspect involved in the transformation of blanks into backed tools, started to be developed thanks to the work of J. Pelegrin (2004). In order to reconstruct how armatures were manufactured in the Magdalenian site of Étiolles (France), the Author tested three different techniques: soft stone percussion on anvil, pressure by an antler compressor and abrasion with stone. For each technique Pelegrin described the modes of operation, the practical limits and few macroscopic distinctive criteria. He also identified some typical wastes, such as the *Krukowski* microburin (and its corresponding negative), which he recognised as characteristic of soft stone percussion on anvil. Following the criteria defined by Pelegrin's work other authors attempted to identify retouch techniques applied to different Upper Palaeolithic and Mesolithic contexts (Chesnaux, 2014; Mevel et al., 2014; Mussi et al., 2008; Naudinot, 2008; Naudinot et al., 2017; Tomasso, 2014, 2016; Tomasso et al., 2018).

A detailed study of retouch techniques has been published by R. Duches and colleagues (2018) focused on an inquiry into the flexibility of manufacturing methods for projectile implements in the Late Epigravettian of Northern Italy. By adopting an experimental approach, Authors tested the same techniques proposed by Pelegrin (2004) and drew a report on the criteria useful for the discrimination of each of them. Unintentional breakages typical of each technique are also examined allowing Authors to confirm the association of the Krukowski microburin to soft stone percussion on anvil and to identify two new types of fractures strictly related to pressure by antler: cone fractures generated by an overshot retouch flake and bending fractures with feathered terminations.

Moving to the Early Upper Palaeolithic techno-complexes, M. Baillet (2018) with the collaboration of S. Maury, proposed an experimental study focused on the identification of backing techniques to produce Chatelperronian backed blades. Three backing techniques have been experimented: soft stone percussion on anvil, abrasion and a further technique called *"abrasion tangentielle localisée sur appui".* This latter recalls the backing technique defined in our work as "pressure by soft stone" but it seems to differ in both the gesture and the retoucher position during the backing process. It should be considered as a variant of abrasion rather than pressure since retouch flakes are detached by a rubbing of the retoucher and not by a punctual pressure.

V. Rots (2010), on the other hand, applied the protocol used for functional analysis to the identification of production traces on a series of experimental assemblages. As regards retouch, she focused on a high-power approach (50-400X). The following techniques were taken into consideration: stone and antler direct percussion and percussion on anvil. This type of analysis is not yet particularly developed in lithic studies and an application to an archaeological assemblage is still lacking.

While these studies have led to greatly improve the definition of a methodology for the analysis of backed tools and backing techniques, a systematic and comprehensive protocol for their differentiation through a combination between a qualitative (high and low power approach) and quantitative analysis is still missing as well as an evaluation of the degree of reliability of identification procedures based on blind tests. For these reasons, in this dissertation a first experimental session was dedicated to the manufacture of armatures by a backed retouch. Furthermore, a second and a third experimentation were dedicated to intentional fracturing techniques: a session was focused on the microburin blow technique, and another one was aimed at examining other fracturing techniques.

The "microburin blow" is a key element in the *chaîne opératoire* that involves microliths. It periodically appears in Italy during the Late Epigravettian (Bisi et al., 1983) and in France during the Solutrean and the Middle and Upper Magdalenian (Langlais, 2008). However, it was at the onset of the Mesolithic and the Early Neolithic that this method of blank segmentation reached its maximum diffusion. The discussion concerning when this type of fracture transformed from an unintentional breakage into a deliberate method (*Krukowski* microburin vs. ordinary microburin) and whether in Europe it was a Mesolithic invention or rather the results of a gradual development during the Late Upper Palaeolithic is still open (De Wilde and De Bie, 2011).

Microburins were firstly identified by G. Chierici in 1875, who was able to understand their technical connotation. Later, several pioneers faced to this production waste, such as L. Siret (1893), H. Breuil (who in 1921 introduced the term "microburin" due to a misinterpretation), Vignard (1934, 1923), Octobon (1926) and Brézillon (1968). Nonetheless, it was J. Tixier to explain in detail for the very first time the technical process involved in this fracturing technique (Tixier et al., 1980). According to the Author, the procedure requires the use of a blank (flake, blade or bladelet), which must be positioned at the edge of an anvil (stone, wood, flint core, ridge of a thick blade) with its ventral face facing up and its axis inclined. Then a deep notch is produced by applying an abrupt retouch as long as the fracture of the blank is reached. The breakage, oblique to the blank axis, follows the anvil edge direction. In the literature two force application modes for obtaining the *piquant-trièdre* fracture have been proposed (Finlay, 2000; Miolo and Peresani, 2005; Tixier et al., 1980): percussion and pressure/bending. If few observations between their efficacy have already been published (Finlay, 2000), micro, meso and macro-scopic criteria useful for differentiating them have been never discussed.

The practice to intentionally break blanks during the *façonnage* phase using techniques other than the microburin blow was proposed by several Authors for armatures production of different Late Glacial (Duches and Peresani, 2010; Guerreschi, 1996; Serradimigni, 2009) and Sauveterrian sites (Bintz, 1995; Lorène Chesnaux, 2014). However, only Christensen and Valentin (2004) carried out an experimental session in order to demonstrate such an activity, but experimental results are not available.

3.2. Methodology

In order to analyse armatures production, a methodology was developed based on two complementary approaches, an experimental and a technological one. Both were aimed at reconstructing the whole *chaîne opératoire* of armatures manufacture starting from blanks selection. As already mentioned, three main experimental sessions were carried out. The **1st experimentation** was dedicated to the investigation of four main research axes:

- which retouch techniques are effective to produce backed armatures by testing different combinations of retouchers (lithic vs. organic), anvils (lithic vs. organic) and force application modes (percussion vs. pressure vs. abrasion);
- to identify criteria useful for the recognition of different retouch techniques;
- to test reduction schemes (namely retouch sequences) applicable to obtain backed points, backed truncated bladelets and backed bladelets, along with the identification of diagnostic elements for their recognition;
- to achieve a better comprehension of specific technical expedients attested for the manufacture of Late Glacial armatures.

The **2nd experiment** was aimed at examining the microburin blow technique and in particular:

- which force application modes (percussion vs. pressure/bending) are more effective to apply a microburin blow;

- to identify on microburins the criteria useful for the recognition of the different microburin blow techniques experimented;
- to test the variability of production schemes suitable for the manufacture of Sauveterrian geometrics, namely how many microburins and geometrics can be obtained for each blank;
- to evaluate the suitability of each backing technique to produce Sauveterrian geometrics;

The 3rd experiment was focused on fracturing techniques different from the microburin blow but useful to achieve a controlled fracture, along with the identification of diagnostic morpho-scopic features for their recognition.

The workflow established for the study of the experimental materials provides the use of two main methods of analysis: a qualitative and a quantitative one. The former is based on both a low- and high-power magnification analysis. Such a combined approach is often used in use-wear analysis, but has rarely been applied to the reconstruction of production modalities of lithic artefacts (Rots, 2010). The low-power approach was aimed at identifying and describing several meso- and macroscopic criteria useful for the identification of each retouch and fracturing technique experimented. The validity of results obtained was then verified through several blind tests carried out by the Author and four researchers with a solid background in lithic technology (the Author, F. Fontana, D. Visentin, A. Potì and D. Delpiano). The high-power approach was designed to detect micro-polishes and striations related to the backing process and in particular to the friction between the retoucher and the retouch platform. One of the problems with backing techniques recognition may be the subjectivity of interpretation of diagnostic morpho-scopic criteria which may lead to incorrect evaluations. To reduce such a risk, a quantitative analysis aimed at measuring several morphometric back features, by examining a random sample of retouch negatives, was also carried out.

3.2.1. 1st experimental activity: retouch techniques (after Fasser et al. 2019)

3.2.1.1. Experimental sets

The experimental manufacture of backed armatures was carried out by the Author (NF) and by other two knappers (Davide Visentin and Alessandro Potì) following a specific protocol that is here detailed, along with the methodology adopted for their analysis.

3.2.1.1.1. Phase 1 - Raw material procurement

Raw materials selected for the experimental flaking are represented by nodules belonging to the Cretaceous Maiolica Formation, which outcrops extensively in the Lessini area. This type of chert is characterised by a very fine texture and overall good quality.

3.2.1.1.2. Phase 2 - Blanks production and selection

Two independent reduction sequences were adopted: the first one was aimed at obtaining blades and bladelets starting from large nodules and the second one was to obtain microbladelets from small blocks. Two different knapping techniques were used: soft stone (limestone and sandstone) and organic (antler) percussion. Blanks characterised by parallel or sub-parallel edges were selected and divided into three main dimensional classes to test retouch techniques on blanks with different morphometric values (Fig. 3.1):

- Blades: length between 59 mm and 110 mm
- Bladelets: length between 36 mm e 59 mm
- Microbladelets: length between 10 mm e 35 mm

In addition, bladelets and microbladelets were divided into two subcategories according to their thickness, a parameter that strongly influences the efficacy of backing techniques (cf. Pélegrin, 2004):

- Bladelets with thickness > of 3 mm
- Bladelets with thickness ≤ of 3 mm
- Microbladelets with thickness ≥ of 2 mm
- Microbladelets with thickness < of 2 mm

Contrary to other technological studies focused on lamino-lamellar assemblages, the width was not considered as an important value since it may be deeply reduced through backed retouch and it is therefore difficult to evaluate on the archaeological assemblage.

3.2.1.1.3. Phase 3 - Armatures manufacture

The retouch process was aimed at obtaining the three main armature categories mostly attested in the Late Glacial techno-complexes analysed during this dissertation (Fig. 3.2):

- backed points
- backed truncated bladelets
- backed bladelets

The total number of items produced are listed in Table 3.1

Table 3.1 - Number of experimental armatures per type

	n
Backed points	55
Backed truncated bladelets	11
Backed bladelets	17
Unfinished pieces	21
Total armatures produced	104

Different retouch sequences were tested trying to cover the entire variability of *façonnage* schemes applicable to obtain the above-mentioned morphologies. The back was applied by three main retouch methods:

Figure 3.1 – 1st experiment

- The first one occurs by shaping one extremity up to the sought-after width and then retouching progressively the longitudinal axis of the blank by one single sequence of direct abrupt removals.
- The second one consists of two distinct sequences of direct removals, the first one from one extremity, the second one from the other extremity.

- The third one provides a back designed by several unidirectional sequences of direct abrupt removals (e.g., from the distal to the proximal portion) or bidirectional (e.g., from the distal to proximal and vice versa).

Once the main dorsal ridge of the blank is reached a few inverse detachments were occasionally flaked.

According to the desired armature category, specific retouch sequences are adopted: concerning backed points, the apical extremity was generally shaped out before the mesial and basal portions although an opposite sequence in which the apex was produced for last has been also tested. By contrast, as regards backed truncated bladelets, truncations were retouched both before and after the main backing process.

Finally, to regularise the profile and morphology of armature extremities or to better delineate the mesial portion, direct and inverse abrupt, semi-abrupt and flat complementary retouches were employed.

Round, flat and elongated limestone, sandstone and serpentinoscisto cobbles, as well as bone and antler compressors were selected as retouchers. Concerning the latter, they were collected from red deer and fallow deer antler tines. Organic compressors were used both with a wooden handle and without. Little elongated cobbles were also hafted on a wooden handle. Retouchers used for this experimentation are illustrated in Figure 3.3.

Four main retouch techniques (Fig. 3.2) were adopted both for the main back and the complementary retouches. Mixed techniques on the same artefacts were also experimented.

***Soft stone percussion on anvil* (SSPA)**:

Retouch was performed by progressive backing while holding the blank on an anvil. Three types of anvil, characterised by a different capacity to absorb the percussion force, were used: a boxwood log, a flat sandstone pebble and a leather-covered pebble. Round and flat-tampered cobbles of different sizes were used as retouchers (Fig. 3.2 a).

Pressure by organic tool (POT):

Blanks were either held directly on the palm of the hand (using a piece of leather) or laid on a boxwood log or on a flat leather-covered sandstone pebble. The compressor was oriented approximately parallelly to the blank surface while the backing proceeded by applying pressure perpendicularly through a flick of the wrist (Fig. 3.2 b). In the case of thicker blanks (4.5 mm), the compressor was holding perpendicularly to the blank and the pressure was applied pushing with the arm and shoulder.

Pressure by soft stone (PSS):

The main difference with respect to the other pressure technique is represented by the use of a lithic pebble characterised by a tapered extremity. Two different gestures were applied through this technique depending on the retoucher morphology. Elongated compressors with a sub-circular cross-section were held perpendicularly to the blank and the pressure was applied pushing with the arm and shoulder, whereas in the case of cobbles with a flat cross-section and little cobbles hafted on a wooden handle, the compressor is oriented parallel to the blank surface and the backing proceeded by applying pressure perpendicularly through a flick of the wrist (Fig. 3.2 c). The blank was laid on a boxwood log, on a flat leather-covered sandstone pebble or directly on the leg.

Abrasion (Ab):

This technique corresponds to the one called "pressure by stone or by soft stone" by Duches et al. (2018), "égrisage" by Pelegrin (2004) and Baillet (2018) and "sfregamento" by Mussi et al. (2008). It was performed with two main modalities: (a) rubbing the soft stone cobble on the edge of the blank held in one hand, while the palm of the other guides the movement of the retoucher along the edge (cf. Duches et al. 2018), and (b) the retoucher is held in the palm of both hands and the blank is rubbed on it thanks to the pressure of the thumbs (Fig. 3.2 d).

Mixed techniques (MT):

The use of multiple retouch techniques on the same blank was also tested, trying to adopt the most functional one at each stage of the backing process.

These techniques were applied to the different categories of blanks selected as illustrated in Table 3.2.

Table 3.2 - Number of experimental armatures per retouch technique and blank category

	SSPA	**POT**	**PSS**	**Ab**	**MT**	**Total**
Blades	5	1	2	-	3	11
Bladelets > 3mm	5	1	2	2	7	17
Bladelets < 3mm	10	7	13	5	3	38
Microblad. ≥ 2 mm	5	5	8	1	2	21
Microblad. < 2 mm	4	4	7	2	-	17
Total	29	18	32	10	15	104

3.2.1.1.4. Phase 4 – Low power approach for the analysis of retouch

In the following phase, a morpho-scopic analysis of the 104 experimental backed armatures was carried out using a stereo-microscope (Optika SZN-T) with a range of magnification between 0.63x to 3x. Multiple descriptive variables were evaluated and 9 of them were deemed to be significant for the identification of backing techniques. The 9 selected parameters are the following (Fig. 3.4):

- (a) **sequence of removals**, the distribution of removal negatives along the back.
- (b) **morphology of the edge** formed by the back and the retouch platform along the entire longitudinal axis.
- (c) **longitudinal profile**, delineation of the retouched edge along the longitudinal axis as seen from the dorsal face.
- (d) **morphology of removal scars**.
- (e) **termination of the removal scars**.
- (f) **initiation of the removal scars**.
- (g) **retouch inclination**, measured as the angle between the retouched surface and the retouch platform.

Figure 3.2 – a: Soft stone percussion on anvil; b: Pressure by organic tool; c: Pressure by soft stone; d: Abrasion

- (h) **transversal profile**, delineation of the retouched edge as seen in transversal section.
- (i) **incipient cones**, presence or absence.

Independently, a morpho-scopic analysis was applied also on marginal retouch (i.e., complementary retouches). The parameters identified as significant for their identification are more or less the same as backing techniques, but we added the retouch extent (short, long, invasive or covering), while the presence or absence of incipient cones was not considered.

Figure 3.3 – Retouchers used during the experiment. 1-3: Limestone and and sandstone pebbels used for applied soft stone percussion on anvil; 4: Limestone pebbel used for applied abrasion; 5-9: Elongated pebbels used for applied pressure by soft stone; 10-13 Organic compressors used for applied pressure by organic tool.

3.2.1.1.5. Phase 5 – Backing fractures analysis

In order to classified unintentional fractures occurs during the manufacturing process four different categories has been established:

- **cone fracture**
- **bending fractures:** snap, hinge, feather and step
- **complex fractures**, namely multiple fractures (e.g. double cone fracture or cone fracture plus bending fracture) or fractures characterised by a secondary detachment (spin-off)
- **resumed fractures,** namely fractures covered by a retouch phase before recording

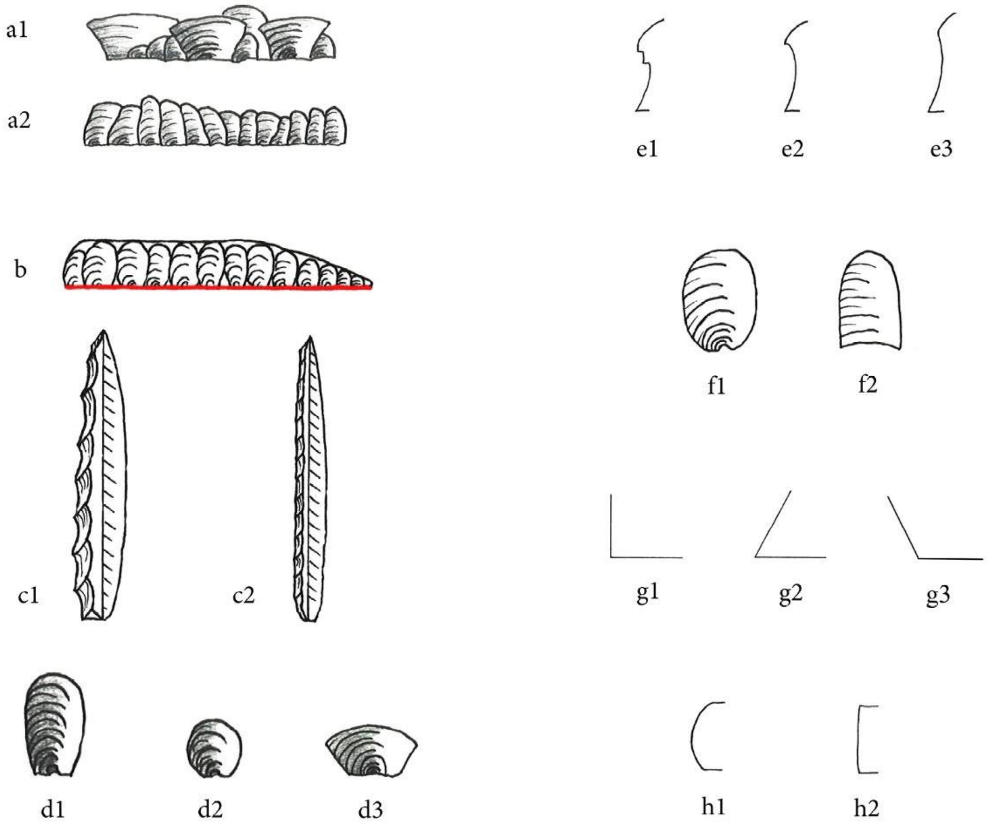


Figure 3.4 - Illustration of the selected parameters. a sequence of removals: 1 irregular, 2 regular; b edge (red line); c longitudinal profile: 1 denticulated, 2 linear; d morphology of removal scars: 1 elongated, 2 sub-quadrangular or sub-trapezoidal, 3 fan-shaped; e termination of the scars: 1 step, 2 hinged, 3 simple; f initiation of the scars: 1 punctiform, 2 large impact point; g back inclination: 1 abrupt (approximately 90°), 2 semi-abrupt (approximately between 60° and 45°), 3 obtuse (more than 90°); h transversal profile: 1 convex, 2 rectilinear.

their morphology.

Moreover, to better characterise fracture morphology several parameters have been considered (Fig. 3.5):

- (a) **direction**, i.e. fracture initiation and termination according to retouch position: it can develop from the retouch platform towards the opposite surface (Fig. 3.5 a2) or vice versa (Fig. 3.5 a1). It can be also indeterminable when any ripple or *languettes* formation reveals a specific direction of the fracture.
- (b) **orientation** according to the morphological axis of the blank: transverse (Fig. 3.5 b1) or oblique (Fig. 3.5 b2)
- (c) **fracture profile**: "S" profile (Fig. 3.5 c2) or rectilinear (Fig. 3.5 c1)
- (d) ***languettes* length** (Fig. 3.5 d)
- (e) **fracture termination**: snap, step, feather and hinge (Fig. 3.5 e)

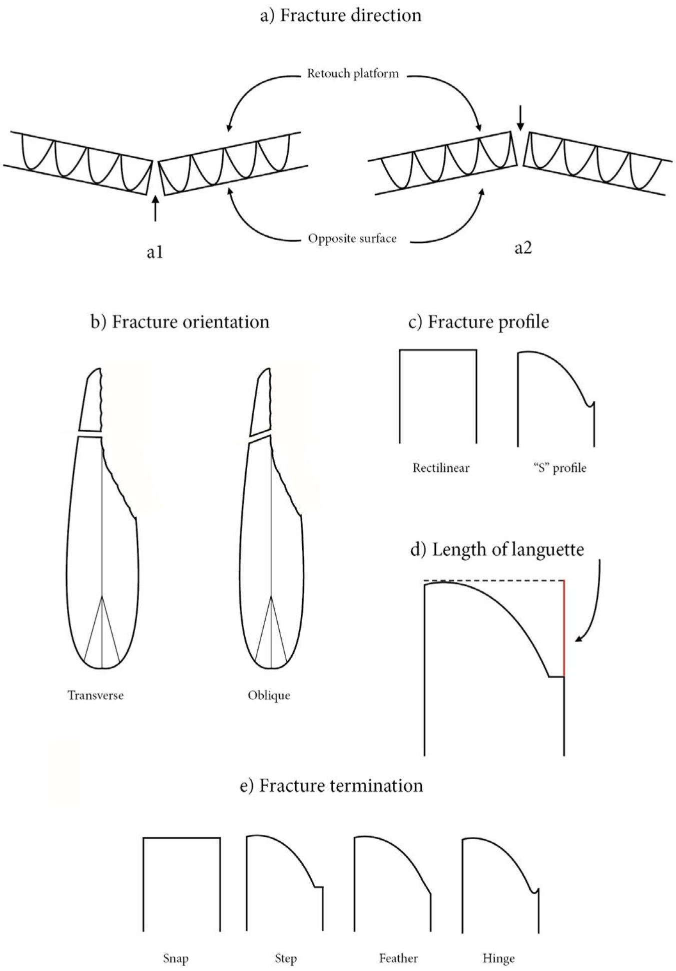


Figure 3.5 – Fractures parameters recorded.

3.2.1.1.6. Phase 6 – Blind Tests

The analysis of the variability of parameters presented in Table 3.4 allowed identifying combinations of features considered diagnostic of each backing technique by the author. Subsequently, the validity of these results (only those related to the backing process and not those for complementary retouches) was verified through three blind tests: The first one was carried out by the author, Davide Visentin and Federica Fontana and was aimed at better clarifying the relevance and variability of the above mentioned parameters trying to determine the backing techniques for a random series of experimental artefacts. NF had to determine retouch techniques of 10 backed points made by DV; DV had to determine 15 backed points made by NF, and finally, FF had to determine 10 backed points made by DV and NF. The second blind test was designed to assess if the selected parameters were valid also on experimental specimens made by a knapper (AP) unfamiliar with the previous phases of the experimentation and therefore to evaluate the significance of gestures and interpersonal variability for the determination of retouch techniques. The experimental sample made by AP counted a total of 50 backed points. Forty were fashioned with single techniques, while the remaining ten were made by applying two different mixed techniques. The third blind test had the purpose to verify if the proposed parameters are usable with a good success rate by researchers with a solid background in lithic technology but completely foreign to this experimental programme. Davide Delpiano had to identify the adopted backing technique on a series of experimental backed points (produced by NF, DV and AP) given the parameters presented in Table 3.4.

3.2.1.1.7. Phase 7 – High power approach

In order to achieve a higher detail in the identification of backing techniques, a further analysis based on a high-power approach has been developed. After manufacturing, experimental artefacts were cleaned with neutral soap, water and an ultrasonic cleaner for 3 minutes. The analysis was carried out using a metallographic microscope with incident light (Optika) and a magnification range between 50x to 500x. The selected sample comprises a total of 52 backed armatures divided between five backing techniques:

- soft stone percussion on anvil (SSPA) (n=10)
- pressure by soft stone (PSS) (n=12)
- pressure by antler tool (PAT) (n=10)
- pressure by bone tool (PBT) (n=10)
- abrasion (Ab) (n=10)

The description of backing micro-traces follows the parameters listed below (from Zupancich, 2019 modified).

Polishes morphological features:

- **Texture**: smooth; rough; rough tend to smooth
- **Topography**: flat; domed; reticulated; granular; melted snow; cratered; pitted
- **Linkage**: open; half tight; tight; compact
- **Localisation**: in contact with the edge; inner surface
- **Distribution**: continuous; discontinuous; spot-like
- **Striations**: presence; absence
- **Orientation compared to the retouch edge:** transverse; oblique; longitudinal

Striations morphological features:

- **Number:** single; multiple
- **Location**: in contact with the edge; inner surface
- **Orientation compared to the retouch edge**: transverse; oblique; longitudinal; chaotic
- **Length**: long; short
- **Bottom**: polished; matt; corrugated; grooved
- **Width**: large (>10 um); narrow (<10 um)

3.2.1.1.8. Phase 8 – Quantitative analysis

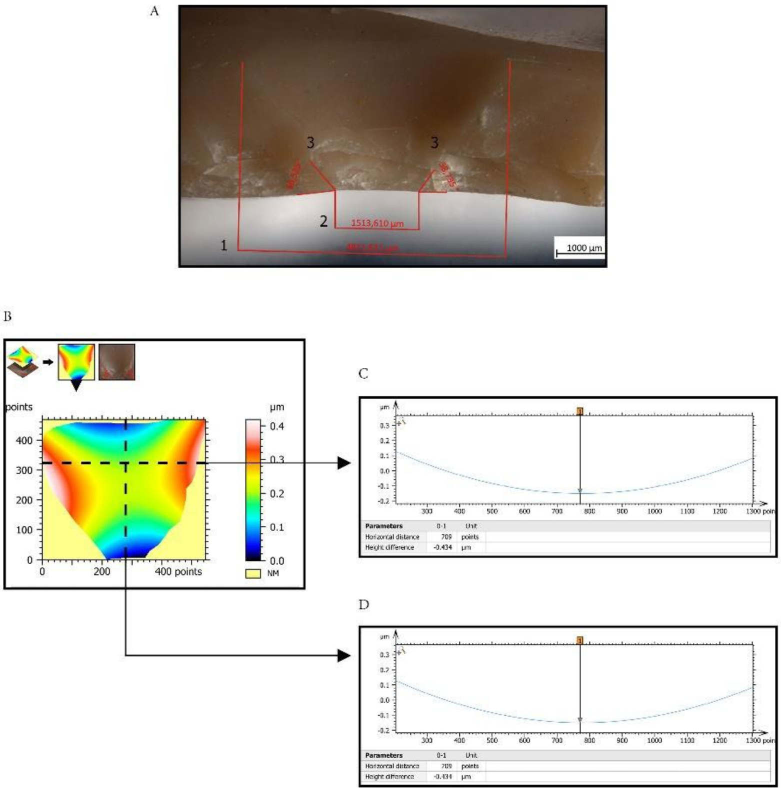
The quantification of experimental backs was based on the examination of a random sample of 80 retouch negatives (20 for each backing technique) recorded on armatures produced by three different knappers (NF, DV and AP). The parameters measured for each negative are:

- width of the initiation and termination of the scar (Fig. 3.6 A, 1 and 2)
- angles of diffusion (Fig. 3.6 A, 3)
- depth of the longitudinal and transverse concavity (Fig. 3.6 C-D)

The first two parameters were recorded using a motorised digital stereomicroscope (ZEISS AxioCam Zoom v16; ZEISS Zen Core v.) as shown in Figure 3.6 A, whereas the concavity was computed using the MountainsLab v.7 (Digital Surf) software following the workflow here detailed:

- pictures of the retouch negative were taken using the digital stereomicroscope and imported in Mountains Lab
- a surface image was then created by merging the CZI image and the jpeg one
- a series of operators were used to level the image and remove the form
- the profiles of the horizontal and vertical concavities were then extracted and levelled
- the distance between the highest and the deepest points was recorded for both concavities

Then, the statistical significance of the metric differences between the negatives produced



Parameters	0-1	Unit
Horizontal distance	709	points
Height difference	-0.434	µm

Parameters	0-1	Unit
Horizontal distance	709	points
Height difference	-0.434	µm

Figure 3.6 – Parameters measured. A: Width of the initiation (2) and termination (1) of the scar and angles of diffusion (3) measured on a digital microscope; B: retouch negative displayed on the MountainsLab software; C: Longitudinal concavity; D: Vertical concavity.

by the four backing techniques has been tested by a non-parametric test, namely Wilcoxon test and by a Principal Component Analysis.

3.2.1.2. Results

3.2.1.2.1. Efficacy of backing technique for deep backed retouch

It should be noted that all the indications concerning the efficacy of difficulty of the presented techniques are to be considered as indicative since may be partially influenced by the experimental knappers' behaviour, skills and experience.

Soft stone percussion on anvil (SSPA):

Soft stone percussion on anvil is functional to the transformation of thick blanks, even thicker than 8 mm with a high operating speed. Nevertheless, after the threshold of 5-6 mm it becomes more and more complicated to carry on the retouch because of the formation of a rearward edge and residual protrusions. On the contrary, this technique is less suitable with bladelets and microbladelets thinner than 2 mm due to the high risk of breakages and the difficulty of holding them on the anvil.

The use of a flat sandstone pebble as an anvil allows to reduce extremely thick blanks (> 5-6 mm), but it strongly increases the risk of manufacturing accidents (fracture index: 100%) due to a low control of the recoil. The use of a leather-covered pebble, due to its superior capacity to absorb the percussion force, permitted to obtain a more regular sequence of removals and to reduce the risk of fractures (50%). On the other hand, this made the backing process slower and more complicated on thick blanks. The boxwood log proved to be the best compromise; firstly, by not absorbing excessively the percussion force it allows an easy and fast back reduction: secondly, it permits a higher control of the recoil compared to the sandstone pebble.

Concerning the retoucher used for applying this technique, it is important to select cobbles with an appropriate size compared to the blank thickness: too heavy cobbles for retouching thin blanks rises the fracture index, on the other hand, a too lightweight one in case of thicker blanks would easily provoke rounded edge portion. Cobbles with a tapered morphology and flat cross-section proved to be more efficient with respect to the rounded ones allowing a better precision of the blow.

Pressure with an organic tool (POT):

Microbladelets and bladelets with a thickness between 1-3 mm were the most suitable blanks, although it was possible to reach a value of 7-8 mm. The retouch can easily proceed up to the main ridge of the blanks without incurring in manufacture accidents. The holding modality is important also in this technique. In fact, if the blank is laid and held on a rigid and uniform surface, a low fracture index is attested. Holding the blank directly on the palm of the hand can easily provoke major fractures especially during the first phase of the backing process. This technique is not very efficient in the initial stage of back reduction when the thickness of the edge is inferior to 1 mm. On the contrary, afterwards, it allows the maintenance of a regular detachment rhythm thanks to the high precision and the lack of unintentional and incipient removals that could produce a rounded and rearward edge. The major disadvantage is a low operating speed.

Pressure by soft stone (PSS):

This technique shows an excellent potential by allowing a high degree of precision, the maintenance of a regular rhythm of work during the retouching process that can continue quite easily up to the main ridge of the blank and the possibility to modify, without particular constraints, blanks up to 3 mm of thickness. With respect to pressure with an organic tool, it is more effective during the initial phases of back reduction and generally more rapid during the entire process, but it also presents an important fracture index. The formation of residual protrusions in case of thicker blanks (4 mm or more) and the low degree of elasticity of the stone can be a hindrance for the prosecution of the back reduction. Both gestures applied with this technique proved to be effective. The perpendicular one (in which the pressure was applied pushing with the arm and shoulder) is more suitable to manufacture thicker blanks (3-4 mm) and tend to produce abrupt back retouch. The parallel one (in which backing proceeds by applying pressure perpendicularly through a flick of the wrist) is more appropriate to thinner blanks (1-2 mm). This latter tends to produce backs with a less abrupt angle (around 70°). A lithic compressor hafted in a wooden handle reveals to be an effective technical solution.

Abrasion (Ab):

Abrasion tends to produce a heavily rounded and rearward edge resulting in the impossibility to carry on the back reduction. It can be used for applying a deep retouch exclusively with thin (1-2 mm) blanks while it is strongly inappropriate with thicker ones. Along with pressure by organic tool it is the technique with the lowest fracture index.

3.2.1.2.2. Efficacy of retouch techniques for marginal retouches (i.e., complementary retouch)

The low degree of precision of soft stone percussion on anvil added to the extremely low angle and thickness of blank edges make this technique poorly suitable for applying marginal complementary retouches. The retouch angle reachable can vary from abrupt to flat depending on the percussion angle applied. However, semi-abrupt and flat retouches are more difficult to obtain and they tend to be short and irregular. On the contrary, both pressure techniques are highly suitable to manage marginal retouches thanks to their high degree of precision and elevated capacity to control the force and retouch angle. The longer the compressor (both lithic or organic), the more covering flat and semi-abrupt retouches become. Abrupt retouches are applicable holding the compressor perpendicularly to the blank surface, while for applying semi-abrupt and flat retouches the compressor must be more parallel. Flat inverse retouches were applied holding the blank directly on the palm of the hands. Abrasion proved to be a rapid and functional technique for a marginal retouch. However, the retouch angle is tough to manage, resulting often abrupt. Retouches are never particularly invasive.

The advantages and disadvantages and degree of suitability of each retouch technique according to the deepness of the retouch are summarised in Table 3.3.

Table 3.3 - Retouch technique efficacy according to type of retouch

	Deep retouch (i.e. backed retouch)		**Marginal retouch (i.e. complementary retouch)**	
	Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
PSS	-To modify thicker blanks. -High operating speed.	-Less appropriate with thin blanks (<3 mm). -Formation of residual protrusions. -Low degree of precision. -High fracture index.	-None.	-Low degree of precision. -Difficulty in controlling retouch angle.
POT	-To modify blanks up to 7-8 mm of thickness. -High degree of precision. -Low fracture index.	-Low operating speed.	-High degree of precision. -Ease in managing retouch angle.	-None.
PSS	-High degree of precision. -High operating speed.	-High fracture index. -Inappropriate with blanks thicker than 4-5 mm.	- High degree of precision. -Ease in managing retouch angle.	-None.
Ab	-Low fracture index.	-Inappropriate with thick blanks (>2 mm) and for performing deep retouches.	-High degree of precision.	-Difficulty in controlling retouch angle.

3.2.1.2.3. A few technical notes

During the experimental activity three main issues concerning a crossed backed retouch were examined:

- when it is possible to apply backed inverse retouches
- what is their purpose
- which retouch technique is the most suitable for this type of retouch

As already observed in the early 60s by J. Tixier (1963), backed inverse retouches can be applied exclusively when the back overpasses the maximum transverse thickness of the blank since the angle formed by the dorsal surface and the backed edge is lower than 90°. However, this is not always true. Sometimes soft stone percussion on anvil can create angles between the ventral surface and the back wider than 90°, which force the abandonment of direct retouch in favour of an inverse one before achieving the main dorsal ridge.

The two pressure techniques revealed to be highly suitable for applying inverse retouches as well as abrasion. By contrast, soft stone percussion on anvil is a far less suitable technique, since a blow on the main dorsal ridge can easily cause the fracture of the piece.

At a general level, inverse retouches are thought to be useful in three main circumstances:

- To remove micro-reflections and to regularise the back delineation (Langlais, 2004; Valentin, 1995), in order to obtain a rectilinear transverse profile, a linear longitudinal profile and an extremely abrupt back inclination. On the thickest portions of the blank it is easier to produce micro-reflections that need to be removed by turning the piece over and detaching some overlapping inverse retouches.
- Once the main dorsal ridge (in triangular cross-section black) or the second dorsal ridge (in trapezoidal cross-section blank) is reached, inverse retouches become extremely useful to thin specific portion of the blank without modifying the armature width (e.g. for achieving a calibrate thickness along the morphological profile of the armature or to point the apex as illustrated in Figure 3.7).

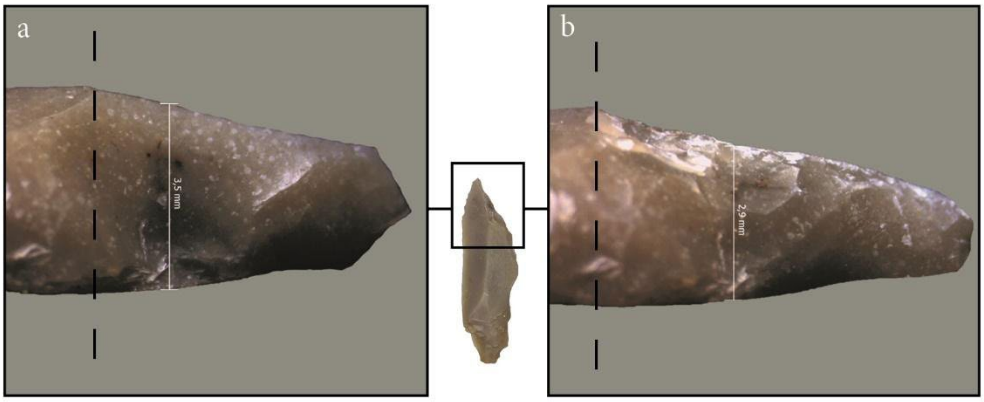


Figure 3.7 – a: Lateral view of an apex shaped by a direct retouch; b: Lateral view of the same apex after applying inverse retouches.

- When the angle formed between the back and dorsal face becomes acute (less than 90°) it is much more convenient from a strictly technical viewpoint to turn the piece over and detach some overlapping inverse retouches.

Armatures fractured during back reduction were not always abandoned, but sometimes they were resumed and turned into a complete item. When the breakage occurs on backed points produced on thin blank (1-to-2 mm), the fracture surface could be effortlessly turned into an apex by continuing the backed retouch. On the contrary, with thicker blanks, resume fracture revealed to be more complicated. In this last case four different solutions were applied (Fig. 3.8):

- *Modality 1*, a complementary inverse retouch was realised on the edge opposite to the back. This allowed obtaining a tip characterised by an acute angle between the back and the complementary retouch (as seen from a dorsal view) and with truncated profile (as seen from a lateral view).
- *Modality 2*, a complementary direct retouch was realised on the edge opposite to the back. The main difference with respect to Modality 1 is represented by the delineation of the tip which presents an obtuse angle between the back and the complementary retouch (dorsal view), while the profile appears similarly truncated (lateral view).

- *Modality 3*, the fracture surface was removed by carrying on the backing process through direct retouches along the same edge. This strategy was not suitable for blanks thicker than 2 mm since in most cases it resulted in the shaping of an oblique truncation instead of a point.
- *Modality 4*, if the back had already reached the main dorsal ridge of the blank before the fracture occurred, an inverse retouch could be performed on the same edge in the apical portion in order to cover the fracture and outline the tip. This resulted in a tapered point both from a lateral and dorsal view.

From an archaeological point of view, backed points resumed by the first three modalities are well identifiable because of the truncated lateral profile of the tip. On the contrary, the fourth modality is nearly impossible to recognize leaving no characteristic traces on the resumed pieces. In other cases fractures were resumed by a transverse truncation changing the manufacture objective, e.g., turning a backed point in a backed truncated point or a backed bladelet in a backed truncated bladelet. Truncations reveal to be an excellent technical solution for covering fractures.

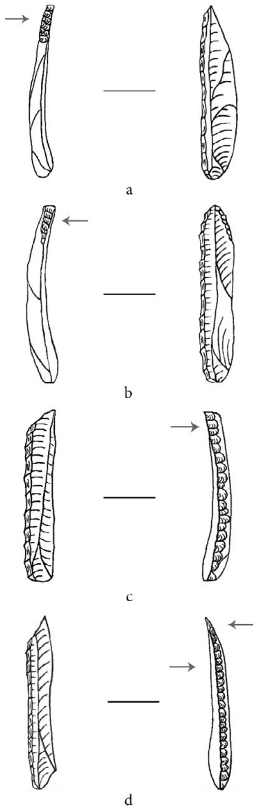


Figure 3.8 - Resumed pieces. a 1st modality; b 2nd modality; c 3rd modality; d 4th modality. Arrows indicate the position of retouches (direct or inverse).

3.2.1.2.4. Diagnostic criteria for the identification of backing techniques

The analysis of the entire experimental sample at the stereo-microscope allowed describing the most characteristic features of the considered backing techniques and identifying diagnostic combinations. Results are summarised in Table 3.4 and illustrated in Figure 3.9, 3.10, 3.11, 3.12 and 3.13.

Generally, the recognition of backing techniques calls for the presence of more than one criterion per piece since some of the identified parameters should not be considered as strictly exclusive of a single retouch technique but as morphologies that tend to appear more frequently with one technique rather than others. Nevertheless, morphologies that are closely related to a specific technique exist such as evident residual indentations (Fig. 3.11 e, f) associated with a large impact point (Fig. 3.11 b, c) or even bending (Fig. 11 a) for pressure by organic tool; clear incipient cones far from the retouched edge (Fig. 3.9 h) and negatives with an oblique / orthogonal development or a fan-shaped outline (Fig. 3.9 b, c, d, f) for soft stone percussion on anvil; rearward and strongly rounded edge along the entire longitudinal axis for abrasion (Fig. 3.13 c). On the contrary, pressure by soft stone always needs a combination of several parameters to be identified, such as a back characterised by elongated, flat and sub-parallel negatives associated with a slightly rearward and rounded edge and a linear longitudinal profile. The initiation of the scars tends to be punctiform with a diffused bulb negative (Fig. 3.12 a, b).

Some features allow distinguishing the anvil raw material in the case of soft stone percussion on anvil. A lithic one tends to create backs characterised by the alternation of direct and inverse retouches as a consequence of the recoil effect (Fig. 3.10 a). Moreover, isolated incipient cones can be formed on the surface in contact with the anvil (Fig. 3.10 B and C) as well as detachments characterised by a little bulb opposite to the bulb negative. In the case of a wood anvil, stigmas related to the recoil effect are extremely rare. Occasionally a little bulb opposite to the bulb negative was observed on thick blanks. Using leather-covered pebble any sign of the recoil effect was observed.

3.2.1.2.5. Diagnostic criteria for the identification of complementary retouches techniques

After identifying the diagnostic criteria for each backing technique, we decided to focus on the identification of retouch techniques applied for complementary retouches. This latter is revealed to be a tougher task since complementary retouches are short sequences of removals in restricted edge portions with a marginal development. Moreover, the force applied is lower compared to deep backed retouch and diagnostic criteria strictly related to this factor do not appear on marginal retouches; for example, negatives with a fan-shaped outline or oblique/orthogonal development, clearly visible incipient cones and extremely deep bulb negative for soft stone percussion on anvil and heavily rounded edge along the entire longitudinal axis for abrasion. By contrast, the two pressure techniques preserved their major diagnostic features: elongated, sub-parallel and flat retouches at regular depth with diffuse or absent bulb negative. Features related to each retouch technique applied on marginal retouch are summarised in Table 3.5. Some of them are illustrated in Figures 3.14, 3.15 and 3.16. Several features are consistent with those already presented in Table 3.4.

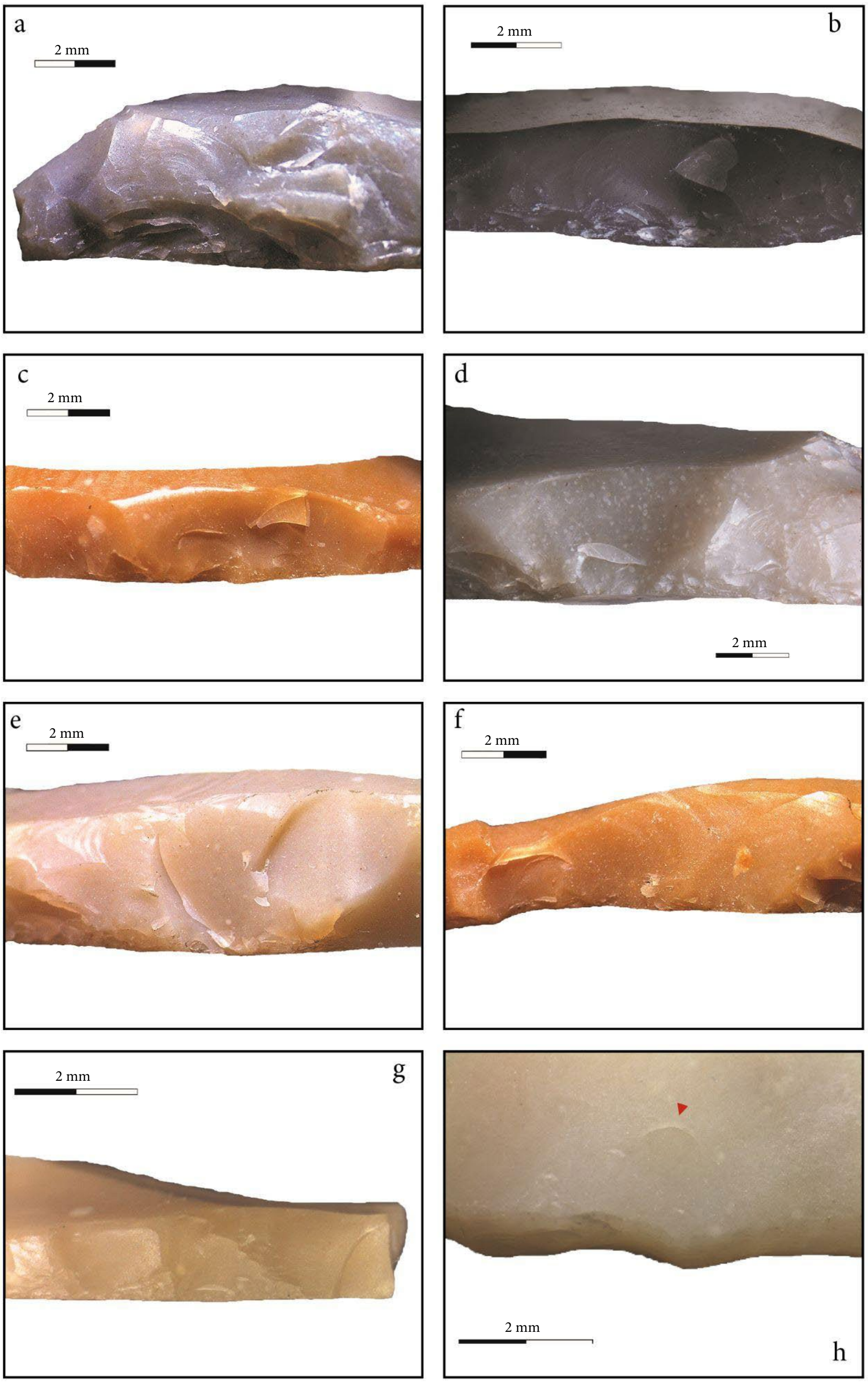


Figure 3.9 - Experimental backed points produced by percussion with a soft stone. a: Multiple-step terminations; b-d: Fan-shaped outline with deep bulb negative, punctiform initiation and hinged termination; e: Lateral step terminations; f: Negative with an oblique/orthogonal development; g: snap terminated bending fracture associated to fan-shaped negative; h: Deep incipient cone.

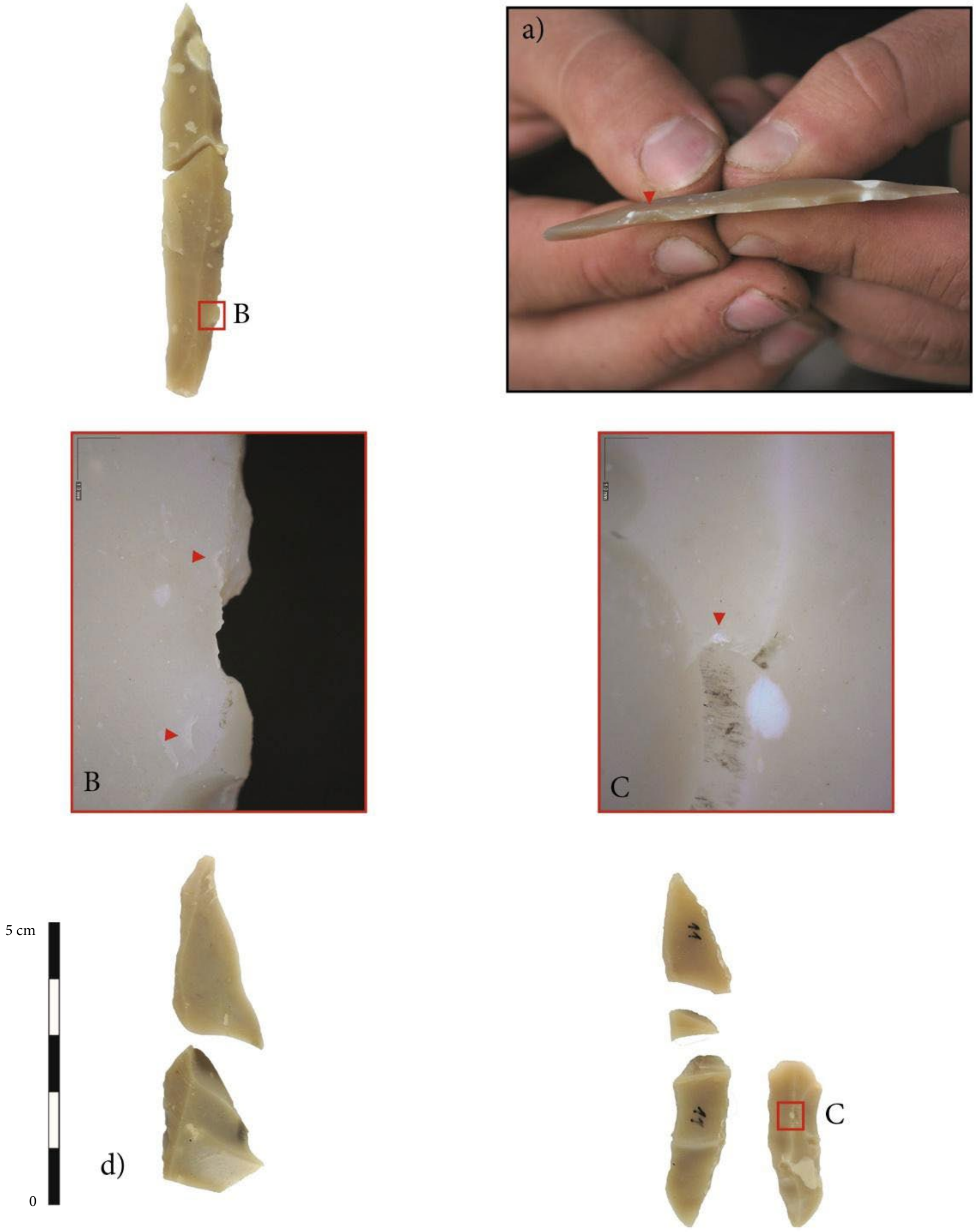


Figure 3.10 – a: inverse retouch occurs due to the recoil effect of a stone anvil; b-c: incipient cones resulting from the recoil effect of a stone anvil; d: Krukowski microburin resulting from the recoil effect of a stone anvil.

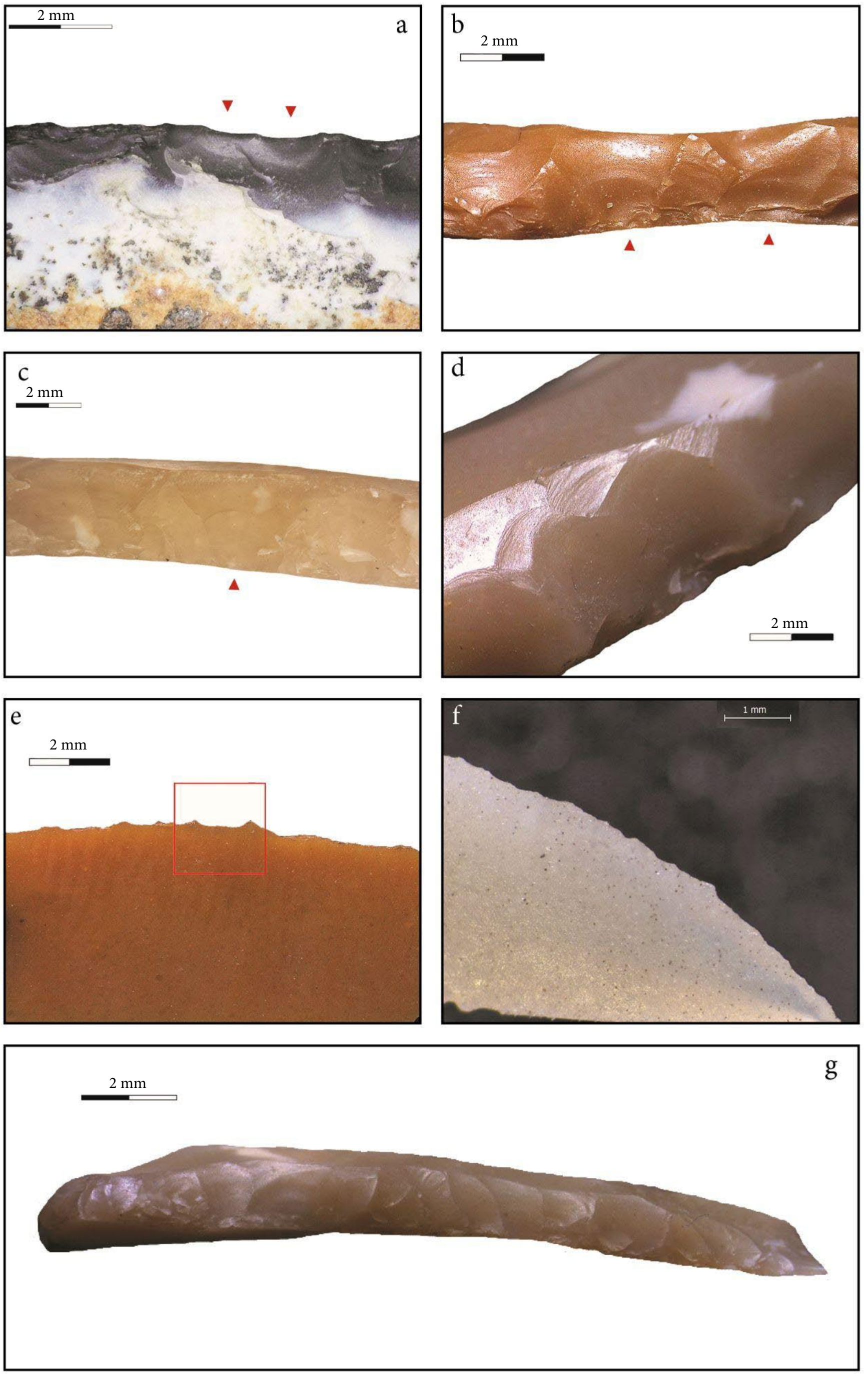


Figure 3.11 - Experimental backed points produced by pressure with an organic tool. a: detachments with a bending initiation; b: large impact point with a diffused bulb negative; c: regular and sub-parallel removal; d: micro-overshots; e-f: sharp residual indentations along the edge visible from the ventral face; g: sequence of Regular, symmetrical and aligned removals.

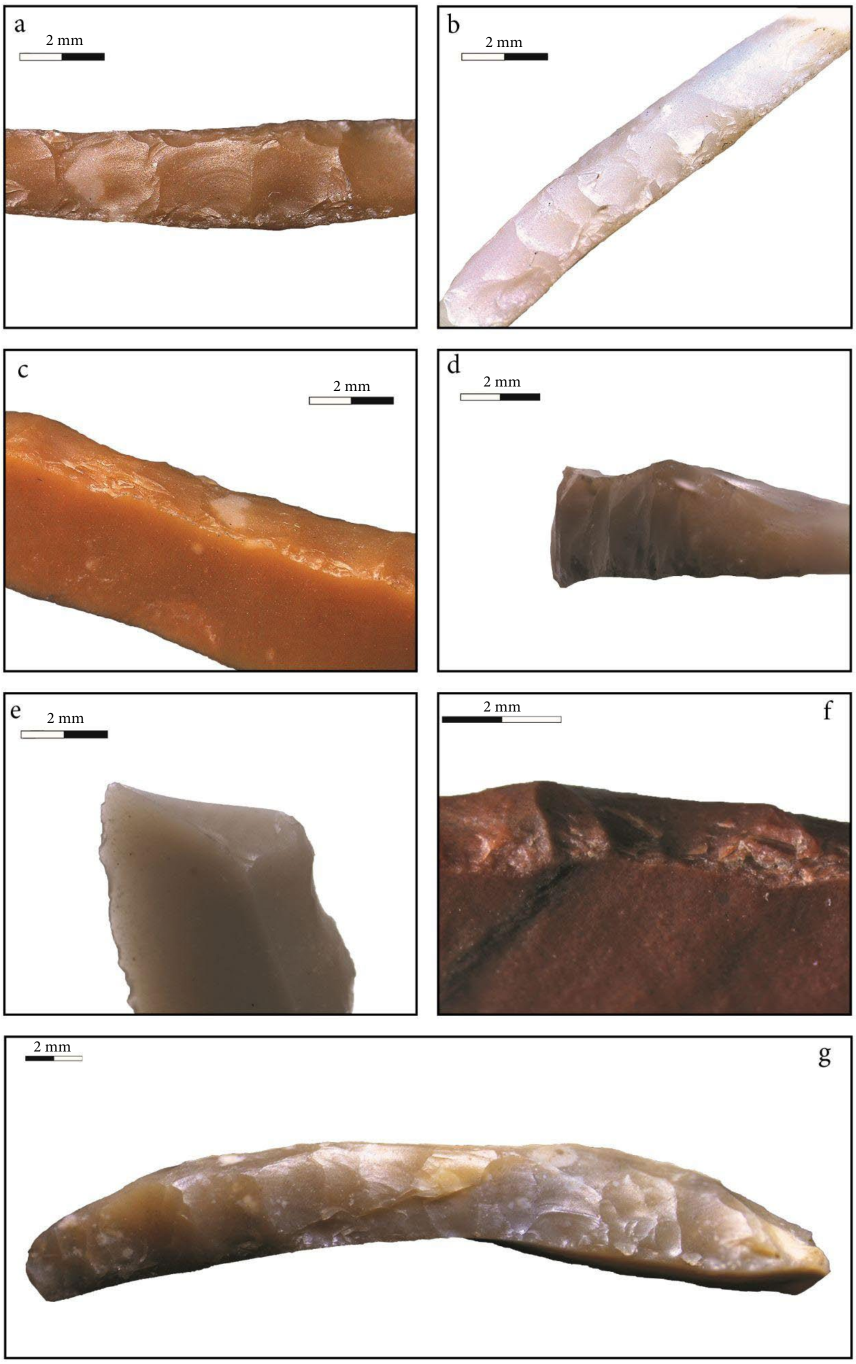


Figure 3.12 - Experimental backed points produced by pressure with soft stone. a-b: sub-parallel and flat scars associated to small unintentional removals along the edge; c: linear longitudinal profile due to a regular depth of the scars; d: rectilinear transversal profile; e: negative of Krukowski microburins; f: pressure with an organic tool on the left side: presence of sharp residual indentations. pressure by soft stone on the right side: absence of sharp residual indentations; g: sequence of regular, symmetrical and aligned removals.

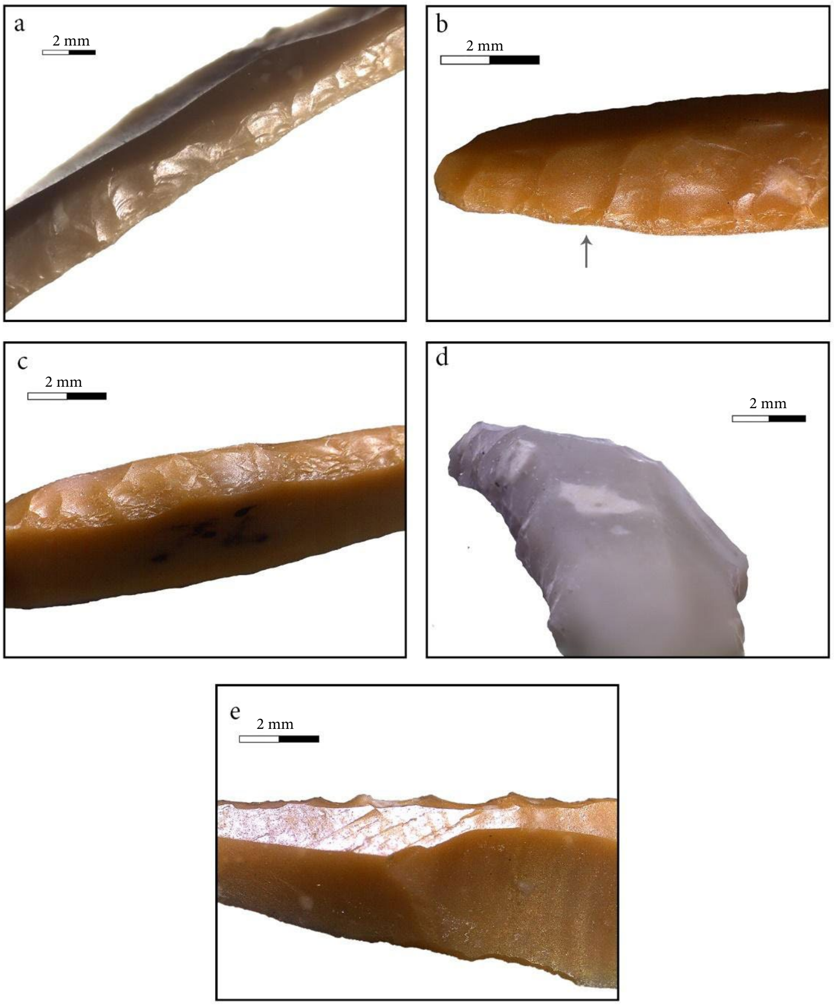


Figure 3.13 - Experimental backed points produced by abrasion. a: regular removals associated to small unintentional removals along the edge; b: sequence of regular and contemporary removals where the last scar is fresh; c: heavily rounded edge; d: convex transversal profile; e: denticulated longitudinal profile with residual protrusions located at regular distance.

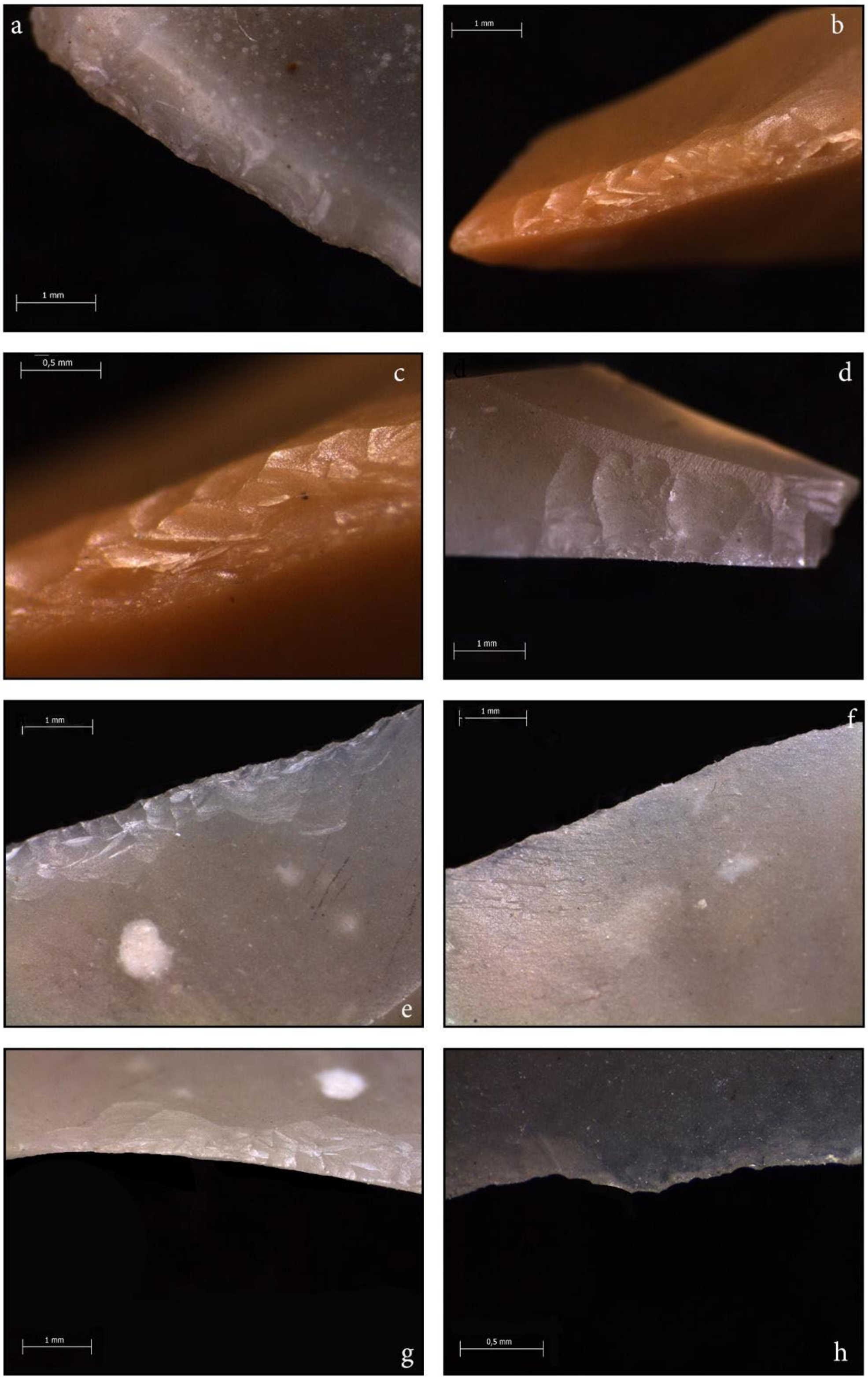


Figure 3.14 – Complementary retouches applied by soft stone percussion on anvil (a-d) and by pressure by organic tool (e-h). a-b: irregular, asymmetrical and chaotic removals; c: micro-step terminations; d: rare sequence of regular removals; e, g: regular, symmetrical and aligned removals; f, h: sharp residual indentations along the edge as seen from the ventral face.

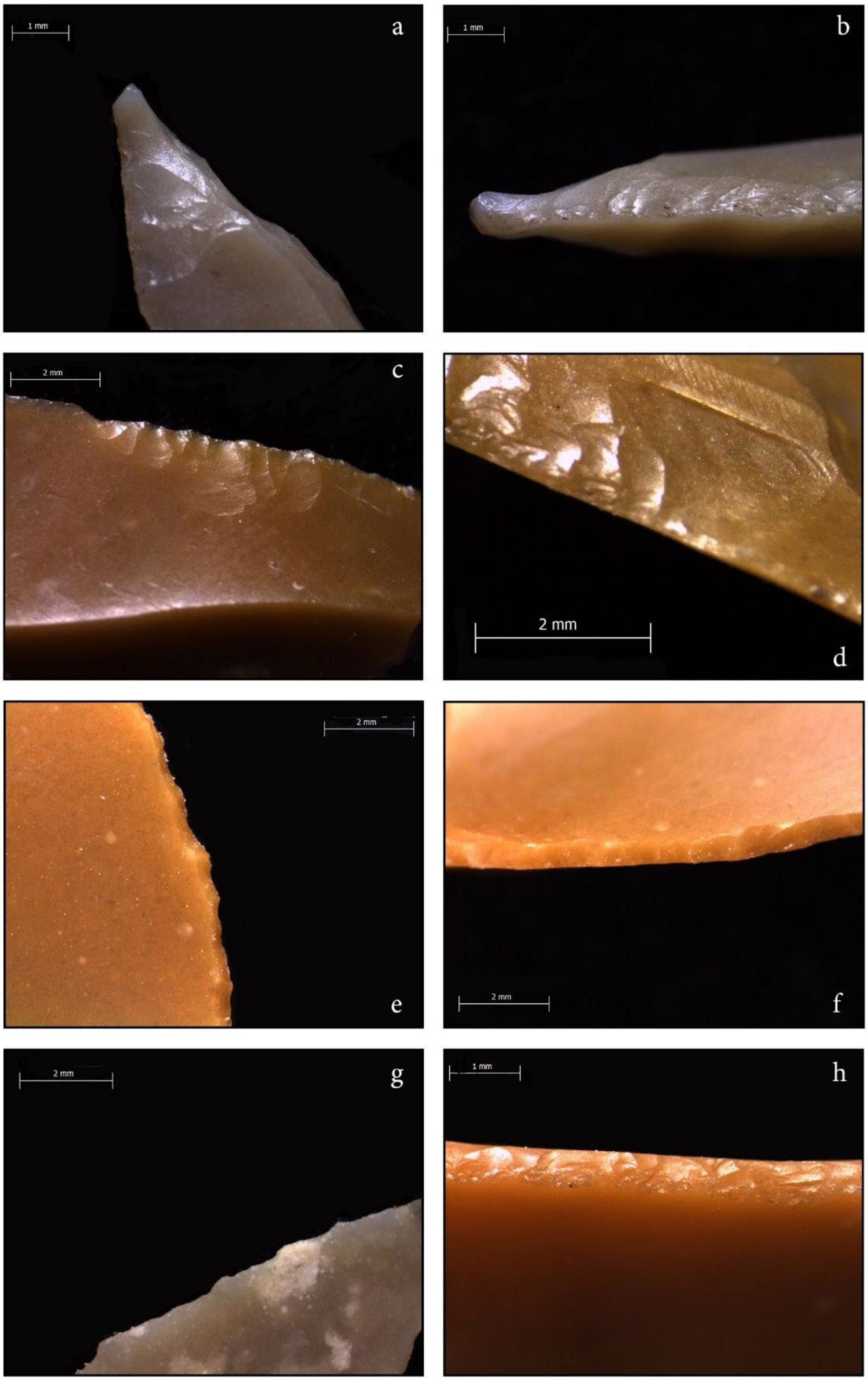


Figure 3.15 - Complementary retouches applied by pressure by soft stone (a-d) and abrasion (e-h). a, c: regular, symmetrical and aligned removals; b: low retouch angle; d: hinge termination; e, g: denticulated longitudinal profile; f: regular, symmetrical and aligned removals; h: slightly rounded edge.

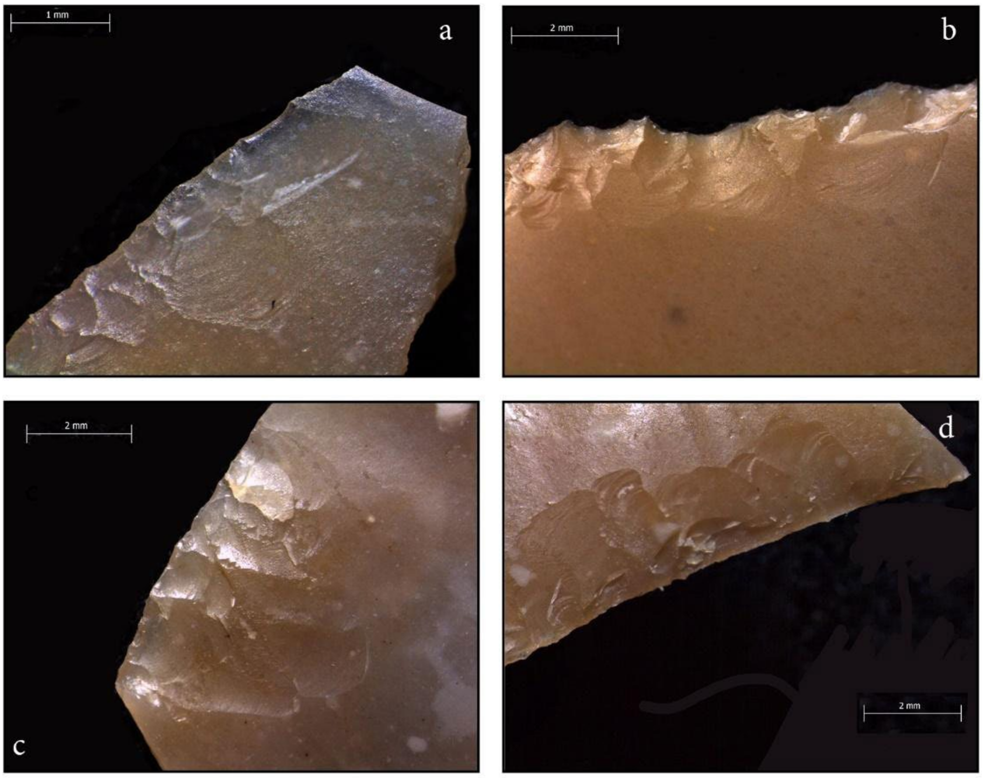


Figure 3.16 – Inverse and flat retouches applied by pressure by organic (a-b) and stone retoucher (c-d). a: negative with a bending initiation; b: evident residual indentations; c-d: no residual indentations.

Table 3.4 - Diagnostic criteria for the identification of retouch techniques on deep backed retouches (modified after Fasser et al. 2019).

	SEQUENCES OF REMOVALS	EDGE	LONGITUDINAL PROFILE	MORPHOLOGY OF REMOVAL SCARS	TERMINATION OF THE SCARS	INITIATION OF THE SCARS	RETOUCH INCLINATION	TRANSVERSE PROFILE	INCIPIENT CONES
PERCUSSION BY SOFT STONE (Fig.3.9 and 3.10)	Irregular, asymmetrical and chaotic removals. Rare short sequence of regular removals.	Rounded with hammered portions alternated to “fresh” ones.	Denticulated with residual protrusions located at irregular distance and variable depth.	Fan-shaped outline. Concave. Sometimes very deep and with an oblique / orthogonal development.	Presence of hinged and step terminations.	Punctiform with a deep bulb negative.	Abrupt. Sometimes obtuse.	Variable.	Incipient cones far from the edge
PRESSURE BY ORGANIC TOOL (Fig. 3.11)	Regular, symmetrical and aligned removals. Each of them corresponds to a single gesture.	“Fresh” edge. Rare cases of rounded edge when the organic compressor has a larger and rounded functional extremity.	Linear with sharp residual indentations along the edge connected to the precision of the propagation of force (as seen from the ventral face). Negatives located at regular depth. Residual indentations are less evident when the organic compressor is made by softer organic material (e.g. deer antler).	Elongated. Sub-parallel. Flat.	Frequent micro-hinged termination with pronounced ripples. Slightly lateral orientation.	Large impact point, sometimes even bending, with a diffused or absent bulb negative. .	From abrupt to semi-abrupt depending on compressor position.	Convex (less frequently rectilinear). With invasive removals on the dorsal face (“S” profile). Presence of micro-overshots attributable to the prolongation of the blow beyond the main axial ridge of the dorsal surface.	Rare marginal incipient cones.
PRESSURE BY SOFT STONE* (Fig. 3.12)	Regular, symmetrical and aligned removals. Sequences of regular and simultaneous removals (among which the last one is “fresh”). Small unintentional removals along the edge.	Portions with a rearward and rounded edge alternated to “fresh” portions.	Linear with possible presence of residual protrusions. Negatives located at regular depth. Sometimes residual indentations can appear in case of semi-abrupt and flat retouches.	Elongated. Sub-parallel. Flat.	Possible micro-hinge termination with pronounced ripples. Slightly lateral orientation	Punctiform with a diffused or slightly pronounced bulb negative.	From abrupt to semi-abrupt depending on compressor position.	Rectilinear with occasional invasive removals on the dorsal surface (micro-overshots).	Rare marginal incipient cones.
ABRASION (Fig. 3.13)	Regular removals. Sequence of regular and contemporary removals where the last scar is “fresh”. Small and short unintentional removals along the edge.	Heavily rounded edge along the entire longitudinal axis. More “Fresh” edge with blanks thinner of 1 mm.	Denticulated with residual protrusions sometimes located at regular distance and depth.	Sub-quadrangular or sub-trapezoidal morphology. Sub-parallel. Concave.	Simple termination.	Punctiform with a pronounced or diffused bulb negative.	Abrupt. Rarely semi-abrupt.	Convex with non-invasive removals on the dorsal face.	Rare marginal incipient cones.

Table 3.5 - Diagnostic criteria for the identification of retouch techniques on marginal retouches (i.e. complementary retouches).

	SEQUENCES OF REMOVALS	EDGE	LONGITUDINAL PROFILE	MORPHOLOGY OF REMOVAL SCARS	TERMINATION OF THE SCARS	INITIATION OF THE SCARS	RETOUCH INCLINATION REACHABLE	TRANSVERSAL PROFILE	EXTENT
PERCUSSION BY SOFT STONE (Fig. 3.13 a-d)	Irregular, asymmetrical and chaotic removals. Rare cases of regular sequences of removals.	Slightly rounded with hammered portions alternative to “fresh” ones.	Slightly denticulated.	Large. Concave.	Simple termination. Sometimes micro-step terminations are located close to the edge.	Punctiform with visible bulb negative.	Abrupt, semi-abrupt and low.	Convex. Rarely rectilinear.	Short.
PRESSURE BY ORGANIC TOOL (Fig. 3.13 e-h, 3.15 a, b)	Regular, symmetrical and aligned removals. Each of them corresponds to a single application of the force.	“Fresh”. Slightly rounded when the organic compressor is made by softer organic material (e.g., deer antler) compared to red deer or bone.	Linear due to negatives located at regular depth. Sharp residual indentations along the edge as seen from the ventral face. With flat inverse retouches residual indentations are more evident, while they are less evident when the organic compressor is made by softer organic material (e.g. deer antler).	Elongated. Sub-parallel. Very flat.	Simple or micro-hinged termination.	Large impact point with a diffused or absent bulb negative. Sometimes even bending.	Abrupt, semi-abrupt and low.	Rectilinear.	From short to invasive.
PRESSURE BY SOFT STONE (Fig. 3.14a-d, 3.15 c, d)	Regular, symmetrical and aligned removals. Small and short unintentional removals along the edge.	“Fresh”, rarely slightly rounded.	Linear due to negatives located at regular depth. Using an extremely tampered stone compressor seldomly sharp residual indentations along the edge could appear, especially applying flat inverse retouches.	Elongated. Sub-parallel. Very flat.	Simple or micro-hinge termination.	Punctiform with a diffused or absent bulb negative.	Abrupt, semi-abrupt and low.	Rectilinear.	From short to invasive.
ABRASION (Fig. 3.14 e-h)	Regular, symmetrical and aligned removals. Small and short unintentional removals along the edge.	“Fresh” or slightly rounded.	Slightly denticulated.	Large Concave.	Simple termination. Sometimes micro-step terminations are located close to the edge.	Punctiform with a pronounced or diffused bulb negative.	Abrupt and semi-abrupt.	Convex.	Short.

3.2.1.2.6. Diagnostic backing fractures (DBF)

The total fracture index was rather high: 53.13%. The attempt to reach (partially or totally) the main dorsal ridge of the blank independently from the technique applied strongly influenced this value. Soft stone percussion on anvil and pressure by soft stone are the riskiest techniques, while pressure by organic tool and abrasion proved to be safer (Tab. 3.6).

Table 3.6 – Fracture index per backing technique.

	SSPA	POT	PSS	Ab
Fracture index	76.4%	33.3%	64.7%	25.0%
Number of fractures	31	8	24	4

Soft stone percussion on a flat sandstone pebble anvil provokes manufacturing accidents related to an excessive recoil effect. In case of leather-covered or boxwood log anvil fractures were mainly related to a too strong blow striking far from the retouched edge or to a non-uniform resting surface. Fractures related to the two pressure techniques result from an excessive pressure of the secondary hand to the blank, an excessive force impressed during the retouch or a non-uniform resting surface. In the case of abrasion, all fractures originate from an excessive push while holding the blank, either with the palm (1st modality) or with the thumbs (2nd modality). At a general level more uniform is the blank surface in contact with the resting surface lower is the fracture index.

Fractures recorded are referred to three main categories: bending fractures, cone fractures and complex fractures. Their morphological features are presented in Table 3.7, whereas Table 3.8 shows types of fracture according to the retouch technique applied.

- **Cone fractures**: they were recorded on armatures produced by soft stone percussion on anvil and pressure by soft stone. Their orientation is mainly oblique (rarely transverse) with respect to the morphological axis of the blank. Generally, fracture initiation matches with the retouch platform. An opposite direction is attested only using soft stone percussion with a sandstone anvil likely due to the recoil effect. *Languettes* length seems to be correlated to blank thickness, backing technique used and the intensity of the force applied. Thinner blanks (1-3 mm) show a *languette* development shorter than 2 mm. By contrast, on thicker blanks (4 mm or more) *languette* of 3 mm up to 7 mm were observed. The latter was produced by percussion by soft stone and the anvil was a sandstone pebbles (without leather). Probably the recoil effect plays a relevant role to the formation of such a long *languette*. It should be noted that cone fractures with a *piquant-trièdre* (i.e. equivalent of Krukowski microburin) occur once the backed retouch achieved the maximum transverse thickness with both a soft stone percussion on anvil and pressure techniques. Krukowski microburins resulting from pressure present a small impact point (sometimes linear or absent) and a diffuse bulb, whereas those with pronounced bulbs and clear impact points (sometimes with an evident hertzian cone formation) are characteristic of percussion. One piece shows a cone fracture generated by an overshot retouch flake (Fig. 3.17). In contrast to what R. Duches and colleagues (2018) claimed, this type of fracture can occur also with soft stone percussion on anvil.

- **Bending fractures:** all backing techniques yielded bending fractures. Their orientation can be oblique or more frequently transverse with respect to the morphological axis of the blank. Conversely, their direction can be indeterminable (n=13), from the opposite surface towards the retouch platform (n=15), or more rarely from the retouch platform towards the opposite surface (n=3). Bending fractures direction depend on several factors: (a) number of points in which the blank is in contact with the anvil (i.e. number of footholds); (b) the topography of the blank surface resting on the anvil and the anvil itself; (c) location of the retoucher according to footholds when the fracture occurs. If the fracture occurs by retouching between two footholds (Fig. 3.18 a) fracture direction is always from the opposite surface towards the retouch platform. In this case *languette* are absent or barely visible (forming snap terminated bending fractures) or between 1 and 2 mm (forming hinge or feather terminated bending fractures). By contrast, if retouching took place on blank extremities and not between two footholds (Fig. 3.18 b) the fracture develops from the retouch platform to the opposite surface. Longer *languettes* (2 mm or 2,5 mm) were produced only in this case due to the minor balances between forces at play. *Languett*es tend to run from the retouch portion to the blocked one. It is interesting to note how this type of bending fracture is extremely rare during the backing process (n=3) and they occur only with abrasion (n=2), due to its particularly holding modality, and percussion by soft stone (n=1). One production waste appears to be strictly related to soft stone percussion on anvil. It is a snap terminated bending fracture developing from the opposite surface to the retouch platform associated with a fan-shaped negative (Fig. 3.10 g).
- **Complex fractures:** multiple fractures, namely double cone fracture or the combination of a bending fracture and a cone fracture (Fig. 3.11 C) occur only with a soft stone percussion on anvil. Fractures with a secondary detachment (spin-off fractures), which are not longer than 1 mm, can be produced by all backing techniques.

Unintentional breakages present different morphologies also according to the retouch

Figure 3.17 - Fracture generated by an overshot retouch flake.

method applied. A back fashioned by retouching progressively along the longitudinal axis of the blank by one single sequence of removals tends to produce a specific morphology called "snap in notch" (De Wilde and De Bie, 2011), which is a proximal or distal notch associated to a transverse or oblique fracture (Fig. 3.19 a). It is important to highlight that using this specific retouch sequence it is possible to obtain an unintentional ordinary microburin and not a Krukowski one. The use of several unidirectional (e.g., from the distal to the proximal portion) or bidirectional sequences (e.g., from the distal to proximal and vice versa) generates total backed fragments with an unfinished delineation (Fig. 3.19 b).

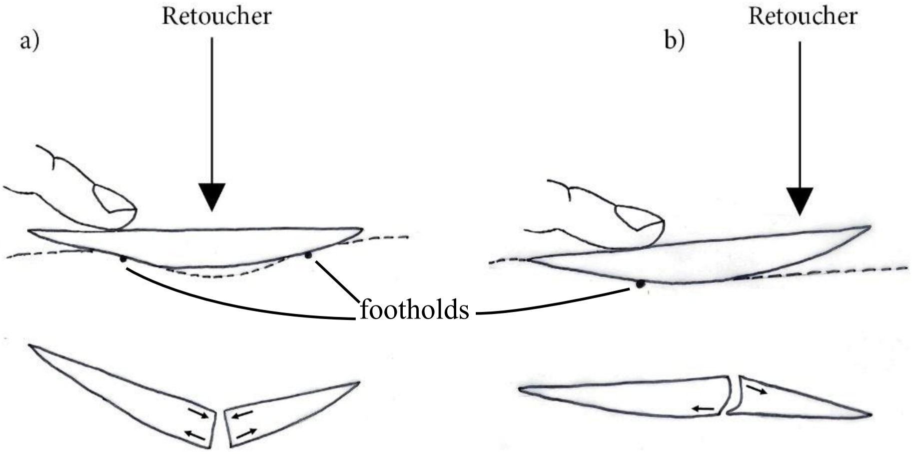


Figure 3.18. Bending fracture modalities during the backing process. a: fracture occured by retouching between two footholds. b: fracture occured by retouching between the blank extremity.

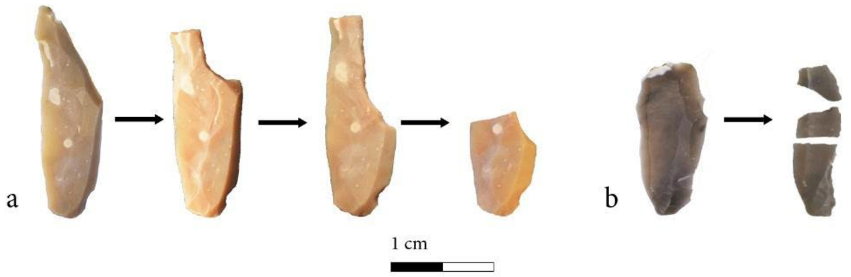


Figure 3.19 – a: single retouch sequence of removals and corresponding unintentional breakage (snap in notch); b: multiple retouch sequences and corresponding unintentional breakage.

Table 3.7 - Type of fracture occurred during retouching and their features

	Cone fracture						Bending fracture							Complex								Resumed
	Snap		P.t.		With lang.		Snap		Hinge.		Feather		Step	Spin-off		Cone+bending		Double cone hinge		Cone spin-off		-
Direction (Initiation-termination)	R.p. - O.s.		R.p.- O.s.		R.p. – O.s.	O.s – R.p.	N. D.	O.s. – R.p.	O.s. – R.p.		R.p. – O.s.	O.s. – R.p.	-	R. p. – O.s.	O.s. – R.p.	R.p. - O.s.	O.s. – R.p.	R.p. – O.s.		R.p. – O.s.		-
	9		9		4	1	13	9	1		3	5		-	2	1	1	1		1		
Orientation	Tr.	Ob.	Tr.	Ob.	Tr.	Ob.	Tr.	Ob.	Tr	Ob	Tr.	Ob.	-	Tr.	Ob.	Tr.	Ob.	Tr.	Ob.	Tr	Ob	-
	6	3	-	9	2	3	16	6	1	-	7	1		2	-	-	2	-	1	-	1	
Longest *languette*	-		-		7 mm		-		1 mm		2,5 mm		-	-		2 mm		2mm		-		-
Total	9		9		5		22		1		8		-	3		2		1		1		7

P.t. Piquant trièdre; ***R.p***. *Retouch platform;* ***O.s.*** *Opposite surface;* ***N.D.*** *Not determinable;* ***Tr.*** *Transversal;* ***Ob.*** *Oblique,* **lang.** languette

Table 3.8 – Type of fracture occurred during retouching according to backing technique.

	SSPA	POT	PSS	Ab
Feather terminated bending fracture	2	-	4	2
Snap terminated bending fracture	5	5	11	2
Hinge terminated bending fracture	-	-	1	-
Step terminated bending fracture	-	-	-	-
Cone snap fracture	8	-	1	-
Cone fracture with languette	4	-	1	-
Cone fracture with a piquant trièdre	5	1	3	-
Cone+bending	2	-	-	-
Double cone hinge	1	-	-	-
Spin-off	1	1	-	-
Cone spin-off	-	-	1	-
Resume - indet	3	1	3	-
Total	31	8	24	4

3.2.1.2.7. Blind tests results

1st Blind test:

The first blind test carried out by the author, DV and FF aimed at better clarifying the relevance of the diagnostic criteria, was quite successful. In 80% (28/35) of analysed experimental backed points it was possible to correctly determine the applied technique (Tab. 3.9).

Table 3.9 – 1st blind test result.

	Techniques recognized	Total backed points
NF	9	10
DV	12	15
FF	7	10
Total backed points	28	35
Success rate	80%	

2nd Blind test:

During the second blind test NF and DV analysed 50 backed points produced by AP. 70% of the 40 backed points manufactured by a single technique were identified while the identification of mixed techniques proved to be more difficult, especially the second one as shown by Table 3.10. At a general level, this second blind test also proved that individual-related variability does not seem to importantly affect the formation of diagnostic features. In fact, it was not possible to identify any consistent difference between the backed points produced by NF and DV and those produced by AP who carried out a completely independent experimental session.

Table 3.10 – 2nd blind test results.

	Single techniques				Mixed techniques	
	SSPA	POT	PSS	Ab	1° MT	2° MT
Backed points recognized by NF	7	7	7	7	3	0
Backed points recognized by DV	8	7	7	6	3	0
Total backed points	10	10	10	10	5	5
Success rate	70%				30%	

3rd Blind test:

The 3rd blind test was carried out in order to verify if the proposed parameters are usable with good results also by other researchers completely foreign to the performed experimental programme. Once more the identification of single retouch techniques yielded a positive outcome, in fact, 67% were identified by DD using the reference grid with the diagnostic criteria identified for each technique (Tab. 3.4). By contrast the recognition of mixed techniques showed again many weaknesses (Tab. 3.11).

Table 3.11 – 3rd blind test result.

	Single techniques				Mixed techniques	
	SSPA	POT	PSS	Ab	1° MT	2° MT
Backed points recognized by DD	4	4	3	5	1	-
Total backed points	6	6	6	6	3	3
Success rate	67%				17%	

By taking into account mis-determined backed points during all three blind tests (Tab. 3.12), it is interesting to note that abrasion, soft stone percussion on anvil and pressure by soft stone were reciprocally confused with similar percentages. This can be related to the same raw material of the retoucher (soft stone). By contrast, the two pressure techniques were confused due to the same force application mode. In this last case, the mistake was mostly unidirectional, namely backed points produced by pressure with an organic tool were interpreted as pressure by soft stone (n=9) and rarely vice versa (n=1). Pressure by an organic tool has never been mistaken for soft stone percussion on anvil and abrasion. The correct identification rates of the 4 techniques are comparable, with an overall score of 72%.

Table 3.12 - Wrong determinations occurred during blind tests.

		Techniques applied			
		SSPA	POT	PSS	Ab
Wrong attributions	SSPA	-	-	4	6
	POT	-	-	1	-
	PSS	5	9	-	4
	Ab	5	-	5	-
Backed points wrongly attributed		10	9	10	10
Backed points analysed		35	35	36	33

Identification rate per technique	71%	74%	72%	70%

3.2.1.2.8. Backing micro-traces

At high magnification it was possible to record several micro-traces developed during the back reduction and related to the friction between the retoucher and the retouch platform. Looking at Table 3.13, it is evident that stone retouchers, no matter what the force applied is, reach a higher frequency index (i.e. number of pieces yielding backing micro-traces) compared to organic ones. Moreover, a strong correlation between backing micro-traces and blank thickness was attested: polishes and striations are more frequently visible on thicker blanks due to the higher force required during the backing process. Micro-traces were identified exclusively on the retouch platform near the retouched edge with a spot-like distribution. Sometimes, they are in correspondence with incipient cones. The entire micro-traces variability according to each backing technique is presented in Table 3.14 and some of them are presented in Figures 3.20, 3.21, 3.22 and 3.23.

As far as a **lithic** retoucher is concerned, the most diagnostic micro-trace is a polish area characterised by a smooth texture, a flat or domed topography and a compact or tight linkage. The directionality of the gesture applied is highlighted by several short, matt, narrow striations with a transverse or oblique orientation compared to retouched edge (Fig. 3.20 d-f; Fig. 3.21 b, d; Fig. 3.22 a-d). Striations with a longitudinal (Fig. 3.22 f) or chaotic (Fig. 3.22 e) orientation were produced only with abrasion. Using an ultrasonic cleaner this type of trace can be strongly reduced revealing its nature, at least partially, of residue. Marginal polishes were mainly attested with abrasion and pressure by soft stone in association with rounded edges (Fig. 3.21 f-h). Figure 3.20 g illustrates a marginal polish produced by soft stone percussion on anvil, but in this case rather than being the result of a punctual friction of the retoucher, it is probably part of a larger polished area partially removed by the backing process. Abrasion and pressure by soft stone tend to produce micro-traces more frequently in contact with the retouch edge, whereas those produced by soft stone percussion on anvil are more inner.

Table 3.13 – number of armatures in which micro-traces were identified according to backing technique.

	SSPA		PSS		PBT		PAT		Ab	
	n	F.I.	n	F.I.	n	F.I.	n	F.I.	n	F.I.
Armatures with micro-traces	8	80%	8	73%	5	45%	5	42%	9	90%
Armatures without micro-traces	2	20%	3	27%	6	55%	7	58%	1	10%
Total armatures analysed	10	100%	11	100%	11	100%	12	100%	10	10

F.I. = Frequency Index

Bone and **antler** retouchers produce a lower number of micro-traces compared to lithic ones. The reason for this lower frequency index is probably related to the different mechanical properties of the raw material and the higher precision of the propagation of the force that often corresponds to a flake detachment resulting in a lower friction between the compressor and the retouched edge. Micro-traces were detected both in contact and far from the edge. At a general level, polishes tend to be poorly developed and therefore difficult to define. Exclusively if the back retouched achieved a thickness equal or higher than 3 mm, well-developed micro-traces appear with both antler and bone compressors. The antler ones produces transverse or oblique linear polishes resulting from the punctual friction between the compressor tip and the flint surface. They are characterised by a rough tend to smooth or smooth texture, domed or flat topography and a tight or compact linkage. They can be single (Fig. 3.23 c-f) or grouped with a parallel distribution (Fig. 3.23 a-b). By contrast, a bone retoucher yielded traces more similar to lithic ones, but normally without matt striations (Fig. 3.24 a-d). Marginal polishes are documented and sometimes they are in correspondence with incipient cones (Fig. 3.24 g) or with sharp residual indentations (Fig. 3.23 f). An extremely marginal polish more or less continuous along the edge is sometimes visible (Fig. 3.23 h).

Table 3.14 – Backing micro-traces according to backing techniques applied.

Polish							Linear polishes	Marginal polishes	Incipient cones
Backing technique	**Texture**	**Topography**	**Linkage**	**Localisation**	**Orientation**	**Striations**			
SSPA	Smooth	Flat or domed	Compact or tight	In contact with the edge or in the inner surface	Transverse or oblique	Multiple short, matt, narrow	Single or multiple	-	Single or concentric and marginal or deep
	Rough	Flat or domed	Half tight or tight	In contact with the edge or in the inner surface	Transverse or oblique	-			
PSS	Smooth	Flat or domed	Compact or tight	In contact with the edge or in the inner surface	Transverse or oblique	Multiple short, matt, narrow	Single or multiple	Associated with a rounded edge	Single and marginal
	Rough	Flat or domed	Half tight or tight	In contact with the edge or in the inner surface	Transverse or oblique	-			
Ab	Smooth	Flat or domed	Compact or tight	In contact with the edge or in the inner surface	Transverse, oblique, longitudinal or chaotic	Multiple short, matt, narrow or large	Single or multiple	Associated with a rounded edge	Single and marginal
	Rough	Flat or domed	Half tight or tight	In contact with the edge or in the inner surface	Transverse, oblique, longitudinal or chaotic	-			
PBT	Rough	Flat or domed	Half tight or tight	In contact with the edge or in the inner surface	Transverse or oblique	-	Single or multiple	Associated with a fresh edge	Single and marginal
PAT	Rough tend to smooth or smooth	Flat or domed	Compact or tight	In contact with the edge or in the inner surface	Transverse or oblique	-	Single or multiple	Associated with a fresh edge	Single and marginal

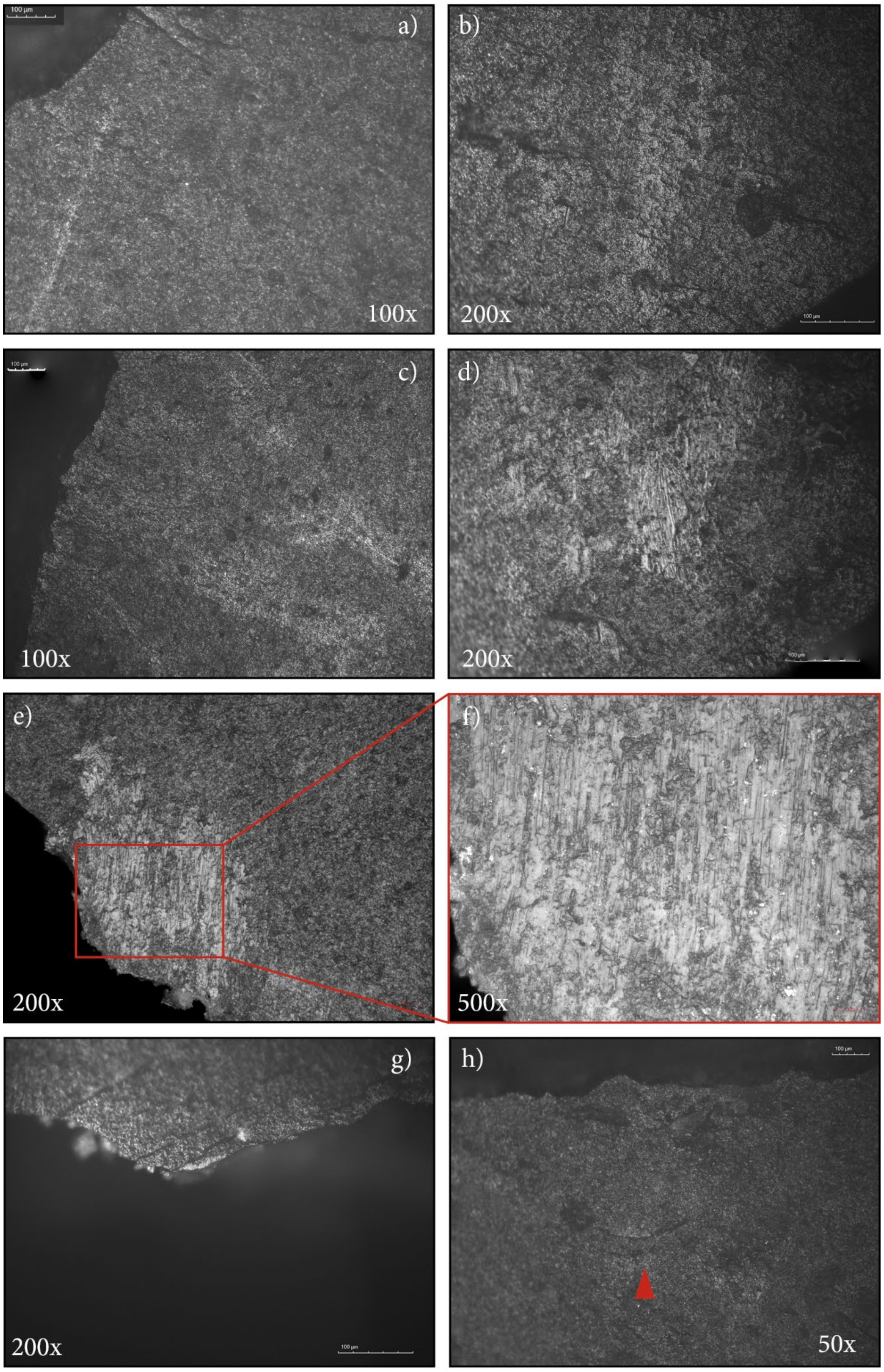


Figure 3.20 – Backing micro-traces produced by soft stone percussion an anvil; a: Linear polish; b-c polishes with a clear transverse or oblique orientation without matt striations; d-f: polishes crossed by matt striations with a transverse or oblique orientation compared to retouched edge;g: marginal polish; h: incipient cone.

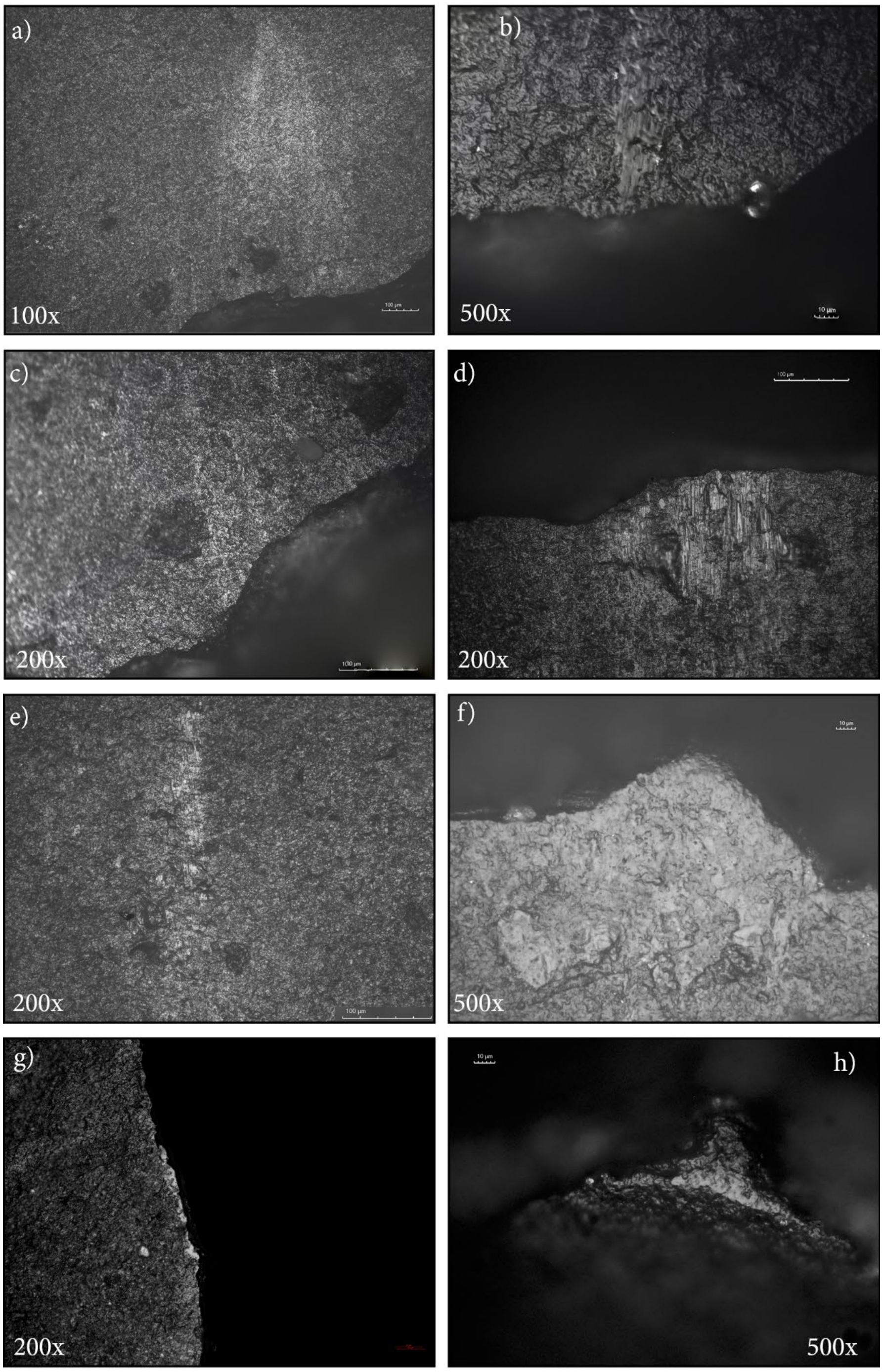


Figure 3.21 – Backing micro-traces produced by pressure by soft stone. a, c: polishes with a clear transverse or oblique orientation compared to retouched edge; b, d, e: polish crossed by matt striations with a transverse or oblique orientation compared to retouched edge; f-h: marginal polishes associated with rounded edge.

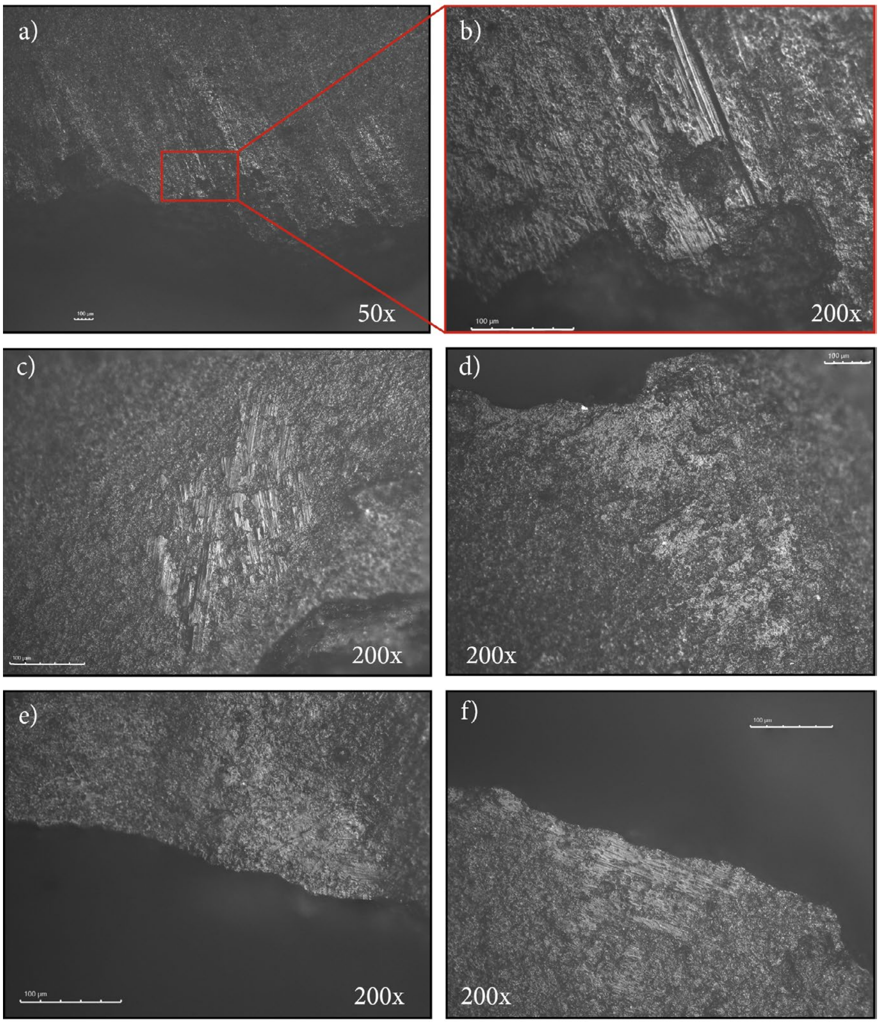


Figure 3-22 - Backing micro-traces produced by abrasion. a-d: polish areas characterised by short, matt, narrow or large striations with transverse or oblique orientation compared to the retouched edge; e: polish with chaotic striations: f: polish with longitudinal striations.

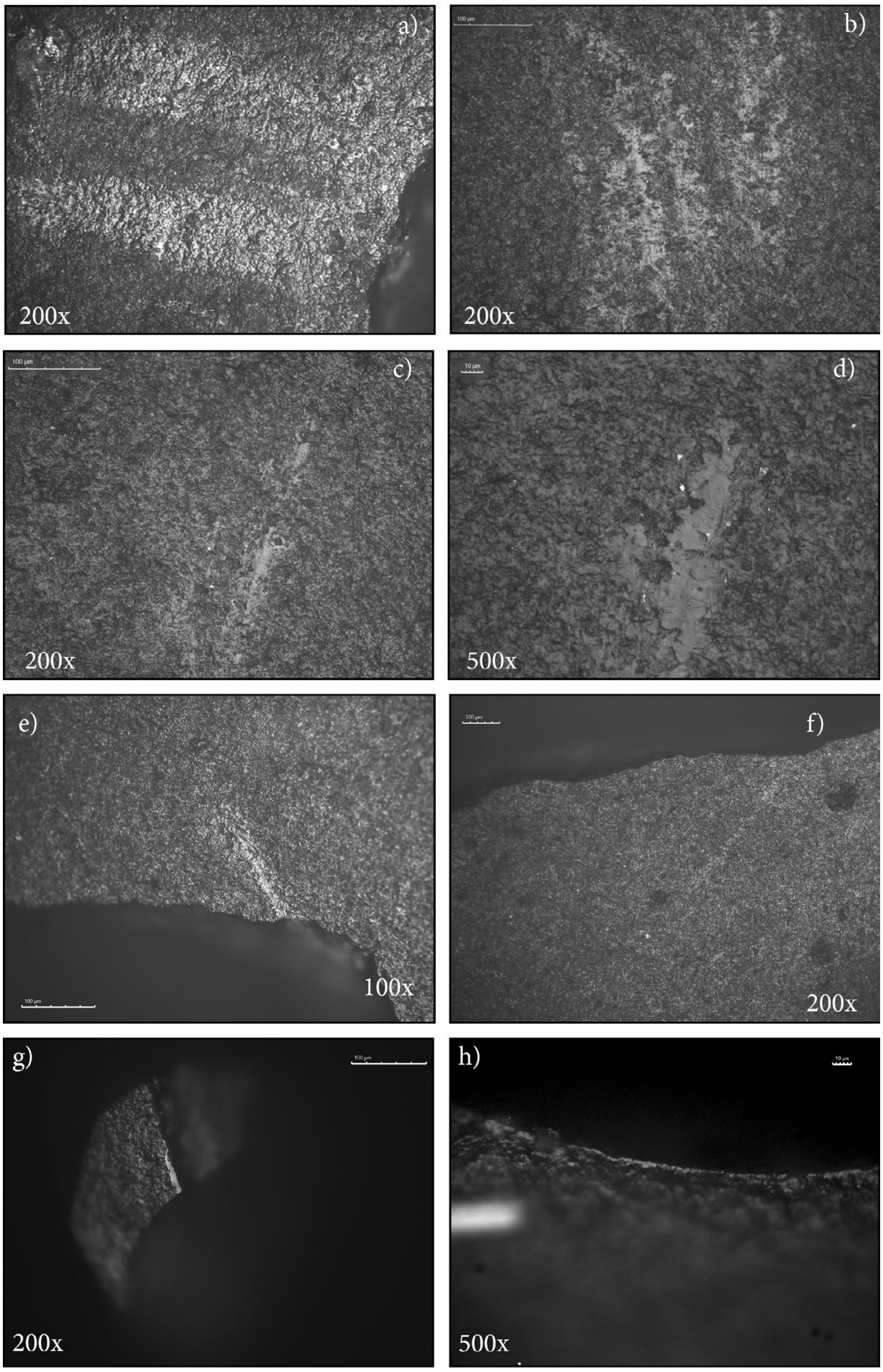


Figure 3. 23 - Backing micro-traces produced by pressure with an antler compressor. a-e: well developed linear polishes without inner striations; f: poorly developed linear polish; g-h: marginal polishes associated with a "fresh" edge.

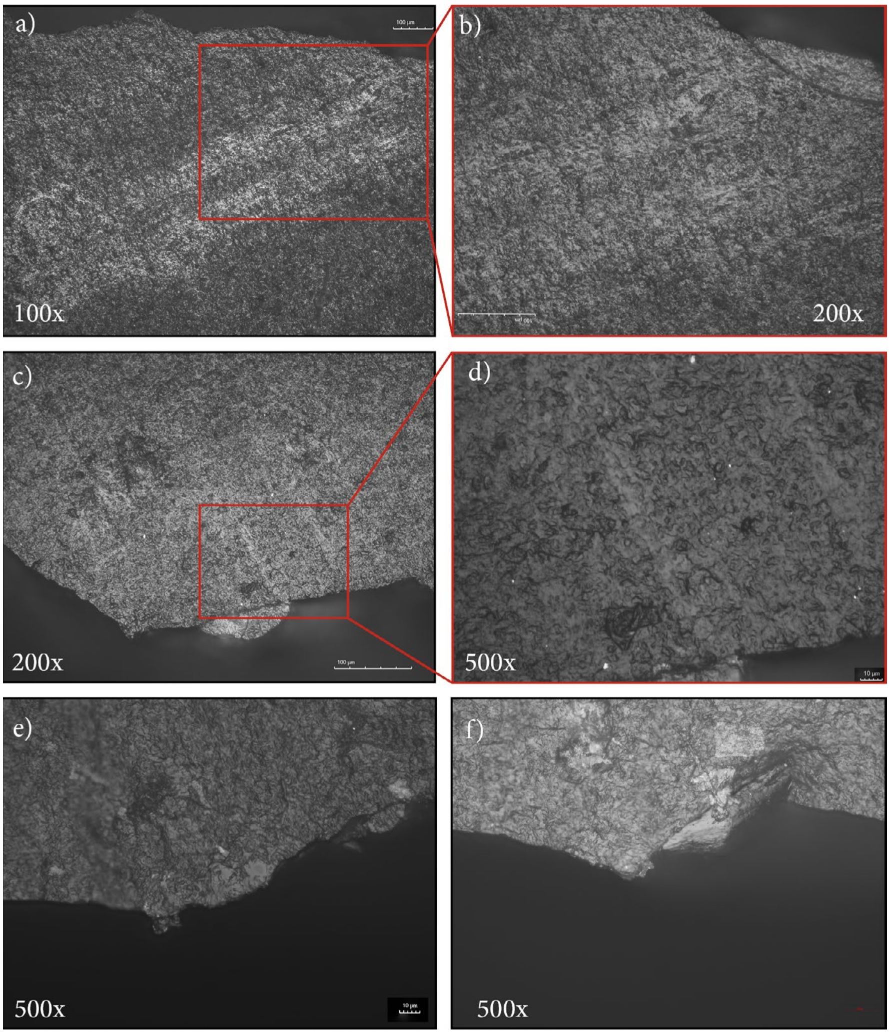


Figure 3.24 – Backing micro-traces produced by pressure with a bone compressor. a-d: polish with a transverse or oblique orientation compared to retouched edge; e-f: marginal polishes.

3.2.1.2.9. Backed retouch quantification

After the recording of the parameters the statistical significance of the metric differences between the negatives produced by the four backing techniques (Fig. 3.25, 3.26, 3.27) were tested by the Wilcoxon test. This allowed to reached some interesting results:

- the width ratio between the initiation and termination of the negative and the angles of diffusion (i.e. morphology of the negative) are statistically significant to distinguish pressure by organic tool from other backing techniques (Tab. 3.15 and Tab. 3.16)
- the transverse concavity is statistically significant to differentiate soft stone percussion on anvil from other backing techniques (Tab. 3.17)
- abrasion and pressure by soft stone do not present any statistical differences according to the parameters recorded
- the longitudinal concavity is not a useful parameter to discern backing techniques
- the ratio between the initiation and termination of the negative and the angles of diffusion are significant parameters for distinguishing the two pressure techniques

Table 3.15 – Evaluation of the statistical significance of difference between the initiation-termination ratio of each backing technique. ns = not significant; * = significant.

		Statistic	p value	p. adjusted	Significance
Ab	SSPA	250	0.181	1	ns
Ab	POT	346.5	<0.001	<0.001	***
Ab	PSS	228	0.461	1	ns
SSPA	POT	303.5	0.005	0.03	*
SSPA	PSS	176	0.525	1	ns
POT	PSS	89	0.003	0.018	*

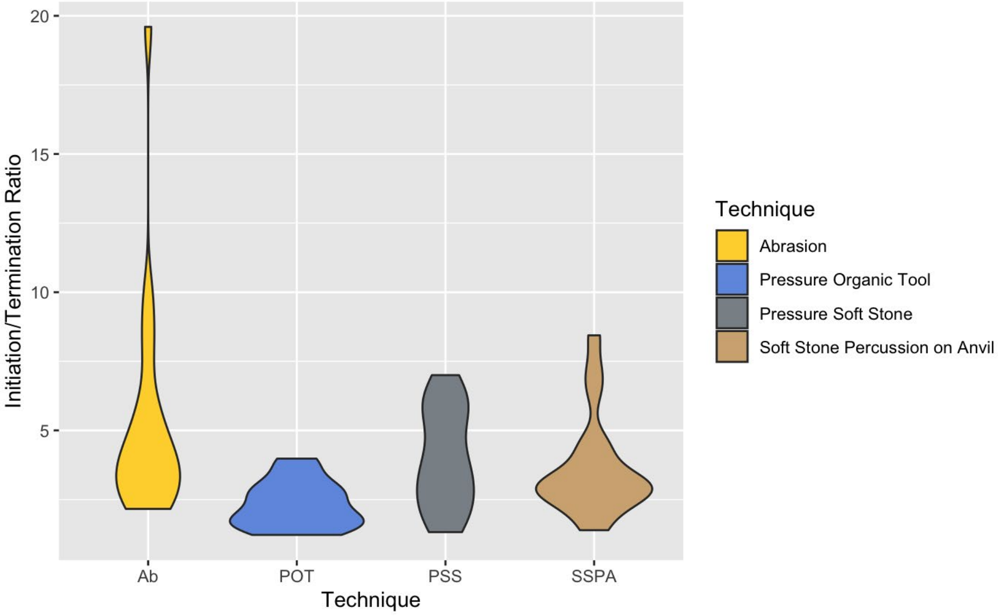


Figure 3.25 - Initiation-termination ratio (μm) variability of negatives according to the backing technique.

Table 3.16 - Evaluation of the statistical significance of difference between average of the two angles of diffusion of each backing technique. ns = not significant; * = significant.

		Statistic	p value	p. adjusted	Significance
Ab	SSPA	269.5	0.062	0.372	ns
Ab	POT	36.5	<0.001	<0.001	****
Ab	PSS	210.5	0.787	1	ns
SSPA	POT	16	<0.001	<0.001	****
SSPA	PSS	150	0.181	1	ns
POT	PSS	332.5	0.000356	0.002136	**

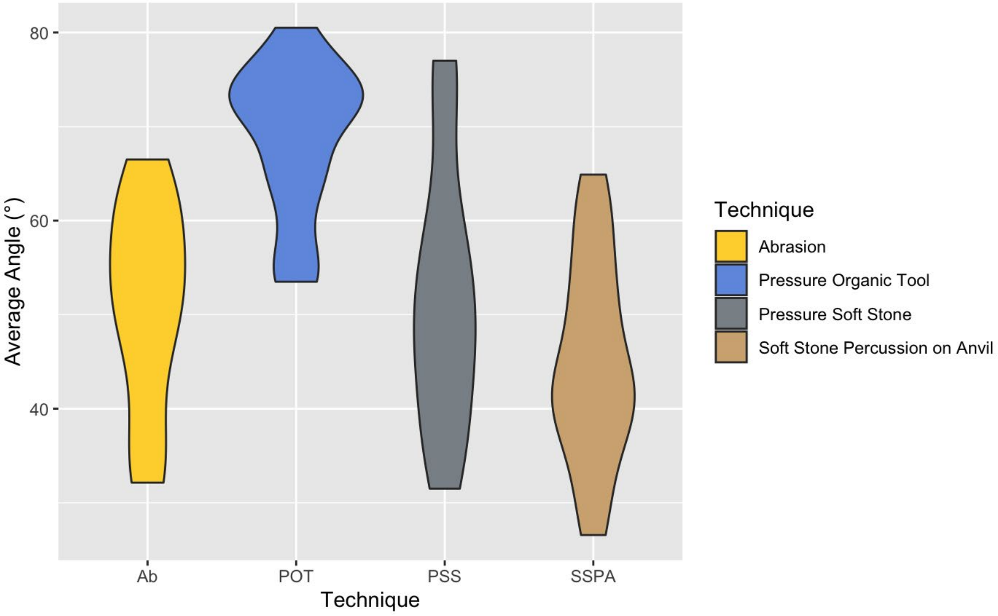


Figure 3.26 – Average angle of the negatives according to the backing technique.

Table 3.17 - Evaluation of the statistical significance of difference between transverse concavity of each backing technique. ns = not significant; * = significant.

		Statistic	p value	p. adjusted	Significance
Ab	SSPA	84.5	0.002	0.012	*
Ab	POT	224	0.525	1	ns
Ab	PSS	179	0.579	1	ns
SSPA	POT	347	<0.001	<0.001	***
SSPA	PSS	320.5	0.001	0.006	**
POT	PSS	146.5	0.152	0.912	ns

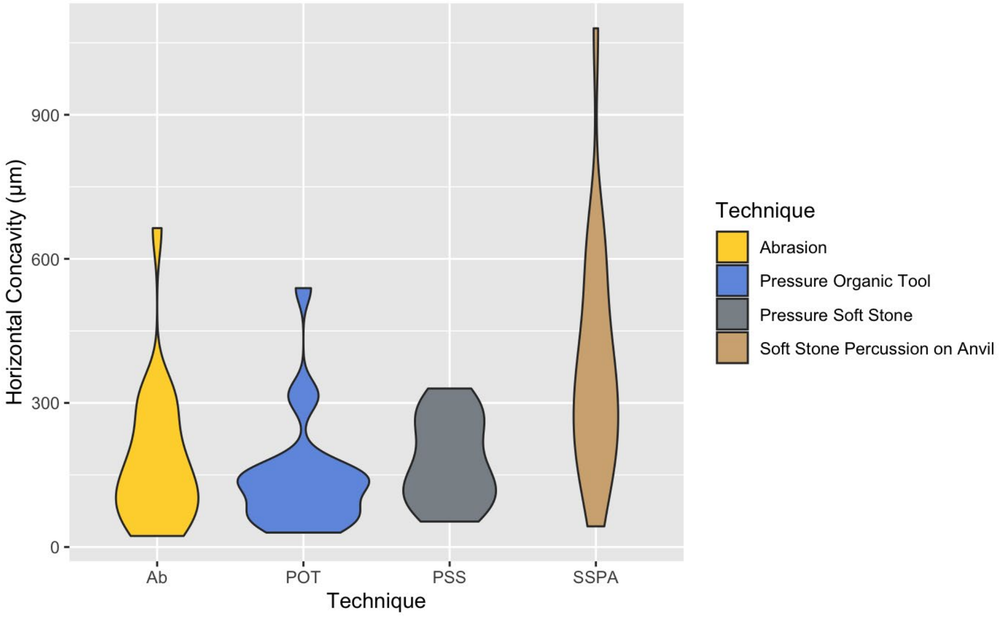


Figure 3.27 – Deep of the transverse concavity (µm) of negatives according to each backing technique.

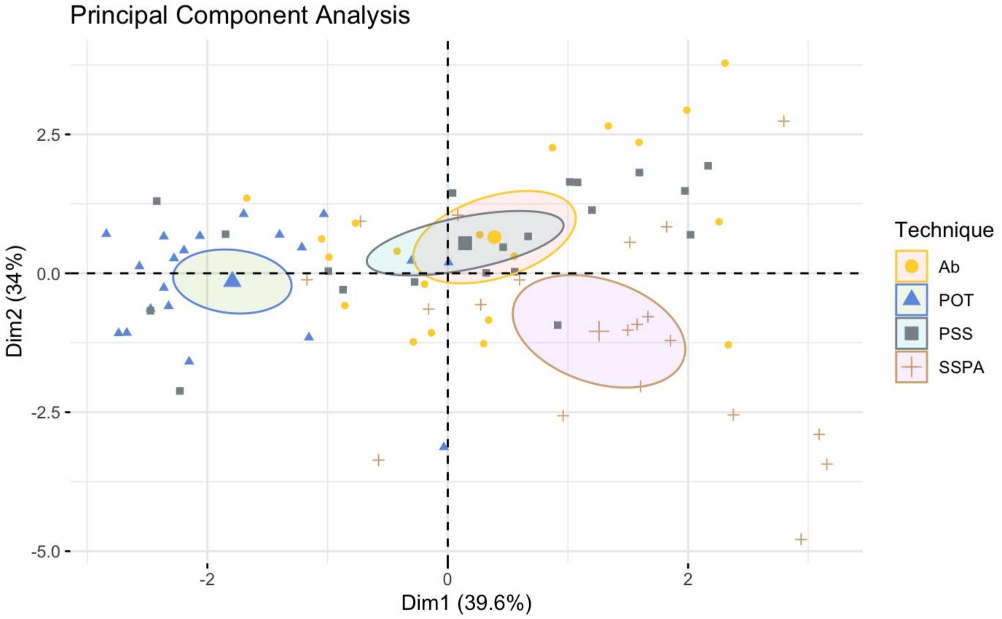


Figure 3.28 – Scatter plot of the PCA.

Figure 3.28 represents a principal component analysis in which variables considered are all the parameters measured, namely initiation and termination width, initiation/termination ratio, 1st and 2nd angle, average between the two angles, transverse and longitudinal concavity. Although it is evident that the high morphological variability of negatives does not allow to identify well-defined clusters, the PCA is consistent with results obtained by significance tests. As a matter of fact, it is possible to identify two distincts clusters for soft stone percussion on anvil (concentrated on the left side of the graph) and pressure by organic tool (concentrated on the right side of the graph) respectively. Abrasion and pressure by soft stone are more scattered and they overlap.

3.2.1.3. Synthesis

The focus of this experimental activity was represented by the reproduction of different retouch techniques with the aim of assessing their efficacy as well as identifying reliable parameters that would allow their identification through both qualitative (low- and high-power approach) and quantitative analysis. For the first time this work also contains an evaluation of the degree of reliability of backing techniques recognition based on a series of blind tests. In addition to a detailed fracture analysis aiming to recognize diagnostic patterns of backing techniques as well as of retouch methods.

Regarding the low power approach, the adopted workflow started from the identification of significant morphological parameters which tend to change depending on the retouch techniques applied. Afterwards a systematic and comprehensive protocol for the description of their variability in relation to the different techniques and type of retouch was developed by adding features which had not been taken into consideration by previous studies (cf. Pelegrin 2004; Duches et al., 2018). Diagnostic criteria to distinguish soft stone percussion on anvil, pressure by organic tool and abrasion identified by prior studies (Pelegrin 2004; Duches et al., 2018) were basically confirmed and integrated with new criteria as summarised below:

- Soft stone percussion on anvil produces backs with an irregular sequence of removals characterised by a denticulated longitudinal profile due to residual protrusions connected to negatives located at variable depths. Edge is rounded with hammered portions and the back inclination is abrupt or obtuse; the morphology of the scars frequently results in a fan-shaped outline and sometimes presents an oblique or orthogonal development. Initiation of the scars is punctiform with a deep bulb negative, termination is often hinged or step and occasionally marginal and deep incipient cones are visible on the retouch platform.
- Pressure by an organic tool generates backs with a regular sequence of removals composed by elongated, flat and sub-parallel negatives producing a linear longitudinal profile. The edge presents a “fresh” aspect with characteristic sharp residual indentations connected to the punctiform contact surface (as seen from the ventral face). Scars initiation is frequently characterised by large impact points (sometimes bending) with a diffused or absent bulb negative, while the termination tends to be simple or hinged. Back inclination tends to be semi-abrupt (although this parameter may vary according to the retouch angle applied) and sometimes invasive removals on the dorsal surface (micro-overshots) are attested.
- Abrasion technique yields regular sequences of removals composed by scars with sub-quadrangular or sub-trapezoidal morphology, a simple termination and a punctiform impact point. Edge is heavily rounded along the entire longitudinal axis, back inclination is abrupt, transversal profile convex and residual protrusions are sometimes located at regular distance and depth.

As concerns the newly proposed retouch technique (pressure by soft stone), it proved to be highly effective both for back reduction and for complementary retouches. It presents advantages that were normally associated exclusively to pressure by antler (high degree of precision, maintenance of a certain regularity during the sequence of removals and capacity to apply flat inverse complementary retouches) and to soft stone percussion on anvil (operating speed) but also some disadvantages such as a higher fracture index. The most diagnostic criteria to identify pressure by soft stone are the following:

- a back characterised by a regular sequence of removals composed by elongated, flat and sub-parallel negatives associated to small unintentional removals along the edge. The edge is slightly rearward facing and rounded although "fresh" portions are also present, the longitudinal profile is linear and the transversal profile is vertical. The initiation of the scars tends to be punctiform with a diffused negative bulb and sometimes invasive removals on the dorsal surface (micro-overshots) are attested. Back inclination can be abrupt or semi-abrupt according to gestures applied and retoucher position.

As far as backing technique concerned the presented parameters are believed to be strictly correlated to the physical variables defining the different backing techniques (modality of application of the force and type of percussor/compressor/anvil). Unlike what has been proposed for debitage techniques, interpersonal variability in their application (e.g. different gestures) seems to play a minor role in the produced features. This assumption is based both on the results of our experimental programme (different knappers obtained identical results, see 2nd blind test) but also on the convergence of described features with those resulting from the few other available experimental references (cf. Pelegrin 2004, Duches et al., 2018). In fact, the technical constraints related to the holding of both the blank and the percussor/compressor leave little space for different gestures or angles.

With respect to blank categories and retouch type, the experimental activity carried out allowed verifying also the efficacy of each retouch technique. Percussion by soft stone is functional to transform bladelets and blades with thickness that may exceed 8 mm, whereas it is less suitable with bladelets thinner than 3 mm, microbladelets and for applying complementary retouches. Conversely, the two pressure techniques modify effectively any blank up to 4 mm of thickness for pressure by soft stone and 7-8 mm for pressure by organic tool and they are extremely useful for applying any complementary retouch (abrupt, semi-abrupt and flat). Abrasion is successful only with marginal retouch, but the retouch angle is difficult to control.

As opposed to results published in Fasser et al. (2019) in which it was not possible to draw an exhaustive discussion about backing fractures due to the low number of fractured pieces, in the present work thanks to further experimental sessions several additional data have been proposed. First of all, it seems relevant to point out that fractures that were considered as diagnostic of pressure by an antler compressor (i.e. bending fractures with feathered terminations and cone fracture generated by an overshot retouch flake) and of soft stone percussion on anvil (i.e. "Krukowski" microburin) by other Authors (Tixier, 1963; Brézillon, 1968; Pelegrin, 2004; De Wild and De Bie, 2011; Duches et al., 2018) also occurred with other techniques. Therefore, the significance of these specific unintentional breakages should be reconsidered.

Snap in fan shaped negative seems to be the only fracture strictly related to a specific backing technique (soft stone percussion on anvil). However, it is a back feature (fan shaped negative) to make this morphology diagnostic, rather than the fracture in *sensu stricto*. It emerges that fracture morphology is not a significant parameter to recognize specific backing techniques.

Several fracture features provide to be essential in order to consider a backed fragment the result of retouching rather than other mechanical processes:

- backs should present an unfinished delineation.
- bending fractures should have a direction from the opposite surface towards the retouch platform and a transverse orientation.
- cone fractures should have a direction from the retouch platform towards the opposite edge and an oblique orientation.

Furthermore, backed fragments morphology proved to be a key element to detect manufacturing methods. For example, a snap-in notch fracture or an unintentional ordinary microburin can be diagnostic of a back fashioned by retouching progressively along the longitudinal axis of the blank by one single sequence of removals. By contrast, backed fragments with a total and irregular backed retouch delineation are diagnostic of the use of several unidirectional or bidirectional sequences.

As regards the assessment of the reliability of the selected diagnostic meso and macroscopic criteria for the identification of backing techniques, the results obtained with the first and second blind tests attest to a rate between 80% and 70%. The slight difference concerning the success rate between the two indicates that different gestures and interpersonal variability do not play a significant role in the formation of diagnostic features. At the same time, the second blind test demonstrated the difficulty to recognize mixed techniques: in most cases it was possible to identify only one of the two techniques applied. The far-reaching applicability of the proposed protocol was verified through the third blind test. This was actually designed to simulate a specific situation in which a researcher with a solid background in lithic technology was to face for the first time the analysis of retouch techniques on a random assemblage of backed points using the reference grid with the diagnostic criteria identified for each technique. The correct identification of 67% of the experimental artefacts allows confirming the efficacy of the proposed parameters and the applicability of the protocol of analysis by other researchers. The results of the three blind tests allowed to estimate the total success score of the protocol at around 72%, with similar identification rates of the single techniques (between 70% and 74%; cf. Tab. 3.12).

Also the high magnification analysis adds important data concerning backing techniques, showing micro-traces closely related to the retoucher raw material, such as well-developed flat and compact polishes crossed by short, matt or and narrow striations for a lithic retouchers and large single or grouped linear polishes with a smooth texture, flat or domed topography and a compact linkage without matt striations for an organic compressor. These latter were actually produced especially with an antler tool. Anyway the identification of backing micro traces remains delicate because of the existence of other processes that may produce similar traces, such as use, hafting, transport, prehension and post-depositional alteration (Rots, 2016; Roux et al., 2020). If MLIT's are well know and distinguishable to backing micro-traces mainly due to an opposite orientation (longitudinal vs. transverse with respect to the back), other processes that might affect archaeological backed armatures need to be tested in further research.

The quantitative analysis revealed some promising results. Even though it will be necessary to increase the experimental sample, this approach seems efficient to discern soft stone percussion on anvil, pressure by an organic tool and a generic pressure by soft stone/abrasion technique, showing a good potential as a validating tool if applied along with a low-power approach.

The importance of reaching equal conclusions through different approaches is expected to be a key element to increase the reliability of our data, especially in Prehistory research in which solid and unquestionable results are difficult to obtain.

3.2.2. 2nd experimental activity (microburn blow technique)

3.2.2.1. Experimental sets

3.2.2.1.1. Phase 1 - Raw material procurement

Raw materials selected for the 2nd experiment are the same exploited during the 1st one, namely nodules belonging to the Middle Cretaceous Maiolica Formation from the Lessini area (VR, Italy). A block of radiolarite from the Cariadeghe plateau (BS, Italy) was also flakesd (Fig. 3.29 a).

3.2.2.1.2. Phase 2 – Blank selection

Firstly we selected a random sample of 60 blanks (microbladelets and bladelets) and we simply split them once or twice by a microburin blow just for understanding the correct blank position and gesture needed. After that, the blanks selection was more parameterized and done in the function of a microlithics manufacture comparable with those attested at Mondeval de Sora (SU 8). Microbladelets (length ≤ 35 mm) with a thickness systematically lower than 3 mm were selected (n=49). Bladelets (length > 35 mm) were rarely exploited (n=6). Blank dimensions were measured before the fabrication process.

3.2.2.1.3. Phase 3 - Notch production, microburin blow and retouching process

Two force application modes for obtaining a *piquant-trièdre* fracture have been experimented:

- percussion
- pressure/bending

Several types of anvils were used: a flat piece of wood, a boxwood log, a flat and large cobble and a flint core. The percussion was applied using a little and flat sandstone pebble (Fig. 3.3, n.2) as suggested by J. Tixier (Tixier, 1976). On the other hand, pressure/bending was employed by a bone, antler and lithic compressor (Fig. 3.3). The former was hafted on a wooden handle, the second one collected from a red deer antler tine and used directly after cutting, whereas the latter was an elongated, flat pebble with a tempered extremity.

Two blank holding modalities were used depending on which blank side (left or right) and portion (distal or proximal) the notch was located. For a right-hand knapper (as the Author) the most convenient way to produce a right notch on the proximal portion and a left notch on the distal portion is the *A modality* (Fig. 3.29 c), while for applying a left proximal notch or a right distal notch the *B modality* (Fig. 3.29 d) is the most appropriate.

The procedure for obtaining a *piquant-trièdre* depends on the technique applied: using a percussion technique the blank was positioned on the edge of the anvil with its ventral face up, its longitudinal axis diagonally oriented compared to the edge (around 45°) and its transverse axis inclined with respect to the anvil surface (around 10°-20°). The notch was generated by repeated and perpendicular strikes until a spontaneous fracture occurs. A microburin blow was successfully applied 26 times, whereas in 28 cases a fracture which did not present a *piquant-trièdre* was produced (Tab. 3.18).

Table 3.18 - Microburin technique applied and success rate.

	Total blows	Success	Failed	Success rate
Pressure/bending by organic compressor	45	32	13	71.11%
Pressure/bending by lithic compressor	8	6	2	75.00%
Percussion	54	26	28	48.15%

The microburin blow fracture involved a different strategy when it is applied by a pressure/bending technique. The notch was retouched while the blank was blocked in the middle of the anvil surface and not on the edge. Once the maximum transverse thickness of the blank was reached (the main dorsal ridge in case of triangular cross-section blanks, or at least the first dorsal ridge with trapezoidal cross-section blanks), the blank was positioned on the edge with its longitudinal axis diagonally oriented (around 45°) and its transverse axis parallel to the anvil surface. The fracture occurs by pushing with the compressor at the middle of the notch. In 38 cases (both with a lithic and organic compressor) a *piquant-trièdre* was obtained. Eleven blanks were discarded due to unintentional fracture during the notch formation.

A total of 42 microlithics have been shaped out, divided between the four major types attested during the Italian *Sauveterriano* (Tab. 3.19). The backing techniques applied are the same tested during the first experimental activity.

Table 3.19 - Backing technique applied to shape geometrics.

Type (Laplace, 1964)	n	Backing technique	n
Gm1	8	SSPA	4
Gm2	1	PSS	12
Gm3	28	POT	23
Gm4	4	Ab	1
Gm1/Gm4	1	PSS+SSPA	2
Total	42	tot	42

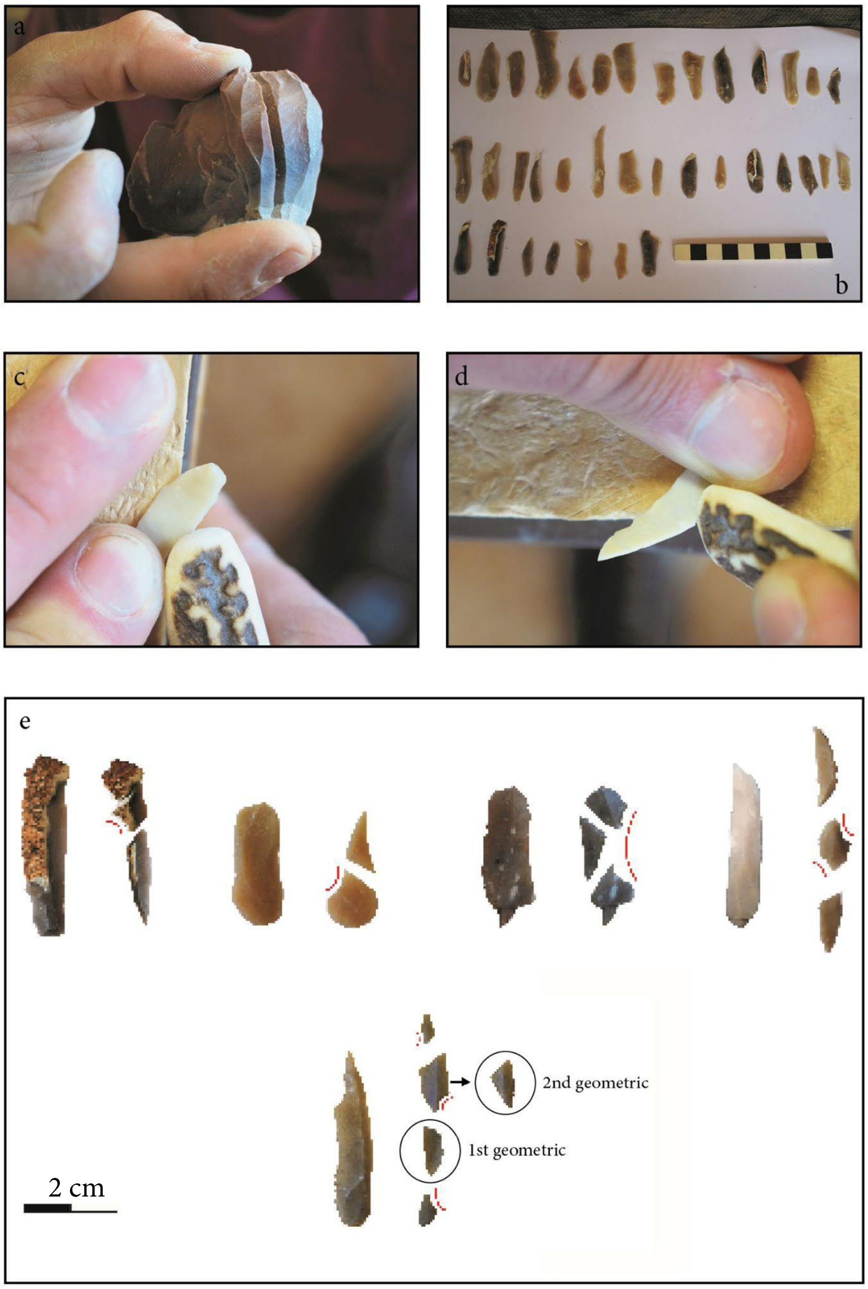


Figure 3.29 – 2nd experimentation. a) microbladelets core; b) experimental blanks; c) "A" holding modality; d) "B" holding modality; e) geometrics production.

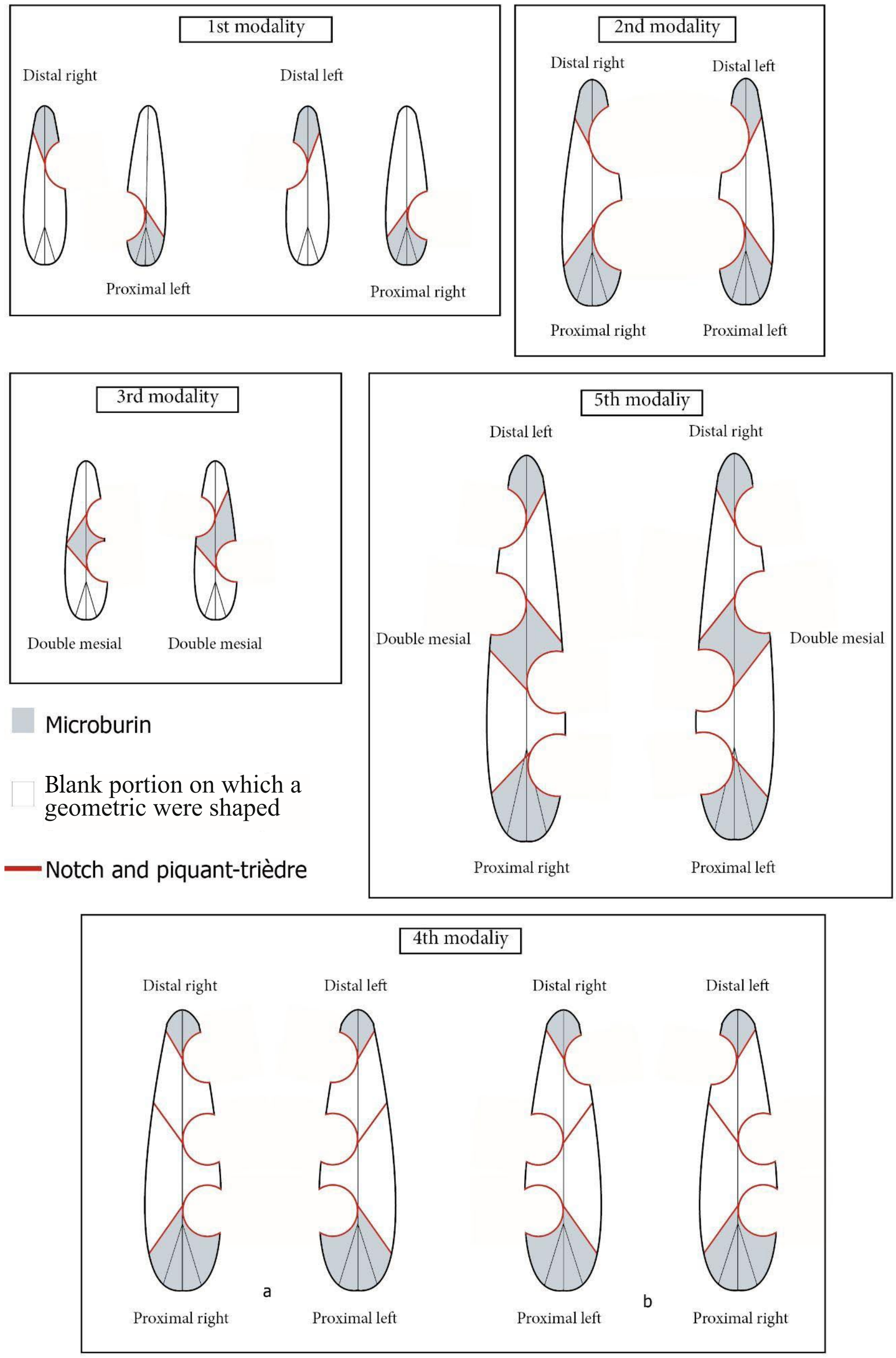


Figure 3.30 – Variability of geometrics production using the microburin blow technique.

Several production modalities were experimented according to the number of microburin blows and geometrics obtained for each blank (Fig. 3. 30):

- 1st Modality - A single geometric for each blank by a distal or proximal microburin blow
- 2nd Modality - A single geometric for each blank by both a distal and a proximal microburin blow
- 3rd Modality - Two geometrics for each blank by two mesial microburin blows.
- 4th Modality - Two geometrics for each blank by three microburins blows. This modality required a double microburin fracture for shaped the first geometric; then, a third microburin was removed on the distal portion of the previous distal microburin resulting in a piece characterised by a microburin fracture opposed to a *piquant-trièdre*. This element was turned into the second geometric by retouching. This modality has two variants: a) all three notches are located on the same side. b) two notches are located on one side, whereas the third is located opposite. In this case the selection of blanks with at least 30-35 mm of length is required.
- 5th Modality - A sequence involving four microburin blows and the production of two geometrics is also possible. However, blanks length selected for this experiment did not allow such a modality.

3.2.2.1.4. Phase 4 - Low power approach

The low magnification analysis was carried out by a stereomicroscope (Optika SZN-T; magnification range 0.63x - 3x). Four main parameters seem to be significant for identifying microburin blow techniques. Their variability is presented below.

Impact point (Fig. 3.31):

- large
- small
- elongated
- linear
- isolated
- multiple
- absent

Bulb morphology (Fig. 3.32):

- compact
- pronounced
- diffuse
- absent

Transverse inclination (Fig. 3.32):

- low (< 45°)
- semi-abrupt (between 45° and 70°)

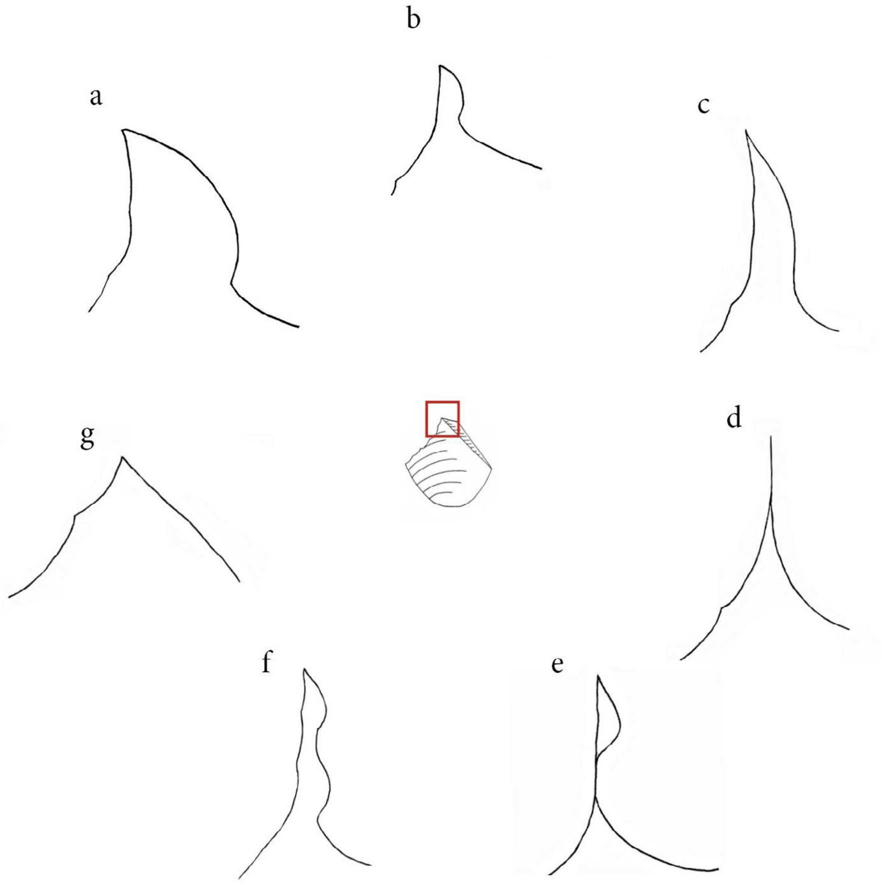


Figure 3.31 - impact points morphology. a: large; b: small, c: elongated; d: linear; e: isolated; f: multiple; g: absent.

- abrupt (> 70°)

Profile delineation (*languette* development) (Fig. 3.32):

- clear horizontal development
- slightly horizontal development
- any horizontal development

Also notch morphology can give important information about the force application mode and retoucher raw material used to achieve the microburin fracture following diagnostic criteria of backing techniques presented in Table 3.4.

3.2.2.1.5. Phase 5 - High power approach

Based on results obtained during the 1st experimental activity in which micro-polishes and striations diagnostic of backing techniques were identified, we decide to evaluate the contribution of this approach also to differentiate the microburin blow techniques here experimented. The cleaning method, the metallographic microscope used and the parameters used to describe micro traces are the same presented during the 1st experiment. The sample selected for the analysis counts a total of 44 microburins: 14 were produced by percussion, 23 by pressure/

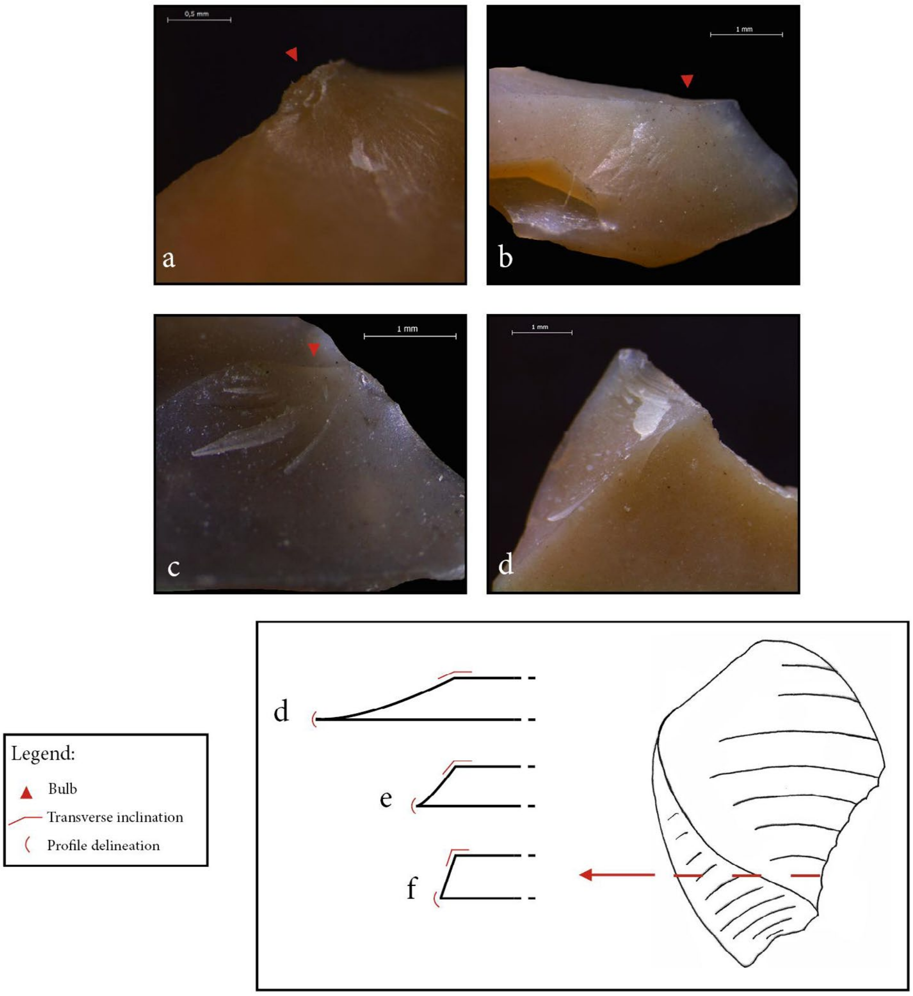


Figure 3.32 – Bulb morphology: a) compact; b) pronounced; c) diffuse; d) absent. Fracture transverse inclination: d) low; e) semi-abrupt; f) abrupt. Fracture profile delineation (i.e. languette development): d) Clear horizontal development; e) Slightly horizontal development; f) Any horizontal development.

bending with an organic compressor and 6 by a pressure/bending with a lithic compressor.

3.2.2.1.6. Phase 6 - Blind Tests

The validity of the aforementioned parameters was verified through a single blind test aimed at better clarifying their relevance and their variability, as well as to test the significance of gestures and interpersonal variability. This blind test consists of determining, using both a high and low power approach, the microburin blow techniques applied for a random series of experimental artefacts (n=31) produced by a knapper (Alessandro Potì) unfamiliar with this experimentation. Two microburin blow techniques were used: pressure/bending by organic tool and percussion by a lithic retoucher.

3.2.2.2. Results

3.2.2.2.1. The efficacy of the different microburin blow techniques

As already claimed by several Authors (Finlay, 2000; Miolo and Peresani, 2005; Tixier, 1976; Tixier et al., 1980), both percussion and pressure/bending prove to be effective to obtain a *piquant-trièdre* fracture. However, the former turned out to be less precise due the high degree of accuracy required resulting in a high margin of error (Tab. 3.18). A blow too far from the notch edge or an inappropriate blank position can easily provokes a fracture without a *piquant-trièdre* (mainly a snap terminating bending fracture or a snap terminating cone fracture). This low degree of precision and the large active surface of a lithic retoucher compared to an organic one, forces to create larger notches resulting in a production waste more comparable to a Krukowski microburin rather than an ordinary one. With this technique it is always important to adapt the hammer dimension and weight to blank thickness. More tampered the retoucher extremity is, the more precise the blow. The main advantage of a percussion microburin blow technique is a good flexibility. It can be easily applied both with the a) or the b) holding modality.

The anvil raw material can play a significant role depending on its capacity to absorb the percussion force. A lithic anvil (flat pebble, a core, or the main dorsal ridge of a thick blank) increases the risk of unintentional breakage during the notch production because of the low control of the recoil. Furthermore, the recoil effect can create an inverse microburin fracture. The use of an organic anvil (boxwood log) due to its superior capacity to absorb the percussion force allows an easier control of the backing process.

The low unintentional fracture index makes the pressure/bending the most reliable technique (Tab. 3.18). Another important benefit concerns the possibility to decide the exact fracturing moment and location on the blank. An organic compressor allows to manage positively both thin (from 1 to 3 mm) and thick blanks (more than 4 mm). This latter obviously required a higher force which can be obtained by lengthening the handle of the compressor. Also a lithic retoucher turned out to be appropriate to obtain a *piquant-trièdre* by pressure/bending even though it presents some constraints: firstly, the low elasticity of the stone makes more complicated reached the fracture in case of thicker blanks, furthermore it tends to create extremely large notches. As far as our experience concerns, the only way to use a lithic compressor without any particular limitation is to haft a little and tampered pebble in a wood handle, as illustrated in Figure 3.3 n. 9. The pressure/bending microburin blow technique can be effortlessly applied holding the blank with the *a) modality.* At the beginning the *b) modality* can cause some troubles and needs a bit of practice.

3.2.2.2.2. Diagnostic meso and macro-scopic criteria

The analysis of 95 experimental microburins (those produced by the Author and by AP for the blind test) through a low-power approach allowed describing the variability of four parameters according to the microburin blow techniques applied. The parameters described are: impact point, bulb, transverse inclination and profile delineation (namely, *languette* development).

Impact point (Tab. 3.20):

Looking at the variability of the impact point according to microburin blow technique, interesting results were recorded. A microburin reached by percussion almost systematically produces a clear impact point (92%). The lack of impact points is rare. The most frequent morphology is the small one (35,00%), followed by multiple (20,00%) and large (10,00%). Occasionally, the percussion shock caused the removal of the impact point resulting indeterminable (15,00%). The isolated type and the elongated one reach a percentage of 7,50% and 5,00% respectively. A linear impact point is lacking. Sometimes a Hertzian cone is visible.

The pressure/bending technique frequently does not develop any impact point (32,73% Fig. 3.31 g and 3.32 d). This is related to the fact that the fracture was reached by resting the tip of the compressor exactly on the notch edge and not on the ventral face. If the impact point is present, it tends to be small (20,00%), large (12,73%) or linear (9,09%). Although the latter do not achieve a high percentage, it is extremely diagnostic being missing on microburins produced by percussion. The multiple impact point is poorly recorded.

Sometimes a little flake detached from the dorsal face, due the anvil recoil effect, removes completely or partially the impact point (Fig. 3.33 a, b). By using the percussion technique this feature was most frequently attested with a lithic anvil (27,27%) rather than an organic one (16,67%), whereas using the pressure/bending technique it was identified exclusively on blanks resting on a lithic anvil (Tab. 3.21).

Table 3.20 - Impact point morphology according to microburin technique.

	Percussion		Pressure	
	n	%	n	%
Small	14	35.00	11	20.00
Large	4	10.00	7	12.73
Elongated	2	5.00	3	5.45
Multiple	8	20.00	2	3.64
Isolate	3	7.50	3	5.45
Linear	0	-	5	9.09
Absent	3	7.50	18	32.73
N.D.	6	15.00	6	10.91
Total	40	100	55	100

Table 3.21 - Presence or absence of the inverse detachment due to the recoil effect according to microburin technique and type of anvil.

	Type of anvil	Inverse retouch	n	%
Percussion	Organic	Yes	3	16.67
		No	15	83.33
Total			18	100
Percussion	Stone	Yes	6	27.27
		No	16	72.73
Total			22	100
Pressure	Organic	Yes	-	-
		No	38	100
Total			38	100
Pressure	Stone	Yes	8	47.06
		No	9	52.94
Total			17	100

Bulb (Tab. 3.22):

The morphology strongly changes according to the microburin blow techniques. A percussion blow provokes compact (40,00%) or pronounced (25,00%) bulbs (Fig. 3.32 a, b). Otherwise the pressure/bending creates diffuse bulbs (38,18%) or none (41,82%) (Fig. 3.31 c, d). The latter is generally associated with an absent impact point.

Table 3.22 - Bulb morphology according to microburin technique.

	Percussion		Pressure	
	n	%	n	%
Absent	2	5,00	23	41,82
Diffuse	7	17,50	21	38,18
Pronounced	10	25,00	3	5,45
Compact	16	40,00	4	7,27
Break	5	12,50	4	7,27
Total	40	100,00	55	100,00

Transverse inclination (Tab. 3.23):

Looking at Table 3.23 is evident how fracture inclination tends to be between 45° and 70° with both techniques. Fractures with a low angle (< 45°) were more frequently attested with a pressure/bending technique, while an abrupt angle (> 70°) was mainly related to percussion. However, the transverse inclination should not be considered as strictly related to the microburin blow technique (in *stricto sensu)*, but to the blank position (inclination of the transverse axis of the blank) with respect to anvil surface and therefore to the retouch angle. More the ventral face is inclined, the more the fracture angle is abrupt and vice versa. Thus, this strong dichotomy between pressure and lower angles and percussion and abrupt angles comes from the Author's different way to position the blank according to the technique. The only exception is represented by blanks with a triangular cross-section and a width-thickness ratio at least close to 1:1. In this case the blank turns spontaneously in an inclined position producing fractures with an abrupt transverse inclination also with a pressure/bending technique.

Table 3.23 - Transverse inclination according to microburin technique.

	Percussion		Pressure/bending	
	n	%	n	%
Low	7	17.50	24	43.64
Semi-abrupt	24	60.00	30	54.55
Semi-abrupt/abrupt	1	2.50	-	-
Abrupt	7	17.50	1	1.82
N.D.	1	2.50	-	-
Total	40	100	55	100

Profile delineation (Tab. 3.24):

A *languette* development seems to be related both to the transverse inclination of the blank on the edge and the microburin blow techniques applied. In fact, a low transverse inclination of the fracture is systematically associated with a clear or slightly horizontal development, while when the transverse inclination is abrupt it does not have a *languette* development. However, focusing on artefacts with a semi-abrupt transverse inclination, those produced by

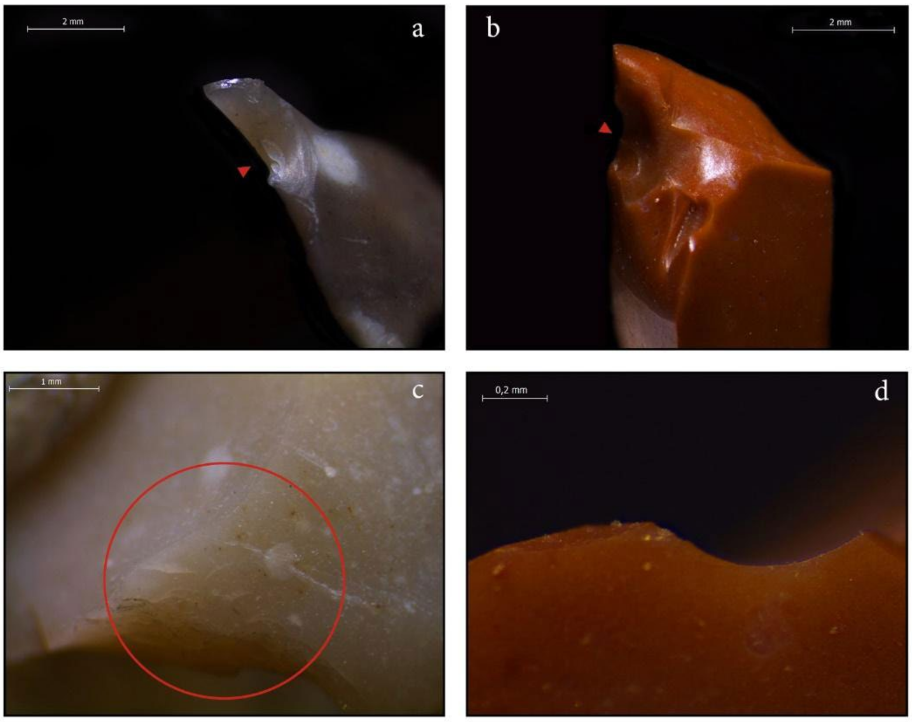


Figure 3.33 – a-b: inverse detachments due to the recoil effect of a lithic anvil; c: deep incipient cones diagnostic of a percussion technique; d: residual identention diagnostic of a pressure with an organic tool.

pressure/bending present more frequently a slightly horizontal development as opposed to those obtained by percussion (Tab. 3.24). Thus, the pressure/bending technique tends to produce more invasive *languette* resulting in a more rearward *piquant-trièdre*.

Table 3.24 - Profile delineation in microburins with a semi-abrupt transverse inclination according to microburin technique.

	Percussion		Pressure/bending	
	n	%	n	%
Clear horizontal development	2	8.00	3	10.00
Slightly horizontal development	9	36.00	20	66.67
Without horizontal development	14	56.00	7	23.33
Total	25	100	30	100

Notch morphology:

Percussion by soft stone produces large notches with a rounded edge and hammered portions. The initiation of the scars tends to be punctiform with a pronounced bulb negative and sometimes deep, single or grouped incipient cones far from the edge are visible on the ventral face (Fig. 3.33 c). Pressure by an organic tool creates smaller notches with a fresh edge characterised by sharp residual indentations visible from the ventral face (Fig. 3.33 d) associated with negatives with a large initiation (or even bending). The edge can be rounded in case of thick blanks. Notches produced by pressure by soft stone are characterised by a rearward and rounded edge and initiation of the scars are punctiforms.

Table 3.25 – Combination of features that tend to appear more frequently with one technique rather than others.

	Macro and meso traces						
	Fracture features				**Notch features**		
	Impact point	**Bulb**	**Transverse inclination**	**Profile delineation**	**Edge**	**Scars initiation**	**Incipient cones**
Percussion by soft stone	-Impact point systematically present. -Multiple morphology. -Visible Hertzian cone.	-Compact or pronounced.	-Depends on the blank position.	-Slightly horizontal development or any. Rarely a clear horizontal development	-Rearward and rounded.	-Punctiform with a pronounced bulb negative.	-Single or grouped located far from the edge or marginal.
Pressure/bending by organic tool	-Absent or-linear.	-Diffuse or absent.	-Depends on the blank position.	-Clear or slightly horizontal development. .	-Fresh or rounded according to the blank thickness.	-Sharp residual indentations as seen from the ventral face associated with large scar initiation or even bending.	-Single and marginal.
Pressure/bending by lithic compressor					-Rearward and rounded.	-Punctiform.	-Single and marginal.

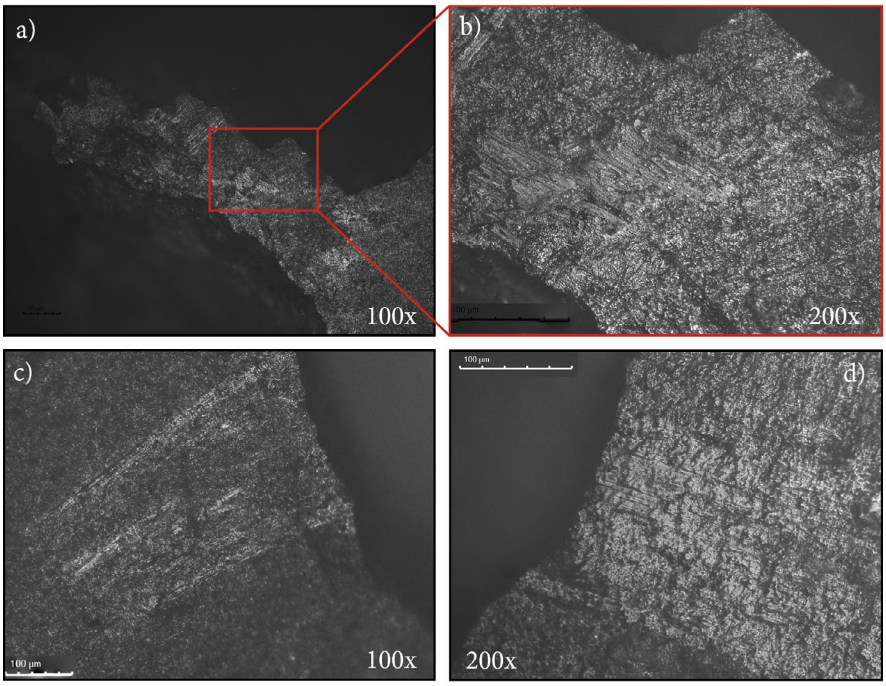


Figure 3.34 – Micro-traces recorded on experimental microburins. a-c: micro-traces produced by a lithic retoucher; d: micro-traces produced by a bone compressor.

3.2.2.2.3. Micro-traces

Looking at Table 3.26 we can appreciate how applying a microburin blow by lithic retoucher leaves a higher number of micro traces (FI: 71,11%) compared to an organic one. They are basically comparable with those produced by the backing process (Fig. 3.34 a, b, c). They are located in correspondence with the impact point (e.g., Fig. 3.34 a, b) or adjacent to the notch edge (Fig. 3.33 c, d). However, striations orientation is not systematically transverse or oblique to the notch, but sometimes can be also longitudinal or even crossed (Fig. 3.33 b) likely due to a change in blank position during notch production.

Only the 21,74% of microburins obtained by an organic retoucher (n=5) yielded micro-traces. The only difference with those attested during the 1st experiment is the presence of one well-developed polish produced by a bone retoucher characterised by a smooth texture, a domed topography and a compact linkage crossed by several narrow, short and matt striations with a transverse orientation compared to the retouched edge (Fig. 3.33). Considering all the experimental artefacts analysed by a metallographic microscope, it is the only one retouched by an organic compressor (bone) which yielded matt striations.

Table 3.26 – Presence of micro-traces according to microburin blow techniques. F.I.= Frequency Index.

	With traces	Tot.	F.I.
percussion	10	14	71,43%
organic pressure	5	23	21,74%
lithic pressure	2	6	33,33%

3.2.2.2.4. Blind test results

The Author analysed 31 microburins produced by A.P. by a low power approach (Tab. 3.27). If a morpho-scopic analysis was not enough to determine the microburin blow technique, a high-power approach was also adopted. Although 80% of microburins were positively identified, by dividing the sample according to the two techniques employed well distinct success rates appear (Tab. 3.27): 93% for percussion and 71% for pressure/bending. Microburins obtained by pressure/bending and interpreted as percussion are a total of 4, while only one microburin produced by percussion was considered as obtained by pressure/bending. This result must be related to the occasional formation of features generally reported for percussion on microburins obtained by a pressure/bending, such as:

- a semi-abrupt transverse inclination without horizontal development (n=4).
- multiple impact point (n=2)
- a domed and compact polish cross by narrow, matt and short striations (n=1; Fig. 3.33 d).

The first point was already detected on a few microburins previously produced by the Authors. In fact, as we already explained, an abrupt transverse angle is related to blank position rather than the technique applied. On the contrary, the other two features were totally absent on the Author experimental sample produced by a pressure/bending applied with an organic retoucher. For example, the development of multiple impact point depends on a different strategy used by AP for applying the pressure technique. AP places the blank directly on the anvil edge (like the Author did for the percussion technique) and while he was creating the notch, he immediately tried to reach the fracture before achieving the thickest transverse point of the blank. This modality requires the use of a higher force during notch production provoking more frequently marginal incipient cones which, once the microburin is removed, turn into a multiple impact point. Furthermore, it is likely this greater force applied to be the cause also of the well-developed polish illustrated in Figure 3.33 d.

Table 3.27 - Blind test results.

	Percussion	Pressure/bending
Microburins recognized	13	12
Microburin not recognized	1	5
Total microburins per technique	14	17
Success rate per technique	92.86%	70.59%
Total success rate	80.65%	

3.2.2.2.5. Notch lateralization. What is its meaning?

The experimental activity allowed to develop some consideration concerning notch lateralization. Based on the assumption that the *A) holding modality (*Fig. 3.29 c*)* is the most convenient position for applying a microburin blow, a right-hand knapper would locate a right notch on the proximal portion and a left notch on the distal portion, while a left-hand knapper would do exactly the opposite. However, this condition is not systematically true in practice. The blank morphology could require to locate the notch on the opposite side compared to the handiest one forcing to switch to the *B) holding modality* (Fig. 3.29 d). Using this latter a right-hand knapper can easily locate a left notch on the proximal portion and a right notch on the distal portion and vice versa for a left-hand knapper.

Another element that can strongly affect notch lateralization is the modality adopted for manufacturing geometrics. Using the 1st modality (Fig. 3.30) notch lateralization simply depends on the dichotomy between the most comfortable position (*A holding modality*) according to knapper lateralization and blank morphology which can be required to use the *B) modality*. On the contrary, by applying the 2nd modality (Fig. 3.30), notches lateralization (which must be the same for both microburins) is not only influenced by the knapper lateralization, blank morphology and holding modality but also depends on which portion (proximal or distal) is removed first. For example, if the manufacturing process starts with a left notch on the distal portion, the proximal microburin will have a left notch too. The same goes for the 4th (Fig. 3.30) and 5th modality (Fig. 3.30) and in general for all modalities that provide more than one microburin.

To summarise, many factors can influence the notch lateralization in contrast to what was proposed by M. Peresani and R. Miolo (2012). Such parameters are:

- knapper lateralization (right-hand vs. left-hand)
- notch location (proximal or distal)
- blank holding modality (*A* or *B*)
- blank morphology
- modality adopted for manufacturing geometrics.

Furthermore, this 2nd experiment allowed verifying that according to the production modality adopted a different microburin assemblage was produced. Two main categories can be identified: modalities that produce proximal and distal microburins with an opposite notch lateralization and modalities that produce proximal and distal microburins with an equal notch lateralization. In the first category are included the 1st modality (if applied by knappers with the same hand lateralization always using the same holding modality), the 4th*a* one and the 5th one (Fig. 3.30). The latter would also produce a significant number of double mesial microburins. On the other hand, the modalities that belong to the second category are the 1st one (if applied using different holding modalities depending on bank portion removed), the 2nd one and the 4th*b* one (Fig. 3.30). The 3rd modality generates exclusively double mesial microburins. Thus, a detailed analysis of notch lateralization of an archaeological assemblage can provide important information about production modalities and therefore the number of microburins and geometrics obtained from a single blank and in large sense the existence of common normalised technical procedures within specific human groups or cultural facies.

3.2.2.2.6. Suitability of backing techniques for geometrics production

The small size of Sauveterrian geometrics does not allow a great freedom in the choice of retouching technique to be applied. Percussion by soft stone and abrasion prove to be poorly suitable. The former because of the reduced workspace and the high fracture index, the latter for the impossibility to hold the artefact in one hand while rubbing the edge with stone cobble. Conversely, the two pressure techniques (POT and PSS) are extremely appropriate thanks to their high degree of precision and elevated capacity to control the force and retouch angle employed. With both pressure techniques the blank was laid on a boxwood log. Moreover, removing the unnecessary blank portions by the microburin blow technique, the shaping process becomes extremely reduced and the major disadvantage of pressure by an organic tool, which is a low operating speed, turns out to be completely irrelevant. The same goes for pressure by soft stone: the difficulty to modify thick banks (> 4 mm) and the high fracture index recorded during the first experimentation did not occur during geometrics production.

3.2.2.3. Synthesis

To sum up, the experimental activity presented here allowed verifying a higher efficacy of pressure/bending compared to percussion for applying a microburin blow due to two main reasons: the low unintentional fractures index and the better capacity to control the exact moment and location of the fracture. Concerning the archaeological identification of each technique, parameters presented in Table 3.25 must be considered as morphologies which tend to appear more frequently with one technique rather than other (i.e. bulb and butt morphology) or as features related to blank position during the blow (i.e., transverse inclination) or even both (i.e., horizontal development). Thus, in most cases the recognition of a microburin technique calls for the presence of more than one criterion per piece and should be applied to large collections due to the partial superposition of some diagnostic features. By considering the main aforementioned meso and macro-scopic features for each technique (Tab. 3.25), it was possible to recognize three main microburin morphology whose absence or present (and frequency) in an archaeological assemblage can be used as a guideline for microburin blow technique identification:

- Category A: microburin characterised by an absent impact point and bulb, a low or semi-abrupt transverse inclination and a slightly or clear horizontal development (Fig. 3.35 a).
- Category B: microburin characterised by a visible impact point and bulb, a low or semi-abrupt transverse inclination and a slightly or clear horizontal development (Fig. 3.35 b).
- Category C: microburin characterised by a visible impact point, pronounced or compact bulb, semi-abrupt or abrupt transverse inclinations without horizontal development (Fig. 3.35 c).

The A category is strictly diagnostic of a pressure/bending technique, the C category of a percussion one, while the B category is equally attested with both techniques. In this last case other macro-and meso-scopic features can be used to discern microburin blow technique, such as:

- linear impact points and diffuse bulbs for pressure/bending
- pronounced bulbs, hertzian cones visible on the impact point or deep incipient cones located far from the retouch edge

As concern the assessment of the reliability of the selected diagnostic micro, meso and macroscopic criteria for the identification of microburin blow techniques, the results obtained by the blind test attests to a percentage of 93% for percussion and 71% for pressure/bending. Furthermore, it has shown how individual variability can affect the formation of some criteria. In particular, the identification of features originally related to the percussion by the Author and produced by A.P. through pressure/bending, such as abrupt transverse inclination, multiple impact points and well-developed polishes. Finally, it is important to highlight that a detailed analysis of our experimental microburins allowed to attest to a connection between notch lateralization and the modality used to produce geometrics, providing an important tool for reconstructing the number of microburins and geometrics obtained from a single blank.

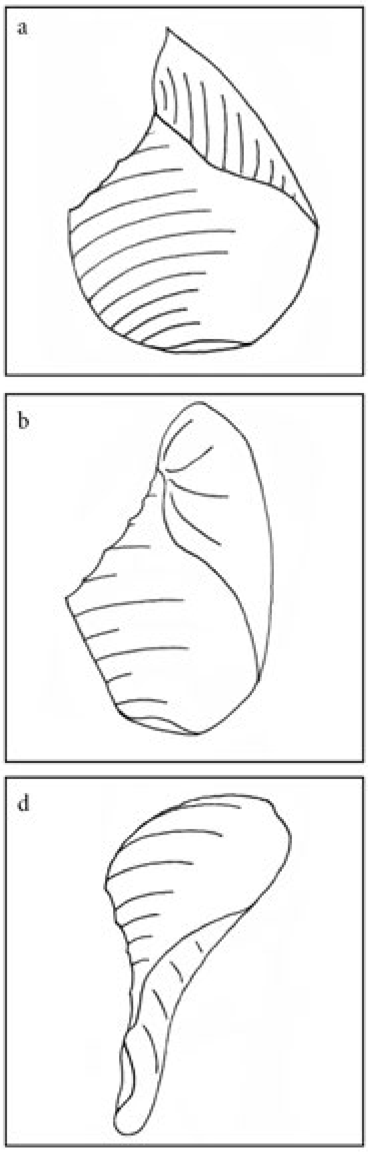


Figure 3.35 - Main microburin categories identified during experimentation.

3.2.3 3rd experimental activity

3.2.3.1. Experimental sets

Nodules belonging to the Maiolica Formation from the Gargano area were exploited. One single reduction sequence was adopted to produce bladelets and microbladelets using two different knapping techniques: soft stone and organic direct percussion. 30 elongated blanks characterised by thickness values between 1 mm and 3 mm were selected. Length and width were not taken into consideration for blanks selection. Before breaking blanks, a backed retouch was applied for achieving the transverse thickest point. Three main fracturing techniques were applied: one by percussion and two by bending (Tab. 3.28).

Percussion on an edge (Fig. 3.36 a):

Blank is blocked on an edge of an anvil with the ventral face downwards and an inclination around 10°-20 ° or parallel to the anvil surface. Its longitudinal axis was oriented diagonally (around 45°) or transversely compared to the edge. The blow is given perpendicular with respect to the blank in correspondence to the transverse thicker point of the blank. Two types of anvils were used: a boxwood log and a piece of antler.

Single foothold bending (Fig. 3.36 b):

Blank is positioned at the edge of an anvil with both the ventral and dorsal face downwards. Its longitudinal axis was oriented diagonally (around 45°) or transversely compared to the edge. The left-hand holds 2/3 of the blank placed on the anvil surface. The right-hand pushes down the extremity beyond the edge.

Double foothold bending (Fig. 3.36 c):

Blank is held directly on the palm of the hand. Fracture is achieved pushing on the middle of the blank (between two footholds) with an antler compressor.

Table 3.28 - Fracture technique applied.

	Number of artefacts produced
Percussion on an edge	25
Single foothold bending	25
Double foothold bending	10
total	60

In order to better define fracture morphology several dependent variables were taken into consideration (Fig. 3.37):

- fracture initiation (cone vs. bending)
- profile delineation (Fig. 3.37 a)
- profile inclination (Fig. 3.37 b)
- fracture termination *(languette* morphology) (Fig. 3.37 c, d)

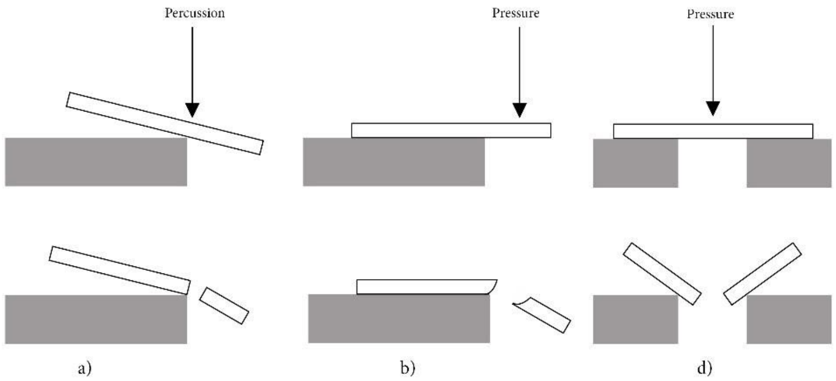


Figure 3.36 – Intentional fracture techniques applied during experimentation. a: percussion on an edge; b: single foothold bending; c: double foothold bending.

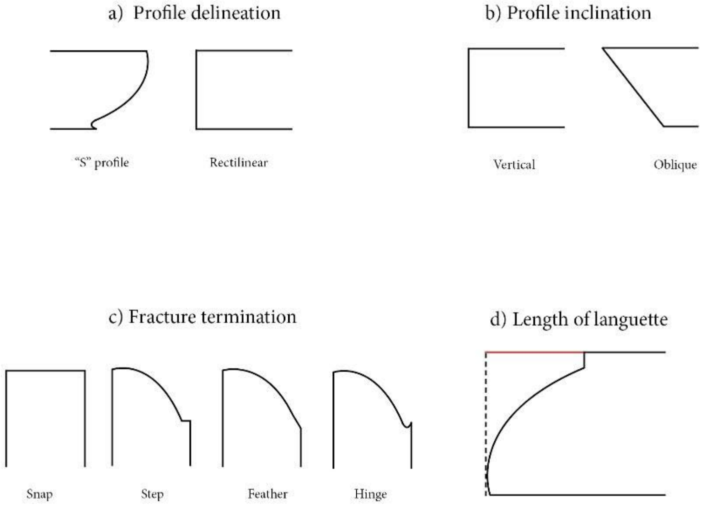


Figure 3.37 – Variables considered.

3.2.3.2. Results

Percussion on an edge:

It is an effective fracturing technique. Fractures orientation can be easily controlled depending on blank orientation with respect to the anvil edge. Fractures produced are both cone and bending. Cone fractures were generated when the blow targets the blank surface in correspondence of the anvil edge. By contrast, whether the blow targets the surface beyond the edge a bending fracture was obtained. Fractures related to this technique were divided into four main types:

- Cone fracture with secondary detachments (spin-off) that remove the impact point. The fracture profile has a S or slightly S delineation and an oblique inclination. *Languettes* of maximum 2 mm with a step or feather termination were attested (n=12).
- Cone fracture with visible impact point, a slightly S profile delineation and an oblique

profile inclination (n=7), rarely vertical (n=2).

- Feather or hinge terminating bending fracture with a S profile delineation and an oblique profile delineation. *Languettes* are not longer than 1 mm (n=3)
- Snap terminated bending fracture with a slightly S profile delineation (n=1)

Single foothold bending:

Although it was not always possible to control fracture orientation, it proved to be an effective fracturing technique. Fractures obtained are bending fractures that systematically start from the pushed surface developing towards the opposite one, whereas *languettes* run from the pushed portion to the blocked one. Only two *languettes* with an opposite development were recorded. Holding the blank on the anvil with the ventral surface facing down is more convenient for two main reasons: firstly, the ventral face has a more regular surface compared to the dorsal one giving a better stability during bending. Secondly, in case of blanks characterised by a slightly curved profile a smaller pressure is required to achieve the break. Fractures resulting by this fracturing technique are:

- Feather or hinge terminating bending fracture with a S profile delineation and an oblique inclination. *Languettes* have a length of maximum 1 mm (n=10).
- Snap terminating bending fracture with a slightly S profile and an oblique or vertical inclination profile (n= 11). Sometimes scars with a radial disposition from the thickest point of the blank (namely, where the fracture begins) are present (n=4). This latter must not be confused with cone fractures.

The fracture profile inclination (vertical or oblique) seems to be related to the blank profile and blank position (namely which surface is facing down). Slightly curved blanks handled with the ventral face facing down tend to produce fractures with an oblique profile inclination. On the contrary slightly curved blanks handled with the dorsal face facing down (which force to increase the pressure for achieving the break) or a rectilinear blank handled both with the ventral and dorsal face facing down tend to produce more vertical fracture.

Double foothold bending:

It is an ineffective fracturing technique since breakage orientation and location are not easy to control. Bending fractures start from the opposite surface with respect to where the pressure occurs. The only fracture type attested is a snap terminating bending fracture with a rectilinear or slightly S profile and a vertical inclination. When the profile is rectilinear (no *languette* formation) it is not possible to understand the fracture direction.

3.2.3.3. Synthesis

In conclusion two fracturing techniques other than microburin seem to be effective to produce controlled fractures and therefore suitable to blank length reduction during armatures manufacture: percussion on an edge and single foothold bending. The former tends to generate cone fractures with an S or slightly S profile delineation and an oblique inclination, whereas the latter creates snap terminating bending fractures with a slightly S profile delineation and an oblique or vertical profile inclination (depending on blank position and profile) and feather/hinge terminating bending fracture with S profile delineation and an oblique inclination. If intentional cone fractures are easier to identify in an archaeological sample, bending fractures resulting from intentional breakages are not so different compared to those attested during backing (see 1st experiment) or post-depositional process (e.g., Chesnaux, 2014; O'Farrell, 1996). The only feature that seems to be distinctive of intentional fracturing by a single fothold bending is a systematic absence of snap terminating bending fractures characterised by rectilinear profile. As we already mentioned, helding blanks with the ventral face down is the most convenient position to reach the break with this technique, but it produces a fracture with an oblique profile inclination forming an obtuse angle between the ventral face and the fracture surface. Consequently, this fracture can be resumed only by inverse retouches. The systematic use of inverse retouch to cover fractures may be a clue of an intentional fracturing by bending.

3.2.4. Methodology applied for the analysis of the archaeological series

3.2.4.1. Production methods

To reconstruct the production methods applied on archaeological armatures several quantitative and qualitative parameters were observed by naked eyes and through the use of a stereo-microscope with a magnification range between 0.63x and 3x (Optika SZN-T). Firstly, data concerning **blank selection** were recorded:

- *chaîne opératoire* sequence
- section
- profile
- blank category, i.e. microbladelets, bladelets or blades.

The distinction between different blank categories was carried out following specific length values (Fontana et al. 2015):

- blades: length higher than 59 mm.
- bladelets: length between 36 mm e 59 mm.
- microbladelets: length lower than 35 mm.

Thanks to the 1st experiment, it was possible to clarify some aspects concerning the variability of blank selection:

- depending on debitage techniques applied and the management of the core convexities (i.e. *cintrage* and *carenage*) thickness, width and length of a full debitage lamino-lamellar blank are positively correlated, (e.g., to a certain thickness corresponds a specific length and width interval).
- among them, only thickness tends to not change (or very little) during the manufacturing process, while length (except for backed bladelets) is systematically reduced.
- the width is the dimensional value mostly reduced by the backing process and therefore

it was not taken into consideration for blanks identification.

Following the above-mentioned criteria, we believe that the blank categories selected for produced armatures in each site can be defined by the comparison between the value of thickness comprised between the interquartile range of full debitage microbladelets, bladelets and blades and thickness values of armatures analysed. Obviously, also armature length was taken into consideration.

Depending on the armature types (backed points vs. backed bladelets vs. backed truncated bladelets vs. geometrics) some variations were applied: during the 1st experimentation, thanks to the comparison between the size of the original blank selected and the finished Epigravettian-like backed points a Length Reduction Index of around 15% was calculated (excluding pieces resumed after an accidental breakage). Therefore, in order to reconstruct the blank selection of these specific items we subtracted 15% (LRI) of length of each blank category. As regards other backed point types, geometrics and backed truncated bladelets any LRI were calculated thus a reconstruction of blank dimensional category is based only on the comparison between thickness value of finished armatures and lamino-lamellar full debitage blanks analysed by previous studies. Any specific reconstructing methods were applied for backed bladelets having a length equal to the original one.

Façonnage **and finished tool features** were also analysed:

- integrity
- size
- backed retouch localization, position, angle and extent
- order of removals
- main back and opposite edge delineation
- relation between backed edge and main dorsal ridge of blank selected
- backed retouch invasiveness as seen from the ventral face
- apex orientation
- presence and position of *piquant-trièdre*
- complementary retouches and truncations localization (basal, mesial or apical portion), position, angle and extent
- identification of morpho-typological categories

The relation between the backed edge and the main dorsal ridge was calculated according to the blank cross-section. If armatures come from triangular cross-section blanks, three cases were identified (Fig. 3.38):

- *Before*, the backed retouch stops before the achievement of the main ridge.
- *Adjacent*, the backed retouch is strictly close or achieves partially the main dorsal ridge.
- *Over*, the backed retouch oversteps the main dorsal ridge along the entire longitudinal axis. In this case the cross-section of the blank results indeterminable.

In the event of trapezoidal cross-section blanks variables increased (Fig. 3.39):

- *Before the 1st ridge*, the backed retouch stops before the achievement of the 1st ridge.

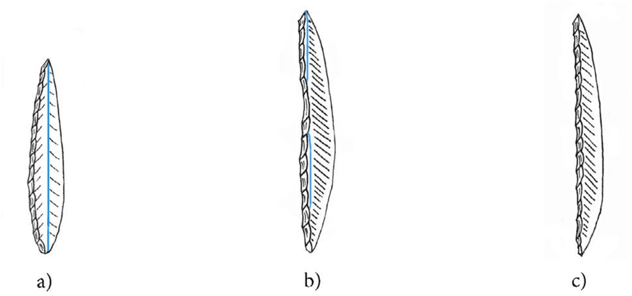


Figure 3.38 - The relation between the backed edge and the main dorsal ridge in case of triangular cross-section blank. a: Before; b: Adjacent; c: Over.

- *Adjacent to the 1st ridge*, the backed retouch is close to or achieves partially the 1st dorsal.
- *Over the 1st ridge*, the backed retouch oversteps the 1st dorsal ridge along the entire longitudinal axis.
- *Adjacent to the 2nd ridge*, the backed retouch is close to or achieves partially the 2nd dorsal ridge. Whether the backed retouch crosses the 2nd dorsal ridge the cross-section of the blank results indeterminable.

In case of backed points we also calculate the relation between the back and the main dorsal ridge during apex delineation. Five different variables were detected in triangular cross-section blanks (Fig. 3.40):

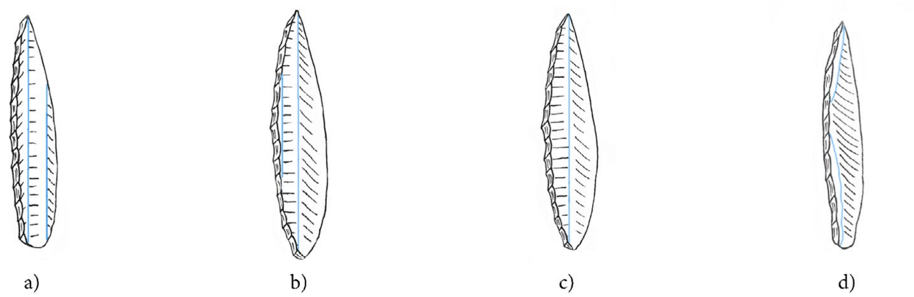


Figure 3.39 - The relation between the backed edge and the main dorsal ridge in case of trapezoidal cross-section blanks. a: Before the 1st ridge; b: Adjacent to the 1st ridge; c: Over the 1st ridge; d: Adjacent to the 2nd ridge.

- *Convergent*, the backed retouch and main dorsal ridge converge in the apical portion to shape up the tip.
- *Secant*, the backed retouch crosses the main dorsal ridge to shape up the tip over the ridge.
- *Before* the ridge, the backed retouch delineates an apex before joining the main dorsal ridge.
- *Over* the ridge, the backed retouch overstepped the main dorsal ridge along the entire longitudinal axis.
- *Break*, the backed points presented a fracture located in the apical portion.

While in trapezoidal cross-section blanks variables considered were (Fig. 3.41):

- *Convergent to the 1st ridge*, the backed retouch and the 1st dorsal ridge converge in the apical portion to shape up the tip.

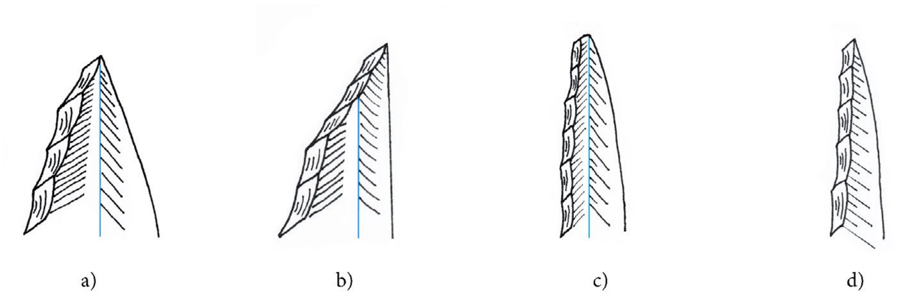


Figure 3.40 - Relation between the back and the main dorsal ridge during the apex delineation in case of triangular cross-section blanks. a: Convergent; b: Secant; c: Before; d: Over.

- *Convergent to the 2nd ridge*, the backed retouch crosses the 1st dorsal ridge and it converges with the 2nd ridge in the apical portion to shape up the tip.
- *Secant to the 1st and 2nd ridge*, the backed retouch crosses the 1st and 2nd dorsal ridge to shape up the tip over them.
- *Before the 1st ridge*, the backed retouch delineates an apex before joining the 1st dorsal ridge.
- *Break*, the backed points presented a fracture located in the apical portion.

To better comprehend the number and the order of retouch sequences adopted during the *façonnage* process, pieces under construction and backed fragments resulting from an unintentional breakage during shaping were included in the analysis. It is important to specify that with the term retouch sequence we intend a series of removals detached from the same side of the blank, with the same position (direct or inverse), following a specific direction (i.e. from the distal portion to the proximal portion or vice versa). A special attention was also given to resumed pieces and therefore to specific recycling processes.

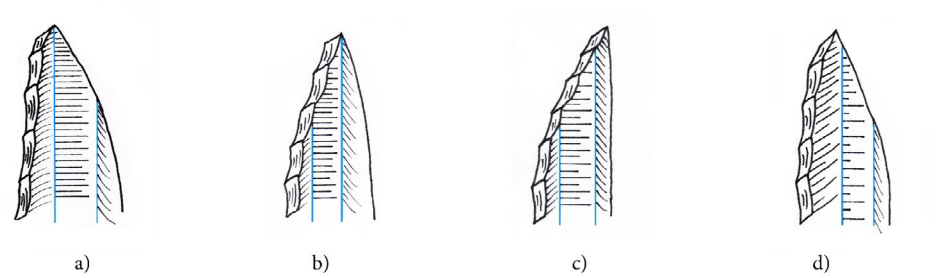


Figure 3.41 - Relation between the back and the main dorsal ridge during the apex delineation in case of trapezoidal cross-section blanks. a: Convergent to the 1st ridge; b: Convergent to the 2nd ridge; c: Secant to the 1st and 2nd ridge; d: Before the 1st ridge.

3.2.4.2. Fractures analysis

In order to identified fractures related to the backing process, the same parameters recorded on the experimental materials were observed on the archaeological ones :

- **initiation** (bending or cone)
- **termination (**snap, hinge, feather and step) (Fig. 3.5 e)
- ***languette* length** (Fig. 3.5 d)
- **direction**, i.e. fracture initiation and termination according to the retouch position: it can develop from the retouch platform towards the opposite surface, vice versa, or it can be indeterminable when any ripple or *languette* formation indicates a specific direction (Fig. 3.5 a)
- **orientation** according to the morphological axis of the blank: transversal or oblique (Fig. 3.5 b)
- **profile** (as seen from a lateral view), *"*S" or rectilinear delineation (Fig. 3.5 c)
- **inclination (**as seen from a later view**),** oblique or vertical (Fig. 3.37 b)

Although a dedicated experimental activity has not been conducted, a preliminary macroscopic use-wear analysis aimed at identifying diagnostic impact fractures (DIF) was also developed. Specific terms are used for the description of fractures and to avoid terminological ambiguity (Coppe and Rots, 2017) we define them here. Generally, the fractures classified as diagnostic of projectile implements since the early studies were those characterised by a secondary detachment along a surface (i.e. spin-off/bifacial spin-off) or along a lateral edge (i.e. burin-like spin-off), as well as step terminating bending fractures (Fischer et al., 1984; O'Farrell, 1996; Odell and Cowan, 1986). Nevertheless, also hinge- and feather-terminating bending fractures were considered diagnostic by several researchers (Caspar and De Bie, 1996; Lòrene Chesnaux, 2014b; Lazuén, 2012; Sano, 2009; Sano and Oba, 2015). Fractures called "burinations'' (burin-like family) attributable morphologically to a burin detachment and characterised by an initiation from a surface or an edge, instead of a previous fracture (as burin-like spin off), have to be added (Odell and Cowan, 1986; Sano, 2009). In this work spin-off, burin-like spin-off, burination and step, hinge and feather terminating bending fractures were considered as diagnostic only when secondary detachments or *languettes* are longer than 3 mm. The only exception regards the Sauveterrian armatures of Mondeval de Sora. In this specific case the length limit is set at 2 mm, following the results obtained by L. Chasnaux (2014) during her PhD. If bending fractures start from the back and developing towards the cutting edge or vice versa the adjective "transverse" was added (e.g., step terminating transverse bending fracture).

Scars diagnostic of project implements are fractures along a sharp edge that remove part of the dorsal or ventral surface, oriented either obliquely or perpendicularly to the longitudinal axis of the armature. Generally, these are considered diagnostic only when associated with other DIF types. According to several Authors (Chesnaux, 2014a; Gassin, 1996) these can be characterised by a step or a hinge termination, while by others (e.g. Yaroshevich et al., 2010) they can be considered indicative of hunting activity only if presenting a step termination.

With the term “indeterminable fractures” we define multiple fractures not attributable to those previously mentioned while “knapping fractures” are unintentional breakages (in the proximal portion) occurred during the debitage and therefore prior to the back reduction.

3.2.4.3. Retouch techniques identification

The workflow established to reconstruct retouch techniques involves the systematic application of a low-power approach with a range of magnification between 0.63x and 3x for the totality of the artefacts included in this project. Because of the high investment of time required, the high-power approach is applied to a selected sample of artefacts from Riparo Tagliente and Mondeval de Sora, whereas the quantitative analysis is applied to a small collection from Riparo Tagliente. The aim is to evaluate if results obtained by a low-power approach are confirmed or not by the quantitative and high magnification analysis.

3.2.5. Location of the activities

The experimental activities along with analysis at low magnification of Italian archaeological materials was conducted at University of Ferrara. Armatures from the site of Troubat were studied at the SRA (Services Régionaux de l’Archéologie) of Toulouse, whereas those from Pont d’Ambon at the National Museum of Prehistory of Les Eyzies. The high-power approach and the quantitative analysis were mainly developed at the Sapienza-University of Rome in collaboration with the DANTE laboratory.

Part 2 – Analysis of archaeological series

Chapter 1 - Pont d'Ambon

1.1. Site introduction

Pont d'Ambon is a rock-shelter (Fig. 1.1 a) located in northern Périgord (Bourdeilles, Dordogne). It opens on the bank of the Dronne river in a region extremely rich in Palaeolithic evidence. Discovered in 1970 and excavated during the entire 70s and 80s by Guy Célérier, Pont d'Ambon rapidly became a key site for the reconstruction of human occupation during the Late Glacial (Célérier, 1998). The deposit covers the span of time between the last part of GS-2 and the beginning of the Early Holocene throughout four main cultural traditions: Upper Magdalenian, Early Azilian, Late Azilian and Early Laborian (Tab. 1.1).

The site has been investigated on a surface of approximately 25 m^2. Unfortunately, the southern zone of the sheltered area has been removed by illegal excavations. As claimed by G. Célérier, the stratigraphy, composed by successive Palaeolithic occupations without visible interruption, was not always easy to understand due to important lateral variations and the high density of archaeological material (Célérier and Moss, 1983). From a sedimentary viewpoint, the deposit can be divided into four main phases (Célérier, 1998; Célérier and Moss, 1983) (Fig. 1.1 b):

- The Lower Unit (layer 6, 5 and 4) is composed of thin anthropic levels related to short human occupations dated to the Upper Magdalenian (layer 6, 5, 4 *inferieur*) and Early Azilian (layer 4 *médiane*, 4 *supérieur*).
- The Middle Unit (layer 3B and 3A) is characterised by a thickness of 40 cm. The transition with the previous phase is abrupt due to a clear change in colour (dark grey brown with yellow and reddish-brown spots) and matrix (silty-sandy clay). The distinction between layer 3B (referred to the Early Azilian) and 3A (referred to the Late Azilian) was based on the presence at the top of layer 3B of thin lenticular levels composed by fine alluvial sands.
- The Upper Unit (layer 3 and 2) is formed by a silty-sandy clay matrix mixed to coarse breccia that increases in frequency and size going up the sequence. The Upper part of SU 3 yielded several overlapped hearth-pits. Layer 3 is dated to the Late Azilian, whereas layer 2 to the Early Laborian.
- The Terminal Unit is divided into two parts. The lower one (layer 2x, 0+), composed by a sediment with abundant snails (*Helix*) and micro-mammals remains (the lithic industry contains few geometrics) and the upper one (layer sur. 2, 0), formed by a clay matrix sediment. Artefacts (fragments of ancient and modern pottery) are few and in a reworked position.

During the last 50 years Pont d'Ambon has been investigated through a multidisciplinary approach. Studies focused on paleoenvironmental reconstruction (Célérier, 1994; Marquet, 1989; Paquereau, 1979; Puisségur, 1976) revealed many climate variations along the sequence, but results were often in contradiction to each other and the chrono-climatic framework of the site remains in some case uncertain. Among the hunted preys, rabbit and fish are dominant all along the sequence (from layer 4 médiane to layer 2). As regards large mammals, in layers 4 *médiane* and *supérieur*, 3B, 3A and 3 ungulates are dominated by red deer, roe deer and wild boar, suggesting the development of a deciduous forest. Few reindeer remains come from the base of layer 4. Layer 3 records an increase of horse and auroch which become dominant in layer 2. These two species indicate the establishment of a more open environment (Célérier, 1994; Célérier et al., 1999; Cravinho, 2009; Delpech, 2018, 1975; Jones, 2009; Le Gall, 1982). Regarding the seasonality of site occupation, data from red deer and fish shows that terrestrial hunting occurred all seasons, whereas fishing exclusively during spring and summer. Pont d'Ambon yielded a modest assemblage of bone tools (Célérier, 1996) as well as artistic objects (Célérier, 1998; Paillet et al., 2018, 2013). Lithic artefacts were analysed through a techno-functional viewpoint (Célérier, 1998, 1993; Célérier and Moss, 1983; Célérier and Jacquement, 2005).

Table 1.1 - Radiocarbon dates

Stratigraphic Unit	BP	Cal BP (2 sigma 95.4% probability)	Lab. Code	Facies	References
6, 5, 4 Inf.	-	-	-	Upper Magdalenian	-
4 Med., 4 Sup.	12840± 220	16006-14787	Gif - 3369	Early Azilian	Célérier, 1998
3B	12130±160	14225-13714	Gif - 3739	Early Azilian	Célérier, 1998
	11600±120	13876-13242	Gif - 7223		
3A	11330±70	13320-13101	Ly 6431	Late Azilian	Fat Cheung et al., 2014
3	10350±190	12677-11048	Gif - 3368	Late Azilian	Célérier, 1998
	9990±120	12427-10476	Gif - 3561		
2	10730±100	12848-12588	Gif - 99102	Early Laborian	Célérier, 1998
	9640±120	11804-10366	Gif - 3740		Pionnier-Capitan et al., 2011
	10130 ± 40	11935-11605	Beta411309		Boudadi-Maligne et al., 2018

1.2. Composition of the studied sample

Armatures analysed are a selected sample of 574 pieces. It corresponds to the totality of complete and almost complete armatures belonging to layers 3B, 3 and 2 and to a collection of complete/almost complete backed points from layer 3A. For each stratigraphic unit examined a series of backed fragments have been analysed aimed at identifying fractures related to manufacture and to the use as projectile implement (Tab. 1.2). In order to highlight differences along the stratigraphic sequence, results of the technological analysis were presented following the cultural attribution of each layer.

The raw material exploited is mainly local. It belongs to the Upper Cretaceous *Santonien* and *Campanien* formations (Célérier 1993; 1998). The preservation state of the analysed sample is excellent. Only a low percentage of artefacts is thermally altered (4%) or patinated (1%). In the past armatures were studied by C. Célérier from a morpho-typological perspective

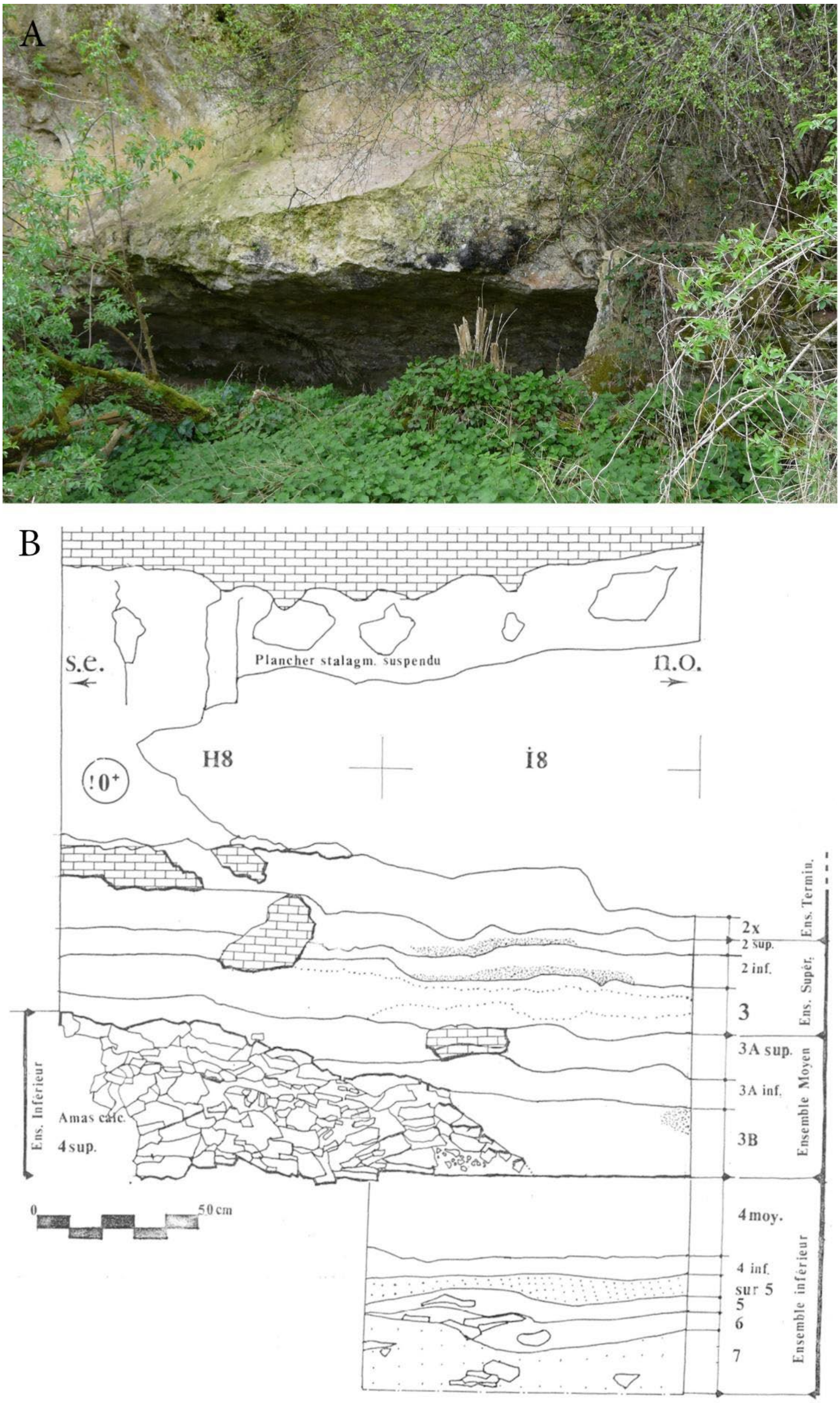


Figure 1.1 – A: Pont d’Ambon rock-shelter; B: stratigraphic sequence.

(Célérier, 1998, 1993a, 1993b, 1979) and a sample of them by E. H. Moss (Célérier and Moss, 1983) and P. Jacquement (Célérier and Jacquement, 2005) from a functional one.

Table 1.2 - Total armatures analysed according to stratigraphic layer.

Layers	Total artefacts
3B	146
3A	146
3	56
2	226
Total	574

1.2.1. Layer 3B - Early Azilian

Two main types of backed points were observed in layer 3B: curved-backed bipoint and curved-backed monopoint (Fig. 1.2; Tab. 1.3). When a major break did not allow to understand the original morphology a third type called curved-backed bipoint/monopoint was included. Except for the presence of a double apex, any significant differences in production modalities have been observed between these two morpho-types. For this reason data are displayed according to the entire backed points assemblage.

Table 1.3 - Composition of the archaeological assemblage from layer 3B.

	n
Curved-backed bipoints	29
Curved-backed monopoints	30
Curved-backed bipoints/monopoints	16
Pieces under construction	70
Fragments	69
Preforms	1
Total	146

1.2.1.1. Blank selection

Early Azilian backed points are mostly produced from full debitage lanimo/lamellar blanks. Only a few naturally backed blanks were recorded. In accordance with unretouched full debitage products (Célérier, 1993a), profiles are slightly curved (43,24%), sometimes twisted (17,11%), whereas less frequently perfectly rectilinear (30,26%). The cross-section is more often triangular rather than trapezoidal and it is always fairly flat. Although cores with two opposite striking platforms were attested in layer 3B (Célérier, 1998), 72 out of 76 backed points show unidirectional negatives on their dorsal face. The thickness is moderately calibrated along the morphological axis and tends to vary between 3-4 mm (Tab. 1.8; Figure 2.2 n. 6 and 9). Thanks to the analysis of pieces abandoned during construction, width of selected blanks seems to range between 8 mm and 20 mm. The majority of debitage products have a width between 12 mm and 30 mm, whereas those with a width of 8-12 mm reach a percenta-

Figure 1.1 – Late Azilian Backed points from layer 3B. 1-5: curved-backed bipoints; 6-9: curved-backed mono-points.

ge of only 15% (Célérier, 1998, 1993a). According to C. Célérier (1998): « *cette classe reste très largement sous-représentée par suite des difficultés à prendre en compte les supports des pointes aziliennes.* ».

The variability in the blank dimensional category shown by Table 1.4 is emphasised by the artificial subdivision between blades (length > 59 mm) and bladelets (length comprises between 35 mm and 59 mm). Actually, products transformed in projectile points have homogeneous length varying between 50 mm and 70 mm. These values are similar to the class length mainly sought-after by Early Azilian knappers which correspond to 60-80 mm (Célérier, 1993a) .

Table 1.4 - Blank dimensional categories selected for Early Azilian backed points production. Backed fragments are excluded.

	n	%
Microbladelets	1	1.32
Bladelets	28	36.84
Blades	24	31.58
Microbladelets/bladelets	1	1.32
Bladelets/blades	19	25,00
Laminar flakes	3	0,88
Total	76	100

1.2.1.2. Retouch methods

1.2.1.2.1. Backed retouch

The retouch process aims at shaping one or two apexes by the convergence of a curved back and a rectilinear cutting edge. The latter is rarely slightly convex or irregular. The type of retouch applied (Tab. 1.5) strongly depends on the width and thickness of blanks selected. The former influences the retouch deepness (marginal or deep), whereas the latter affects retouch position (direct or crossed). In case of narrow blanks (< 12 mm) the backing process is performed by a marginal retouch in the mesial portion and two oblique and deeper retouches on the extremities in order to shape two apexes (curved-backed bipoints), or a single apex and a base (curved-backed monopoint) (Fig. 1.3 n.1). In few artefacts the mesial portion is left untouched. In case of wider blanks the backing process becomes deeper all along the edge (Fig. 1.3 n. 2), even though it rarely reached the half of the original blank width. In fact, the back stops before the main dorsal ridge in triangular cross-section blanks and it is over the 1st dorsal ridge in trapezoidal cross-section ones (Tab. 1.6; Fig. 1.4). The few backed points showing a back located over the main dorsal ridge (Tab. 1.6) result from the selection of lamino-lamellar products characterised by an off-centre ridge or a naturally backed edge. In this case the back retouch is located on the closest side to the main dorsal ridge, leaving the sharper edge untouched.

Table 1.5 - Retouch extent, position and angle along the entire back. Backed fragments are excluded.

	n	%
Deep direct abrupt	202	26.32
Deep direct semi-abrupt	1	1.32
Deep crossed abrupt	48	63.16
Marginal direct abrupt	4	5.26
Marginal crossed abrupt	3	3.95
Total	76	100

Table 1.6 - Relation between back and main dorsal ridge in the mesial portion according to cross-section blank. Backed fragments are excluded.

Triangular/unidentified	n	%
Before the ridge	27	49.09
Adjacent to the main ridge	7	12.73
Over the main ridge	13	23.64
N.D.	1	1.82
Total	55	100
Trapezoidal	n	%
Before the 1st ridge	4	19.05
Adjacent to the 1st ridge	2	9.25
Over the 1st ridge	13	61.90
Adjacent to the 2nd ridge	1	4.76
N.D.	1	4.76
Total	21	100

In order to evaluate the location of inverse retouches, the back was divided into three areas: apical, mesial and basal (i.e. not pointed extremity). In doing so, it becomes evident that a crossed retouch is linked to two specific zones, the apical and mesial one, reflecting two different technical aspects (Tab. 1.7):

- inverse retouches on the apex are applied once the back crosses the main dorsal ridge on triangular cross-section blanks or the 2nd dorsal ridge in trapezoidal cross-section ones and only when the back is thicker than 3 mm. Its role is to thin the tip by detaching a series of small flakes aimed at lowering the dorsal line (Fig. 1.3 b-c). In fact in cases of thinner apexes, which are naturally more pointed, any inverse retouch was applied (Fig. 1.3 a). In confirmation of this observation there is an evident difference in thickness between apexes produced by a crossed retouch (3,7 mm) and those produced by a direct one (2,3 mm)
- the use of an inverse retouch on the mesial portion is less frequent (28,79%) and related to the need to remove protuberances and irregularities formed during the direct retouch. Normally they are applied once the back overpasses one of the main dorsal ridges because the angle between the back and dorsal surface becomes of 90° or less.

The base is hardly ever shaped by a crossed retouch (6,45%; Tab. 1.7), even if it is characterised by a significant thickness.

The backed retouch is generally deeper in the proximal portion in order to remove the butt and the bulb, while can be more variable on the distal extremity according to the artefacts length desired. Moreover, as observed also by other Authors in different sites (e.g., Valentin, 2006), both curved-backed monopoint and bipoints have a slightly asymmetric back (Fig. 1.5). Considering only curved-backed monopoints, the apex is more frequently located on the distal portion (67,74%) compared to the proximal one (32,26%).

The selection of homogeneous blanks and a back delineation fairly normalised leads to a high standardisation in all the three dimensions (length, width and thickness; Tab. 1.8). Backed

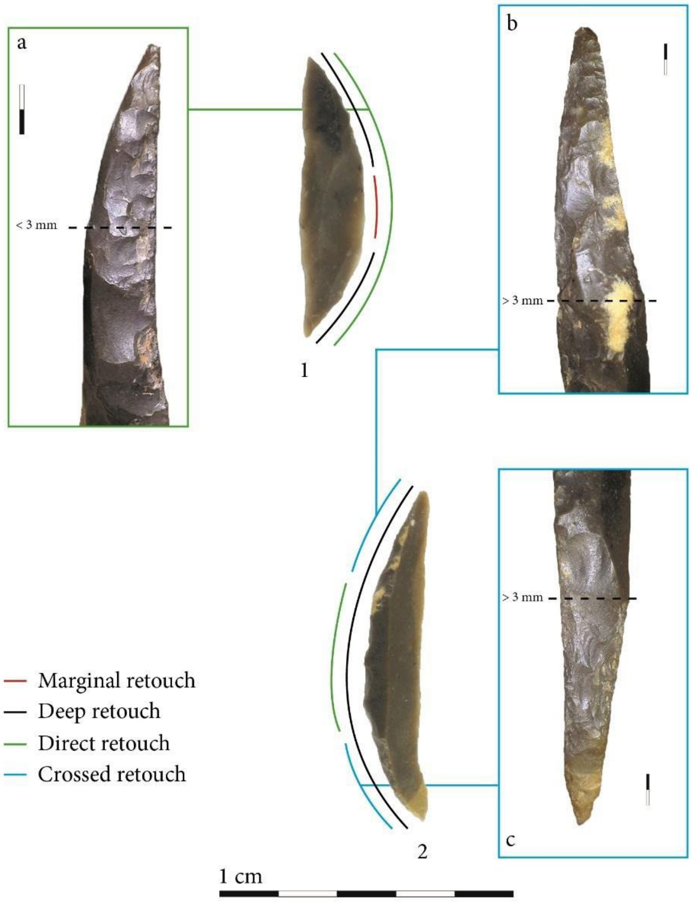


Figure 1.3 - Retouch methods. 1: backed point produced by a marginal (on the mesial portion) and deep (on the two extremities) direct retouch; 2: backed point thicker than 3 mm produced by deep and crossed retouch; a: apex thinner than 3 mm shaped by direct retouch; b, c: apex thicker than 3 mm shaped by a crossed retouch.

points length varies between 30 mm and 59 mm (interquartile range: 41-49 mm), width between 8 mm and 15 mm (interquartile range: 9-11 mm) and thickness between 2 mm and 6 mm (interquartile range: 3-4.25) (Fig. 1.6).

Table 1.7 - Inverse backed retouches localization.

Localization of inverse retouches	n	%
Pointed portion (apex)	49	68.06
Not pointed portion (base)	2	2.78
Mesial portion	20	27.78
N.D.	1	1.39
Total	70	100

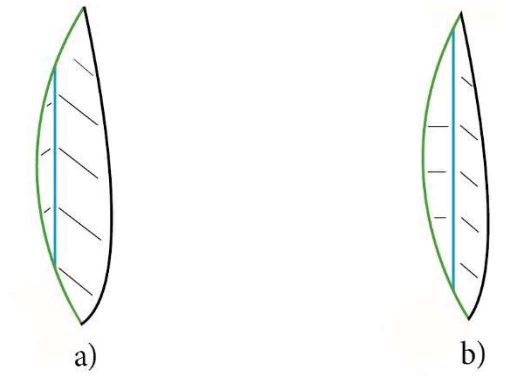


Figure 1.4 – Relationship between the back (green line) and the dorsal ridges (blue line). a: in a triangular cross-section blank the back is located before the main dorsal ridge in the mesial portion and it crosses this latter in both extremities to shape out a tip and a base or a double tip; (b) in a trapezoidal cross-section blank the back is over the 1st dorsal ridge, whereas the apex(s) and the base are both delineated by crossing the 2nd dorsal ridge.

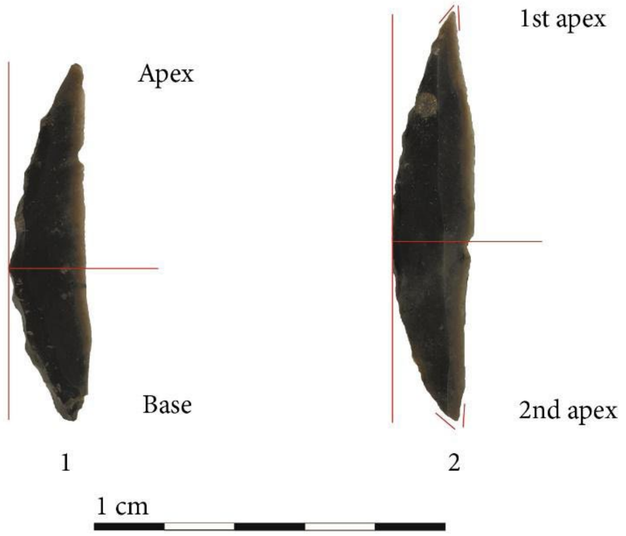


Figure 1.5 – The same asymmetric delineation of the back in both curved backed monopoints (1) and curved backed bipoints (2). In curved back bipoints this asymmetry allows to shape an acute apex (1st apex) and larger one (2nd apex).

Table 1.8 - Backed points dimensional classes of length, width and thickness. Backed fragments are excluded.

	Len.	Wid.	Th.
Min. value	30	8	2
1st quartile	41	9	3
Median	43	10	4
Medium value	44.03	10.21	3,8
3rd quartile	49	11	4.25
Max. value	59	15	6
SD	5.996	1.441	0.900
Total	57	66	76

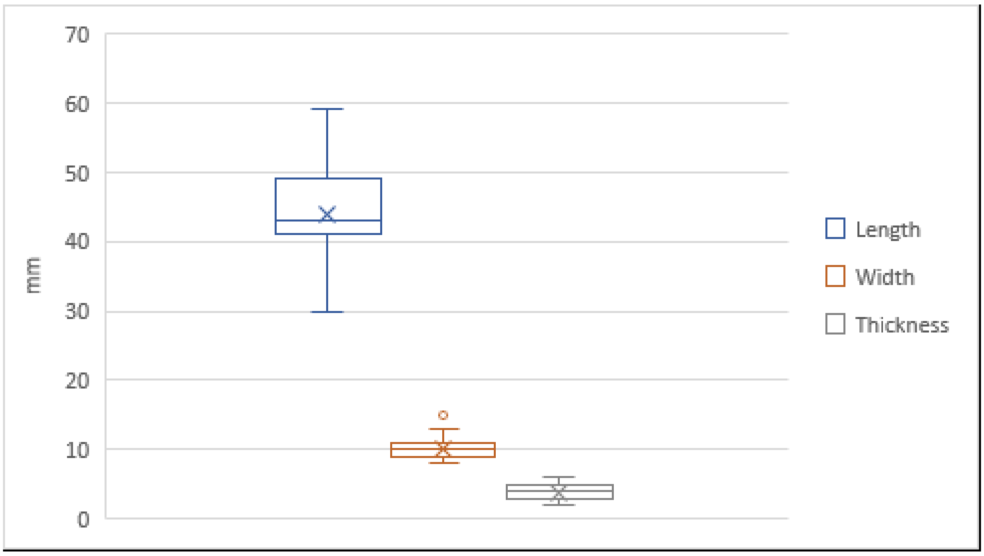


Figure 1.6 – Backed points size.

1.2.1.2.2. Complementary retouch and truncations

An additional retouch phase for modifying the cutting edge or to shape a basal truncation is extremely rare. This is due to the regularity of blank edges that do not need to be adjusted by complementary retouches. Only five backed points have a semi-abrupt direct and marginal complementary retouch on the apex or on the base. Five artefacts present a convex basal truncation. Although they could be the result of mixing process with the overlying level dated to the Late Azilian (3A), the regularity of blanks selected and the retouch technique adopted point to an attribution to the Early Azilian. One of them has a truncation that partially covers a previous fracture.

Other 16 backed points belonging to layer 3B are characterised by an oblique basal truncation. They were excluded from the analysis because of their strong morphological and technological similarities with Late Azilian monopoints of layer 3A.

1.2.1.3. Pieces under construction

Artefacts considered as pieces abandoned during the backing process were divided into two main categories: those discarded due to an unintentional breakage (n=69), and those (n=1) showing an unfinished shape. All types of fracture belong to the first category are presented in Table 1.9. Almost half of them are Krukowski microburins. The enormous disparity between distal and proximal Krukowski microburins depends on two factors:

- the difference in thickness between distal and proximal portions. As a matter of fact, an accidental Krukowski microburin occurs more easily on thinner extremities
- a blank more often blocked by holding the butt and the bulb with one hand while retouching the distal and mesial portion

Table 1.9 - Diagnostic backing fractures identified.

Type of fracture	n
Cone fractures	9
Cone fractures associated to a *piquant-trièdre*	5
Snap terminating bending fractures	21
Fractures generated by an overshot retouch flake	1
Krukowski microburins	33
Distal apical	7
N.D. apical	4
Distal	13
Proximal	2
Mesial	1
N.D.	6
Total	69

Interesting is the presence of 6 artefacts with a snap terminating bending fracture (often on the proximal portion) opposite to the retouched extremity (e.g., Fig. 1.7 n. 2, 3 and 6). These fractures may be related to the pressure of the fingers while holding the blank during manufacture, rather than the contact with the retoucher.

Observing all pieces abandoned under construction, some hypotheses concerning retouch sequences adopted during the shaping phase were formulated. The backing process normally starts from the apex (frequently on the distal portion) and progressively advances towards the opposite extremity (Fig. 1.7 n. 1-4 and 6). Sometimes the first apex is shaped by a crossed retouch before modifying the base or the second apex (Fig. 1.7 n. 6). Then the backing process can continue through a single sequence of removals (Fig. 1.7 n. 4) or by a second retouch sequence from the opposite extremity towards the mesial portion (Fig. 1.7 n. 5).

1.2.1.4. Retouch techniques

1.2.1.4.1. Low-power approach

The analysis of 574 items through a stereomicroscope allows to confirm the application of at least two main backing techniques: soft stone percussion on anvil and pressure by soft stone (Fig. 1.8 and 1.9). Their frequency is related to the size and morphology of the original

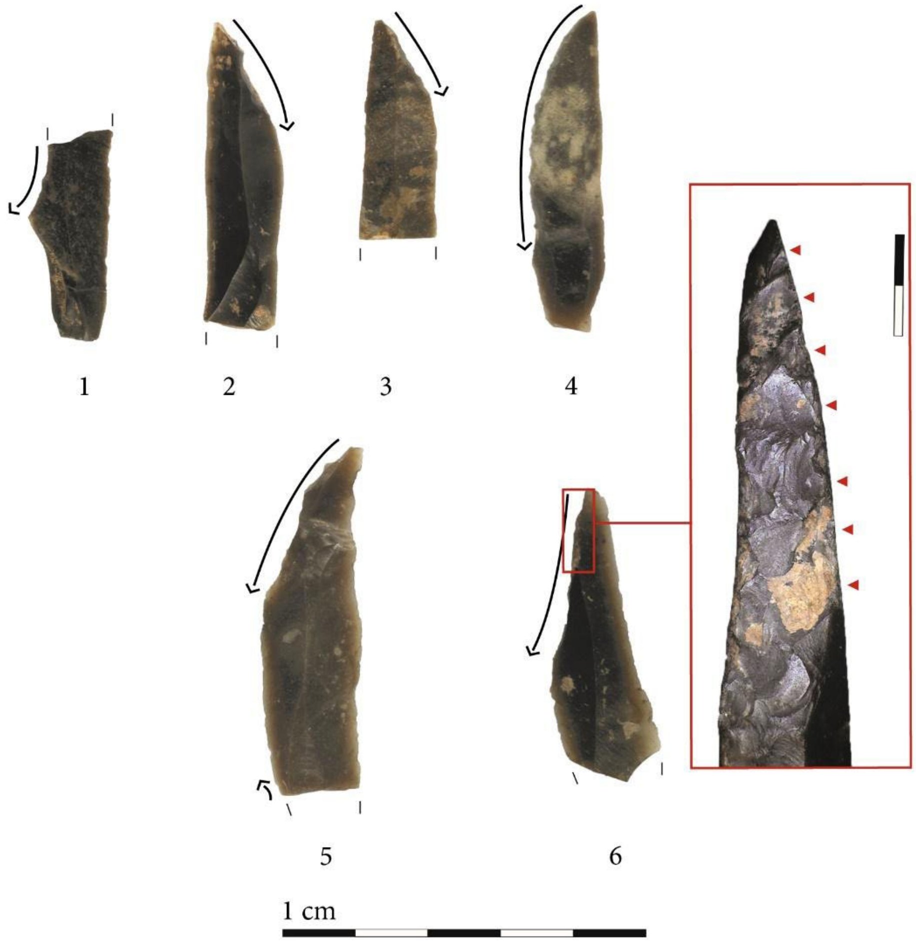


Figure 1.7 – Pieces abandoned during construction. 1-4, 6: the backing process starts from the apex and progressively advances towards the opposite extremity. 5: two independent sequences, the first one from one extremity, the second one from the other.

blank and to the operational step to be carried out. Soft stone percussion on anvil was generally employed to modify thicker and larger blanks that need to be significantly reduced to achieve the sought-after morphology. By contrast pressure by soft stone was applied to shaped thinner and narrower blanks by a less invasive direct retouch. The evidence concerning the use of an organic retoucher is more enigmatic and uncertain. Only few items present a fresh edge with residual indentations (although being not particularly marked) typical of pressure with an organic tool.

An important percentage of artefacts were retouched by alternating soft stone percussion on anvil and pressure by soft stone. As shown in Figure 1.9, the percussion was mainly employed on the mesial portion, while the pressure to point the apex. The latter represents the most delicate operational step and the use of a percussion technique can easily compromise the entire manufacturing process. This mixed technique has a major practical advantage allowing it to easily switch from percussion to pressure without the need to change the retoucher.

This dichotomy between thin blanks modified through pressure and thick blanks modified through percussion is also confirmed by backing fractures. Snap terminating bending fractures (mainly generated by a pressure technique as seen during the 1st experimental session), are associated with blanks that vary between 1 mm and 3 mm of thickness. On the contrary, cone fractures (mainly generated by a percussion technique as seen during the 1st experimental session) are presented on blanks ranging between 3 mm and 7 mm. Moreover, the fact that cone fractures (in *sensu strictu*) are mostly generated by a direct blow confirm the sporadic use of soft stone percussion on anvil for applying inverse retouches.

1.2.1.5. Diagnostic impact fractures

Macroscopic use-wears diagnostic of projectile function have been detected on a total of 30 artefacts (Tab. 1.10): 9 are curved-backed bipoints, 8 are curved-backed monopoints and 13 are generic fragments (six are mesial). Curved-backed bipoints show fractures removing small portions of one or both tips. They are burination starting from the cutting edge (Fig. 1.10 b) and feather or step terminating bending fractures initiate from a surface (ventral or dorsal face), the cutting edge (Fig. 1.10 e) or even the back (Fig. 1.10 a). Edge scars develop towards the larger apex with an oblique direction, suggesting a specific orientation of projectiles on the

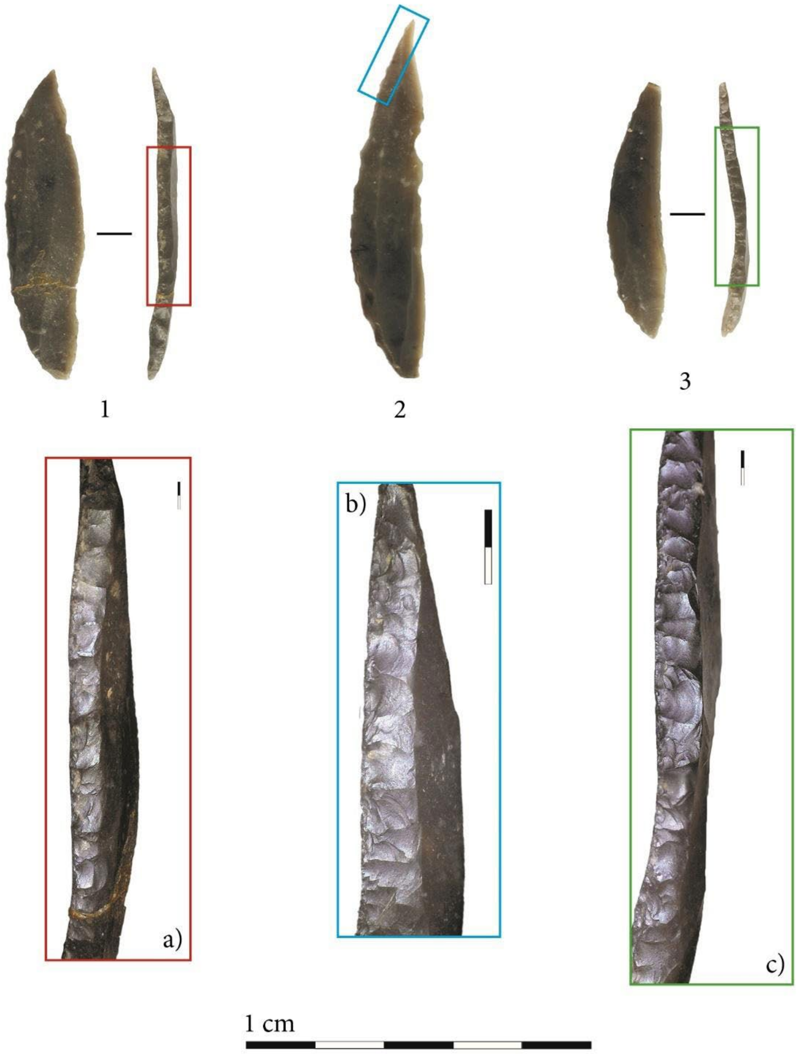


Figure 1.8 - 1-3: backed points produced by pressure by soft stone. a-c: detail of a regular sequence of removals associated to a slightly rounded edge.

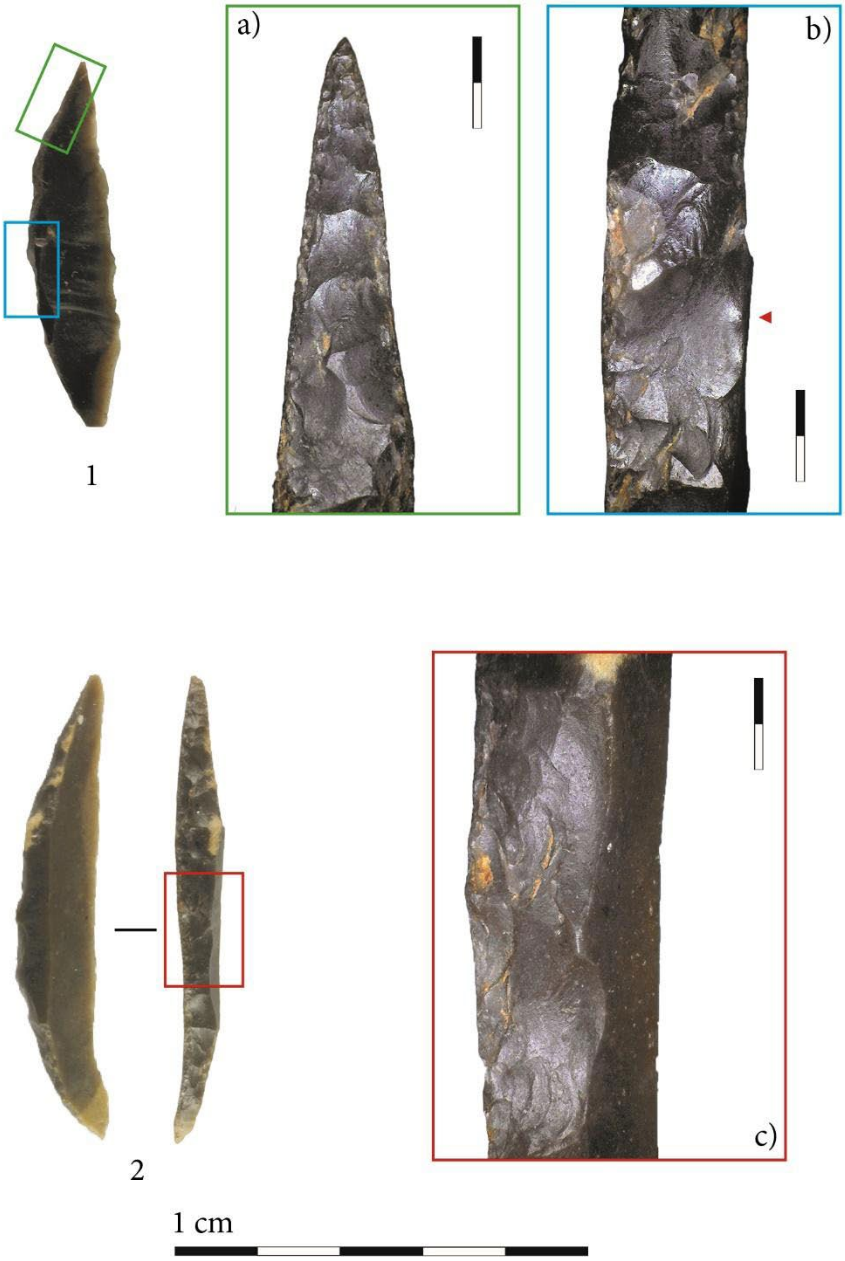


Figure 1.9 – 1-2: backed points produced by alternating pressure by soft stone to shape apexes (a) and soft stone percussion on anvil to reduce the mesial portion (b-c). The red triangle indicates a little bulb formed by the recoil effect of the anvil.

shaft, namely with the acuter apex on the top (Fig. 1.10 c, d).

The high percentage of fractures initiating from the functional edge that remove the tip are generally interpreted as diagnostic of an oblique latero-distal position (e.g., Yaroshevich et al., 2010) confirming the hafting method previously proposed by H. Plisson (2005) at Boit Ragot (layer 4). The Author based on MLIT's orientation advised a latero-distal position of the projectile point with a perforating apex on axis with the shaft and a lateral apex playing both a retentive and cutting role. As regards curved-backed monopoints, the presence of the same types of fractures on the tip (Fig. 1.10 g) and the base (Fig. 1.10 f) compared to curved-backed bipoints suggests a similar hafting method also for this type.

Table 1.10 - Diagnostic impact fractures according to backed point type.

Curved-backed bipoints	**n**
Feather terminating bending with *languette* ≥ 3 mm	2
Step terminating bending with *languette* ≥ 3 mm	3
Feather terminating transverse bending with *languette* ≥ 3 mm (starting from the back)	1
Step terminating transverse bending with *languette* ≥ 3 mm (starting from the cutting edge)	1
Burination ≥ 3 mm (starting from the cutting edge)	2
Edge scars	6
Total fractures	**17**
Curved-backed monopoints	
Apex	
Step terminating bending with *languette* ≥ 3 mm	1
Feather terminating transverse bending with *languette* ≥ 3 mm (from the back)	1
Step terminating transverse bending with *languette* ≥ 3 mm (from the back)	1
Burination ≥ 3 mm (starting from the cutting edge)	1
Burin-like spin-off ≥ 3 mm	1
Base	
Step terminating transverse bending with *languette* ≥ 3 mm (from the cutting edge)	2
Burination ≥ 3 mm (starting from the cutting edge)	1
Edge scars	3
Total fractures	**11**
Backed fragments	
Step terminating bending with *languette* ≥ 3 mm	3
Step terminating transverse bending with *languette* ≥ 3 mm (starting from the cutting edge and the back)	3
Feather terminating bending with *languette* ≥ 3 mm	1
Feather terminating transverse bending with *languette* ≥ 3 mm (starting from the cutting edge)	1
Burin-like spin-off ≥ 3 mm	9
Edge scars	4
Total fractures	**21**

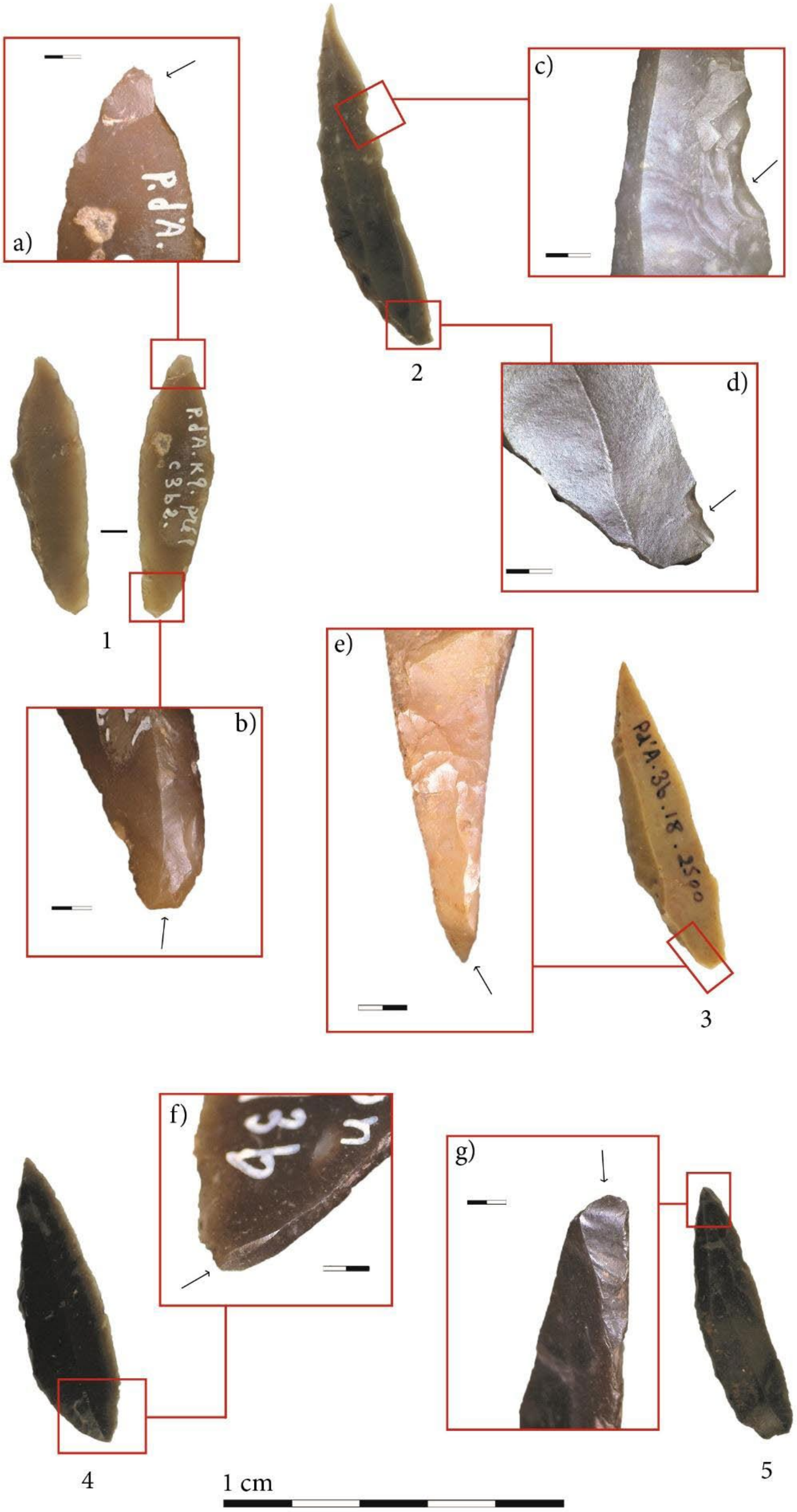


Figure 1.10 - Diagnostic impact fractures. 1-3: bipoints; 4-5: monopoints. a: step terminating transverse bending fractures starting from the back; b: burination starting from the cutting edge; c-d: edge scars; e: step terminating transverse bending fractures starting from the cutting edge; f: burination starting from the cutting edge (as seen from the ventral face); g: feather terminating transverse fractures starting from the back.

1.2.2. Layer 3A and 3 - Late Azilian

The morpho-scopic analysis was conducted on 141 backed points and 59 pieces abandoned under construction (Tab. 1.11). Only two backed bladelets were identified. By considering finished backed points, 70,95% are complete, 23,65% are almost complete, whereas 5,41% have a major breakage that removes at least 2/3 of the original length. To highlight possible divergences in armatures production in a diachronic perspective, results of the technological analysis were presented by comparing layer 3A (dated to the Allerød) and layer 3 (dated to the Younger Dryas).

Table 1.11 - Armatures assemblage analysed from layer 3A and 3.

	3A	3
	n	n
Backed points	95	46
Backed bladelets	-	2
Pieces under construction	51	8
Fragments	44	4
Preforms	7	4
Total	146	56

1.2.2.1 Blank selection

Late Azilian backed points are manufactured from a wide blank array that involves micro-bladelets, bladelets, blades, laminar flakes and flakes (Tab. 1.12). Among them, even though full debitage products are the most attested blanks, a large set of elongated by-products were selected, such as semi-cortical blanks, naturally backed blanks, on edge blanks (thick blade/bladelets with a triangular cross-section) or even surface maintenance blanks. It is important to highlight that the significant reduction process that generally affects Late Azilian backed points can cause uncertainty in both the blank dimensional category and the blank type.

Blank profiles are mostly straight (>50%), sometimes slightly curved. Cross-sections are mainly triangular (>50%) and negatives of the dorsal face prove the exploitation of blanks flaked through unidirectional sequences. Proximal portions not removed by the retouching phase show pronounced bulbs and large and plain butts with an unprepared overhang. In some pieces an incipient cone diagnostic of a direct percussion with a hard stone hammer was observed.

A large part of the blanks exploited is characterised by uneven edges and a thickness poorly calibrated along the morphological axis. The latter ranges between 2 and 8 mm (Tab. 1.19). The estimated original blank width (12-25 mm) is consistent with the most represented width class of debitage products observed by C. Célérier (1993a).

Next to the exploitation of irregular and wide blanks some backed points attests the use of full debitage products with a more regular and elongated shape. The latter are manly attested in layer 3. As a matter of fact, by comparing the two Late Azilian layers a clear change in both morphology and size of blanks selected was observed. In layer 3A thick and wide bladelets

(36,27%) and elongated flakes (22,55%) are dominant. By contrast, in layer 3 backed points are mainly produced on more regular and narrower bladelets (68,00%), attesting a general increment of standardisation and regularity of blanks exploited. Elongated flakes almost disappear.

Table 1.12 - Blank dimensional categories selected for backed points production.

	L. 3A		L. 3	
	n	%	n	%
Microbladelets	6	5.88	1	2.00
Bladelets	37	36.27	34	68.00
Blades	11	10.78	4	8.00
Elongated flakes	23	22.55	3	6.00
Flakes	2	1.96	1	2.00
Microbladelets/bladelets	19	18.63	1	2.00
Bladelets/Blades	2	1.96	5	10.00
Elongated flakes/bladelets	2	1.96	-	-
N.D.	-	-	1	2.00
Total	102	100	50	100

1.2.2.2. Retouch methods

1.2.2.2.1. Backed retouch

The delineation of the back is mainly convex or slightly convex opposite to a rectilinear or slightly convex cutting edge. A rectilinear backed retouch was observed almost exclusively in layer 3 (Tab. 1.13). Back delineation strongly depends on the morphology of the backed point sought-after and to the amount of length to remove. More the back is rectilinear, the more the projectile points are produced by exploiting a longer portion of the blank length, whereas the more convex it is, higher is the length reduction (Fig. 1.11 a).

Table 1.13 - Backed retouch delineation.

	L. 3A		L. 3	
	n	%	n	%
Convex	57	55.88	15	30.00
Slightly convex	39	38.24	22	44.00
Rectilinear	3	2.94	13	26.00
N.D.	3	2.94	-	-
Total	102	100	50	100

The reduction of the original blank width is less important. The back reached at most the half of the original blank, but more frequently it stops before. Considering the relation between backed retouch and dorsal ridge along the entire longitudinal axis of the artefacts, two main modalities were identified as illustrated by Figure 1.12 b. A back located near or completely over the main dorsal ridge of the blank is rare and mainly attested with rectilinear backs of layer 3.

The back is equally localised on the left or on the right edge of the blank. The choice falls on the less sharp edge which normally is the closest to the main dorsal ridge.

In both Late Azilian layers the backing process is mainly performed by a deep, crossed and abrupt retouch. A direct, deep and abrupt retouch is less frequent. (Tab. 1.14).

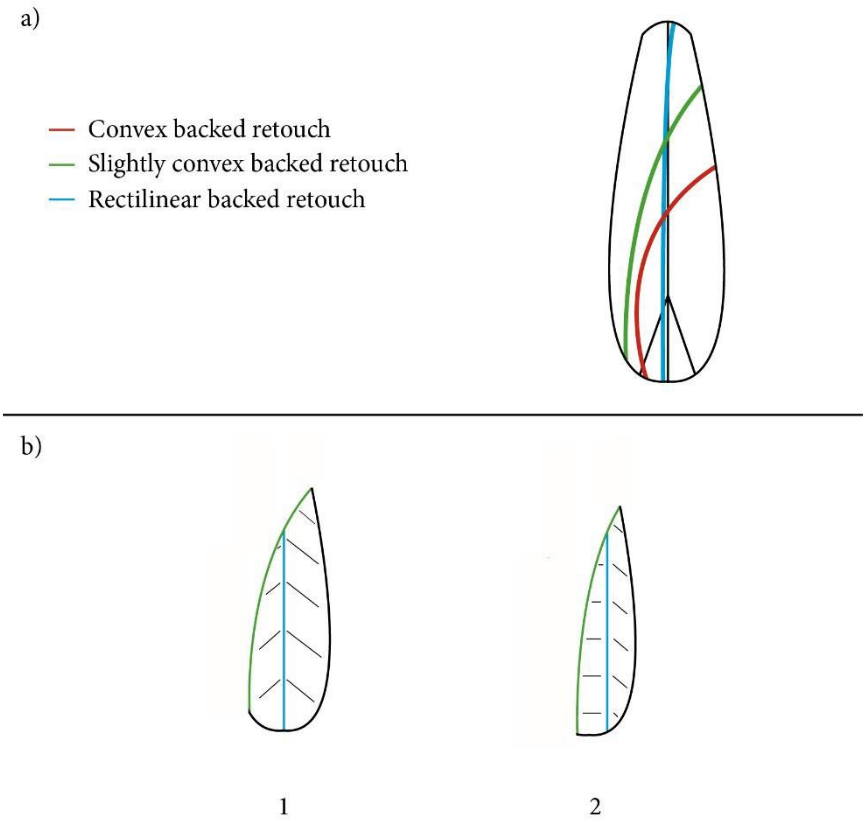


Figure 1.11 – a: blank length reduction according to the convexity of the back; b: relationship between the back and the main dorsal ridge according to cross section blank; 1: In triangular cross-section blank the back follows the main dorsal ridge in the basal and mesial portion crossing it to shape a “secant” tip over it; 2: in trapezoidal cross-section blank the back is located over the 1st dorsal ridge and the apex is shaped by crossing the 2nd dorsal ridge. Sometimes, the back is over the main dorsal ridge (in triangular cross-section blanks) or the 2nd dorsal ridge (in trapezoidal cross-section blanks) also on the basal portion aim at removing the bulb and the butt of the original blank.

Looking at Table 1.15 some differences in the use of crossed retouches between the two occupation phases was highlighted. In layer 3A inverse retouches are more often applied in the apical portion to sharpen tips thicker than 3 mm by detaching a series of small flakes (Fig. 1.12 a). Inverse retouches on the mesial and basal portion tends to be unintentional and related to the backing technique adopted (see Chapter 1.2.2.5.). By contrast, in layer 3 inverse retouches are more often located in the mesial portion and applied intentionally to regularise the back delineation (Fig. 1.12 b).

Table 1.14 - Backed retouch extent, position and angle.

	L. 3A		L. 3	
	n	%	n	%
Deep direct abrupt	32	31.37	14	28.00
Deep crossed abrupt	59	57.84	33	66.00
Marginal crossed abrupt	4	3.92	-	-
Marginal direct abrupt	6	5.88	2	4.00
Marginal direct semi-abrupt	1	0.98	-	-
N.D.	-	-	1	2.00
Total	102	100	50	100

Table 1.15 - Inverse backed retouches localization and average thickness of corresponding portions.

Localization of inverse retouches	L.3A		L. 3	
	n	%	n	%
Apex	37	47.44	17	31.8
Proximal	9		4	
Distal	28		11	
N.D.	-		2	
Base	19	28.21	7	12.96
Mesial portion	22	24.36	30	55.56
Total	78	100	54	100

Apex orientation tends to follow the morphological axis of the blank being positioned on the distal portion in 64% of cases. Tips can be shaped in an axial position by the convergence between two slightly curved edges, otherwise it can be *déjeté* and therefore shaped by curved backed retouch and a rectilinear functional edge. A slight increase of axial points was noted in layer 3.

1.2.2.2.2. Complementary retouches and truncations

An additional retouch phase beside the back retouch is extremely common. In both Late Azilian layers more than 70% are shaped by a complementary retouch or a truncation. Several differences concern localization, extent, position and angle were observed between layer 3A and 3. In the former the retouch is almost exclusively basal (93,67%; Tab. 1.16) and mainly oblique, deep and direct (Tab. 1.17). The aim is to create a sort of basal tang in axis with the apex by removing the butt and bulb. Its orientation can be more transverse (i.e. truncation) or more longitudinal (i.e. complementary retouch) according to the morphology of the blank:

- a slightly convex cutting edge corresponds to a slightly curved back, an axial point and a more longitudinal basal retouch (Fig. 1.13 n. 1)
- a rectilinear cutting edge corresponds to a convex back, a *déjeté* point and a more transverse basal retouch (Fig. 1.13 n. 2)

These two retouch modalities suggest different backed point positions on the shaft: an axial position with a perforating tip in the first case (Fig. 1.13 n. 1), a more oblique position in the second case (Fig. 1.13 n. 2). This type of basal retouch strongly decreases in layer 3 in favour of a more marginal one, which can be direct and abrupt, direct or inverse and semi-abrupt and even inverse and flat (Fig. 1.13 c). Apical complementary retouches increase as well (Tab. 1.16).

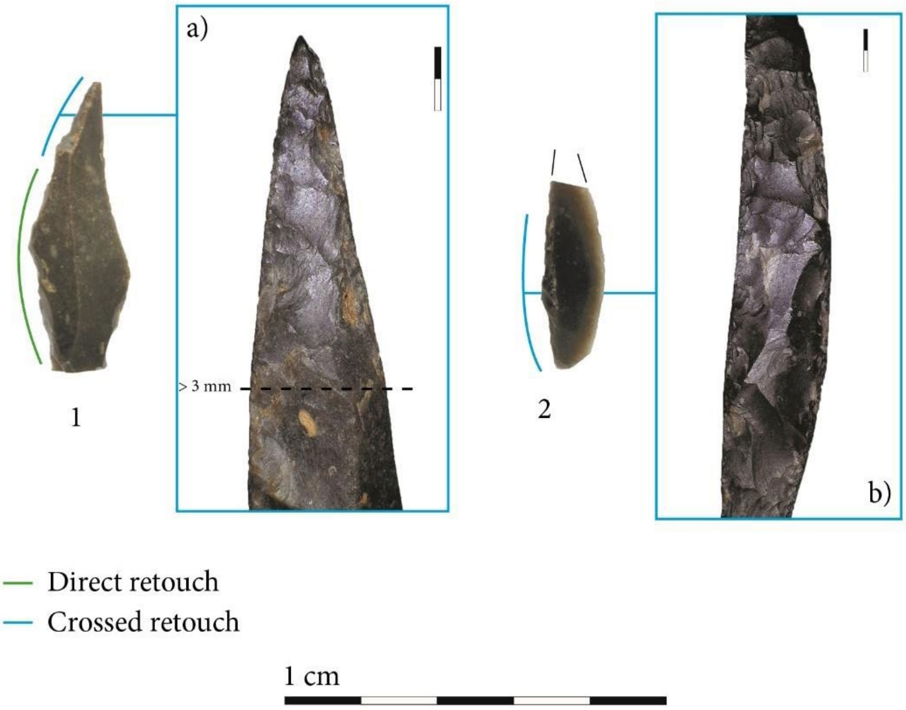


Figure 1.12 – 1: backed point from layer 3A with inverse retouches in the apical portion to thin the apex (a); 2: backed point from layer 3 with inverse retouches located in the mesial portion (b) to regularise the back delineation.

Table 1.16 - Complementary retouch/truncation localization.

	L. 3A		L. 3	
	n	%	n	%
Apical	4	5.06	8	18.60
Basal	74	93.67	31	72.09
Mesial	1	1.27	-	-
Entire edge	-	-	3	6.98
Unidentified	-	-	1	2.33
Total	79	100	43	100

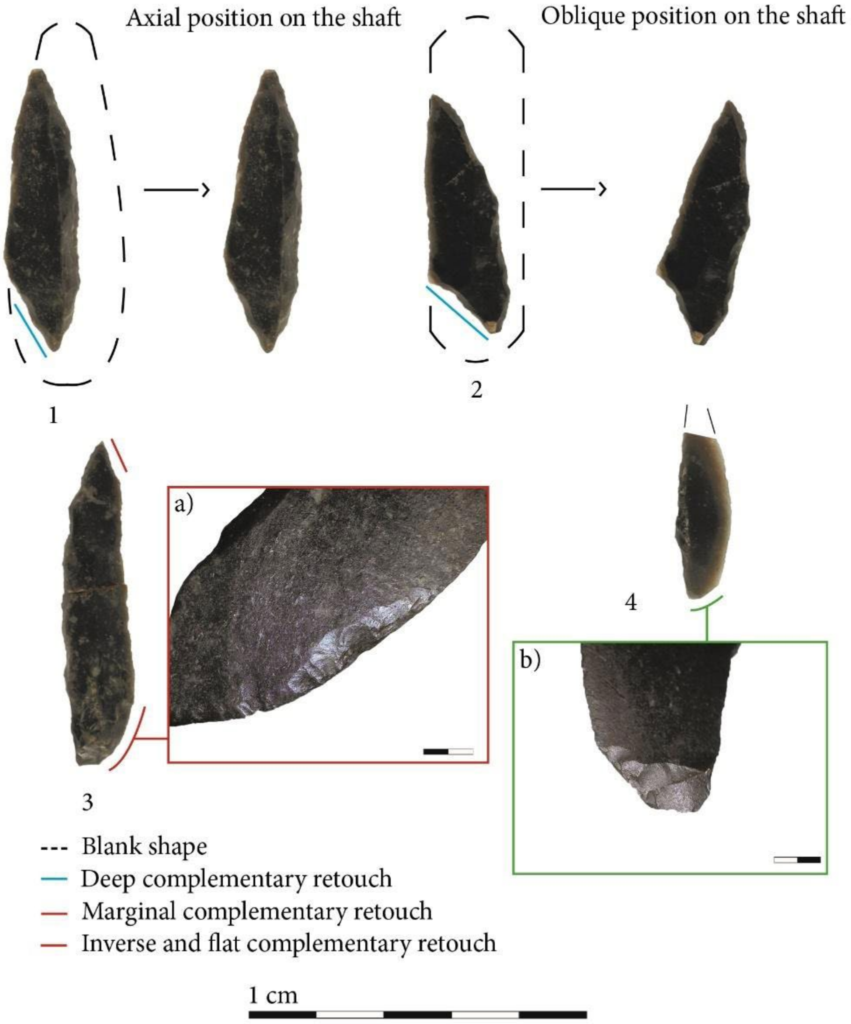


Figure 1.13 – 1-2: backed points from layer 3 A. 1: slightly convex cutting edge = slightly curved back = axial point = more longitudinal basal retouch = axial position on the shaft; 2: rectilinear cutting edge = convex back = *déjeté* point = more transverse basal retouch = oblique position on the shaft. 3-4: backed points from layer 3: marginal, direct and semi-abrupt retouch (a); inverse and flat retouch (b).

Table 1.17 - Complementary retouch/truncation extent, position and angle.

	L. 3A		L. 3	
	n	%	n	%
Marginal direct semi-abrupt	6	7.59	10	23.26
Marginal direct abrupt	9	11.39	11	25.58
Deep direct abrupt	53	67.09	15	34.88
Deep crossed abrupt	3	3.08	-	-
Marginal crossed abrupt	1	1.27	-	-
Marginal inverse semi-abrupt	1	1.27	4	9.30
Deep inverse abrupt	2	2.53	-	-
Deep inverse semi-abrupt	2	2.53	-	-
Inverse flat	-	-	3	6.98
N.D.	2	2.53	-	-
Total	79	100	43	100

Concerning the backed points size, a gradual decrease of mean values of length and width is attested: from 40.2 mm to 38 mm in length, and from 12.1 mm to 10 mm in width. The thickness remains stable. Looking at the degree of homogeneity, the standard deviation (SD) of length and width decreases, attesting a growth in standardisation (Tab. 1.18). Figure 1.14 presents the variability of dimensional values.

Table 1.18 - Backed points dimensional classes of length, width and thickness (mm).

	L. 3A			L. 3		
	Len.	Wid.	Th.	Len.	Wid.	Th.
Min. value	21	6	2	27	7	3
1st quartile	35	11	4	35	9	4
Median	40	12	5	37	10	4.5
Med. value	40.2	12.1	4.7	38	10	4.8
3rd quartile	45.75	13	5.75	41.75	10	5.75
Max. value	60	22	8	55	18	8
SD	7.585	2.529	1.209	5.369	2.241	1.335
Total	102	102	102	42	50	50

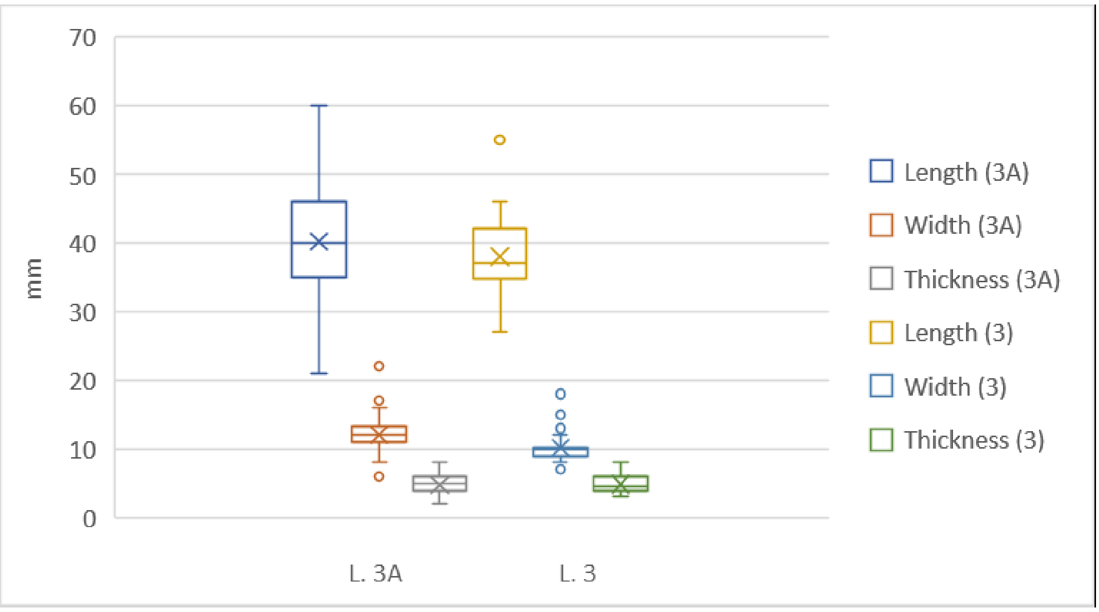


Figure 1.14 – Backed points size according to stratigraphic unit 3A and 3.

1.2.2.3. Morpho-types

The backed points assemblage of layer 3 and 3A can be divided into five main morpho-types characterised by several morphological and technological divergences. A synthesis of each of them is presented below:

- **Curved-backed monopoints with retouched base, type A** (Fig. 1.15 a): they are manufactured on thick and wide bladelets or laminar flakes, rarely on blades. Length varies between 27 mm and 60 mm (interquartile range 36-45 mm), width between 9 mm and 18 mm (interquartile range 11-14 mm), thickness between 2 mm and 8 mm (4-6 mm). The width-length ratio is lower than 1:4. The apex can be axial and shaped by a slightly convex back as well as the cutting edge designing a more symmetric morphology. Otherwise this morpho-type presents an asymmetric shape delineated by a curved backed retouch and a rectilinear cutting edge. The back reduction in the basal and mesial portion was carried out by deep, direct and abrupt retouch that stops before the main dorsal ridge in triangular cross-section blanks or it reaches the 1st dorsal ridge in trapezoidal cross-section blanks. The apex is more often distal and shaped over the main ridge by a crossed retouch. The basal portion is delineated by a deep, direct and abrupt retouch opposed to the back aimed at shaping a sort of peduncle by removing totally or partially the butt and the bulb.

- **Curved-backed monopoints with retouched base, type B** (Fig. 1.15 b): they manufactured on thick and narrower bladelets or blades. Length varies between 23 mm and 58 mm (interquartile range 35-47 mm), width between 6 mm and 13 mm (interquartile range 8-12 mm), thickness between 3 mm and 6 mm (4-5 mm). The width-length ratio is 1:4 or more. The reduction process does not present any particular difference compared to the A type, except for a less curved back retouch and a less transverse complementary retouch in the basal portion.
- **Curved-backed monopoints with unretouched base** (Fig. 1.15 c): they are manufactured on a wide array of blanks (microbladelets, bladelets, blades and laminar flakes). Length varies between 21 mm and 54 mm (interquartile range 33-41 mm), width between 7 mm and 16 mm (interquartile range 9-14 mm), thickness between 2 mm and 8 mm (4-6 mm). The width-length ratio is generally lower than 1:4. The back retouch is consistent with curved backed monopoints with retouched base. The main difference is in the basal portion: the base does not present any peduncle, but the butt-bulb or the distal portion, depending on the backed point orientation, are left unretouched.
- **Elongated backed points** (Fig. 1.15 d): it is a heterogeneous morpho-type manufactured on more regular bladelets. Length varies between 27 mm and 46 mm (interquartile range 34.5-40.5 mm), width between 7 mm and 10 mm (interquartile range 8-9 mm), thickness between 3 mm and 6 mm (4-5 mm). The width-length ratio is 1:4 or more. The back is rectilinear or at least slightly convex as well as the cutting edge. The apex is generally in the distal portion. Back reduction is carried out by deep crossed or direct abrupt retouch and it achieves totally (over) or partially (adjacent) the main dorsal ridge. Marginal complementary retouches are applied to shape out the base and the tip. Two artefacts show even an inverse and flat retouch.
- **Bipoints** (Fig. 1.15 e): it is a small group composed of four backed points. They are manufactured on regular bladelets, their length varies between 31 mm and 44 mm, width between 7 mm and 10 mm, thickness between 3 mm and 4 mm. They are characterized by a slightly curved back and a double apex. One apex is shaped by the convergence between the backed and the cutting edge, the second between the back and a marginal complementary retouch. They do not present any affinity with Early Azilian Curved-backed bipoints from layer 3B.

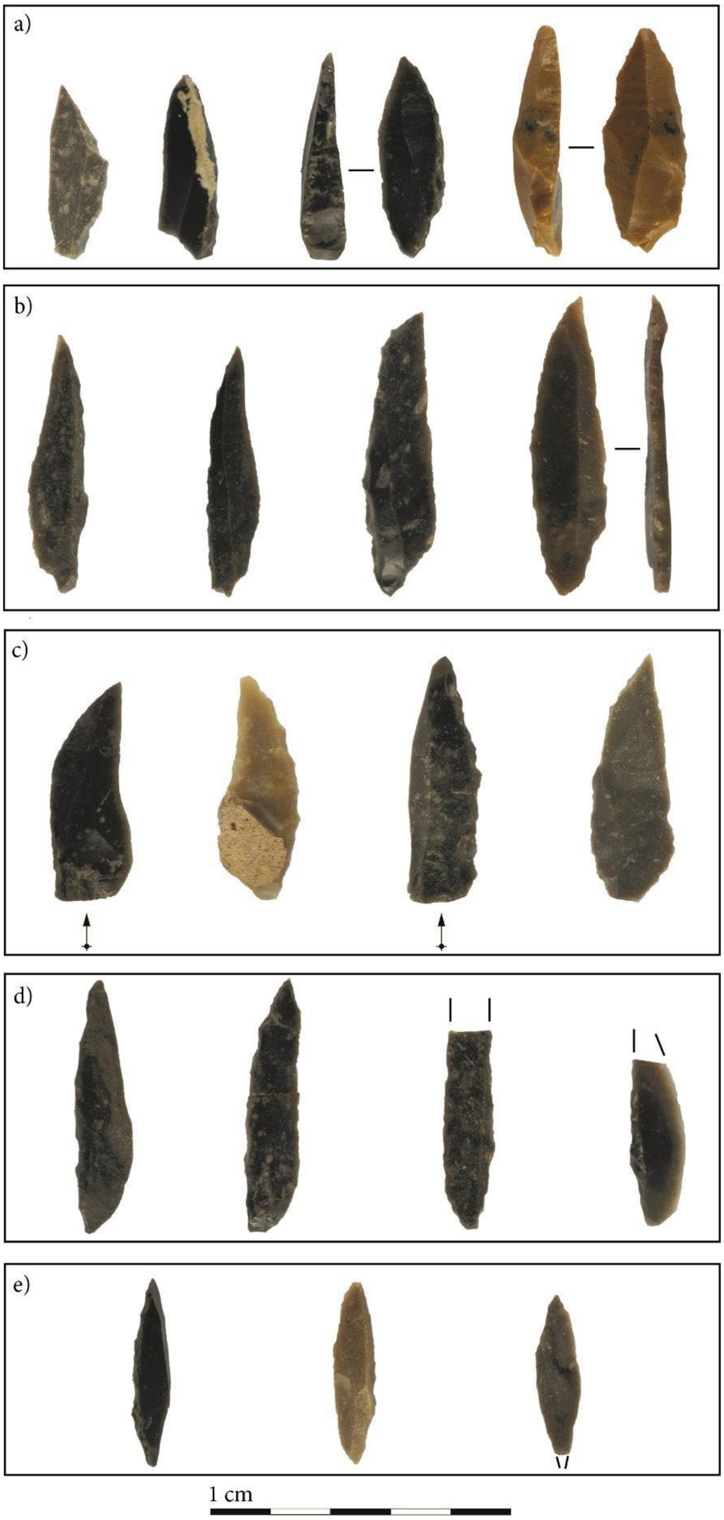


Figure 1.15 – Morpho-types. a: Curved backed monopoints with retouched base, type A; b: Curved backed monopoints with retouched base, type B; c: Curved-backed monopoints with unretouched base; d: Elongated backed points; e: Bipoints.

Table 1.19 - Morpho-types frequency according to layer 3A and 3.

	3A		3	
	n	%	n	%
Curved-backed monopoints with retouched base, type A	63	61.76	10	20.00
Curved-backed monopoints with retouched base, type B	16	15.90	10	20.00
Curved-backed monopoints with unretouched base	14	13.73	4	8.00
Elongated backed points	1	0.98	17	34.00
Bipoints	-	-	4	8.00
N.D.	8	7.84	5	10.00
Total	102	100	50	100

As shown by Table 1.19 morpho-types do not have the same frequency in layer 3A and 3. Curved backed monopoints with retouched base type A are dominant in layer 3A (61,76%), whereas curved backed monopoints with retouched base type B (15,90%) and curved-backed monopoints with unretouched base (15,73%) are a secondary target. In layer 3 a clear change in morpho-types was observed: curved-backed monopoints with retouched base type A strongly decreased giving way to an expansion of new backed point types such as elongated backed points and bipoints produced on more regular lamino/lamellar blanks.

1.2.2.4. Pieces under construction and resumed backed points

Backed points interpreted as pieces abandoned during manufacture count a total of 59. The majority of them belong to layer 3A attesting a more intensive armatures production compared to layer 3. 51 are backed fragments discarded due to an unintentional breakage. The most frequent type is the Krukowski microburin and its equivalent, namely a cone fracture with a *piquant-trièdre*. Krukowski microburins are mainly distal, suggesting a blank more often blocked by holding the butt and the bulb with one hand, while retouching the distal-mesial portion. A snap terminating banding fracture associated with an unfinished back is rare (Tab. 1.20). 8 items do not have any fracture but merely an unfinished shape. They were discarded due to the formation of rounded edge portions that did not allow to carry on the back reduction. Observing the state of abandonment of these elements it was possible to reconstruct the chronological order of retouch sequences adopted by Late Azilian groups for the *façonnage* phase. Two main modalities were observed:

- the use of two opposite direct retouch sequences (Fig. 1.16 n. 3, 4)
- the previous sequences followed by a last sequence of inverse retouches to point the apex or/and on restricted areas of the mesial and basal portion. Actually several backing fractures resulted from a direct blow but associated to a crossed retouch attest also an alternation of direct and inverse retouches to delineate the back

The apex was probably one of the last parts to be shaped as indicated by the low number of backing fragments showing a tip entirely delineated before finishing the backing process. Few artefacts reveal the application of a basal complementary retouch as the first step of the shaping phase.

Table 1.20 - Diagnostic backing fractures identified.

Type of fracture	n
Cone fractures associated to a *piquant-trièdre*	26
Cone fractures	3
Snap terminating bending fractures	2
Krukowski microburins	17
Distal apical	3
Proximal apical	1
Distal	10
Proximal	2
N.D.	1
Total	44

Backed points characterised by a fracture partially resumed are 21. Fractures are entirely related to the manufacturing process. They are visible on the apical portions in form of *piquant trièdre* fractures (positive part of Krukowski microburin) or in the basal portions as a generic snap fracture (cone or bending). In the first case, the fracture is resumed by the back (n=10). In the second case the fracture is covered by the complementary retouch/truncation (n=10; Fig. 1.17). This evidence may be the result of two different situations:

- the high fracture index caused by the backing technique adopted (soft stone percussion on anvil see Chapter 1.2.2.5.) followed by an enforced adaptation of the retouching process.
- a premeditated and controlled fracture used to reduce artefacts length. A distal portion removed by a Krukowski fracture for shaping a secant tip and a proximal portion reduced by a cone or bending fractures to facilitate the hafting on the shaft.

1.2.2.5. Retouches techniques

The size of blanks selected and the invasive backing process applied to produce Late Azilian backed points of Pont d’Ambon necessarily influence the choice of the backing technique adopted. In layer 3A about 80% of backed points are certainly produced through soft stone

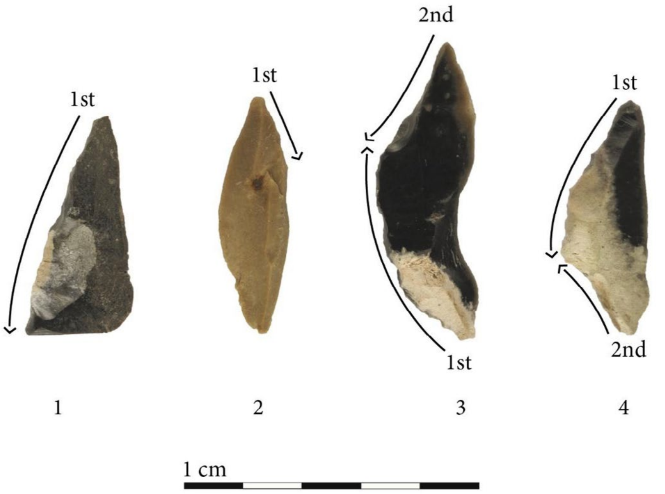


Figure 1.16 – 1-2: backed points abandoned after the 1st sequence of removals; 2-3: backed points abandoned after the 2nd sequence of removals.

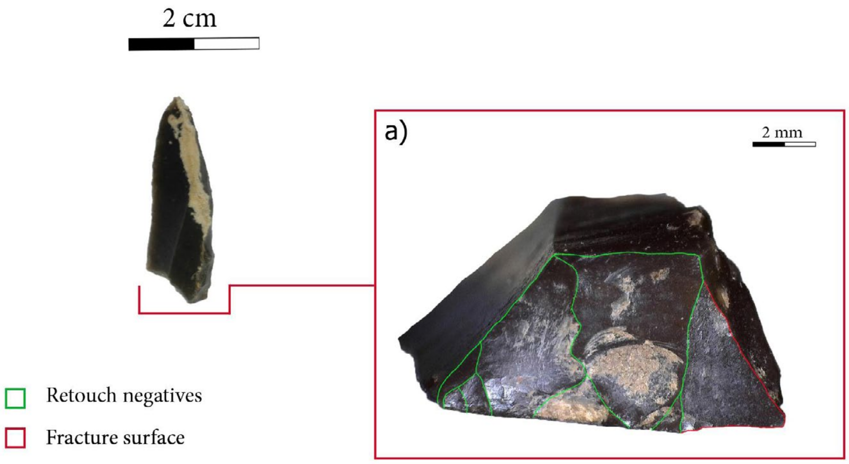


Figure 1.17 - Backed points with a basal fracture partially resumed by the basal truncation.

percussion on anvil, in layer 3 around 60%. This technique is by far the most suitable one to transform thick products by maintaining a high operating speed. Backs are characterised by an irregular sequence of removals, a denticulated longitudinal profile due to residual protrusions and deep negatives, an edge rounded with hammered portions and scars with a fan-shaped outline. Moreover, several backs present isolated incipient cones associated with a little bulb located on the dorsal face diagnostic of the use of a stone anvil (Fig. 1.18 n. 1-3). The latter are visible exclusively on mesial and proximal basal portions thicker than 5 mm. It is interesting to note that thinner portions (i.e. distal) and thin blanks never present dorsal incipient cones linked to the recoil effect. This evidence indicates a shift of anvil raw material according to blank thickness: thick blanks are reduced using a stone anvil, thin ones using an organic anvil. Probably many of the mesial and basal inverse retouches observed on backed points (Tab. 1.15) were generated by the recoil effect rather than an intentional retouch (e.g., Fig. 1.18 a). In confirmation of the use of a stone anvil there are also some inverse Krukowski microburins resulting from the recoil. The same retouch technique was adopted to apply basal complementary retouches/truncations in curved-backed monopoints with retouched base.

The use of a pressure technique was fairly rare. In layer 3A it was occasionally applied by a stone compressor and it was used to retouch apical portions in combination with soft stone percussion on anvil. A slight increase was attested in layer 3 where it was mainly employed to delineate marginal complementary retouches. The use of an organic compressor was identified only in layer 3 for applying flat and inverse complementary retouches (Fig. 1.18 e).

The higher number of cone fractures (in *sensu stricto*) compared to bending ones (Tab. 1.20) is consistent with the greater use of soft tone percussion on anvil compared to pressure.

1.2.2.6. Diagnostic impact fractures

By dividing the backed points assemblage yelding diagnostic impact fractures according to the apex position, namely axial (some curved backed monopoints, e.g. Fig. 1.13 n. 1, elongated backed points and bipoints) vs. *déjeté* (some curved backed monopoints, e.g. Fig. 1.13 n.

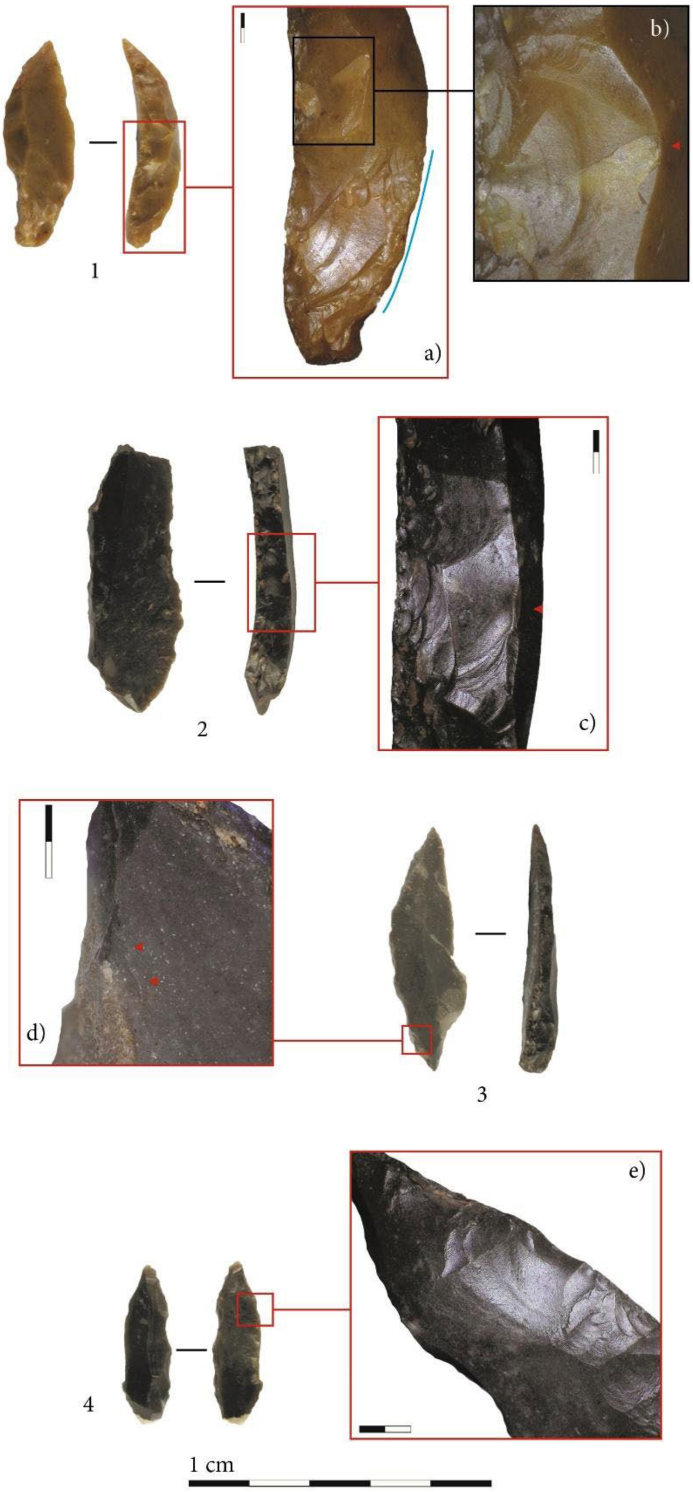


Figure 1.18 – Retouch techniques. 1-3- backed points produced by percussion on a stone anvil; a-b: incipient cones generated by the recoil effect of the stone anvil. In figure a) the blue line indicates the position of inverse retouches generated by the recoil effect. 4: backed points with a complementary retouch applied by pressure by an organic tool; e: flat and inverse retouch with a large initiation diagnostic of the use of an organic compressor.

2), three main tendencies were observed:

- a higher percentage of fractures starting from the cutting edge removing the tip in backed points with a *déjeté* apex, compared to those with an axial one (Fig. 1.19 a-b)
- a higher percentage of edge scars associated with apical or basal DIF's in backed points with a *déjeté* apex (7 out of 14) compared to those with an axial one (1 out of 8).
- the exclusive presence in backed points with an axial apex of bending fractures that start on the back and continue parallel to its longitudinal axis removing part of the sharp edge (Fig. 1.19 c-d).

A. Yaroshevich and colleagues (2010) are among the few Authors having developed archery experiments with different backed points morphology and hafting methods, including straight backed points with an axial position on the shaft and curved backed points with an oblique latero-distal position. Although the Authors study was aimed at investigating projectile implements design during the Late Pleistocene in the Levant, several interesting convergences with our archaeological results were recorded:

- experimental backed points hafted with an oblique latero-distal position present fractures removing its tip that initiate on the cutting edge
- edge scars are more frequently attested on experimental backed points hafted with an oblique latero-distal position compared to axial ones
- bending fractures that start on the back and continue parallel to its longitudinal axis removing part of the sharp edge (a3 type in Yaroshevich et al., 2010) are attested exclusively on backed points hafted axially

Thus, combining our result with those of A. Yarosevich (2010) seems possible to confirm our initial impression illustrated in Figure 2.13 n. 1-2, namely an axial hafting for curved-backed monopoints with an axial apex and elongated backed points and an oblique latero-distal hafting for curved-backed monopoints with a *déjeté* apex. Obviously, these results are preliminary and the investigation of the entire assemblage of backed fragments from layer 3A as well as a MLIT's identification combined to an experimental activity are necessary before trying to fully interpret hafting modalities. The double function of curved backed points with a *déjeté* apex (i.e. perforating and tearing/slashing) may be the reason for the low number (n=2) of backed bladelets in the Late Azilian layers of Pont d'Ambon.

Table 1.21 - Diagnostic impact fractures according to backed point morpho-type.

Axial curved-backed monopoints (n=38)	**n**
Apex	
Feather terminating bending with *languette* ≥ 3 mm	1
Step terminating bending with *languette* ≥ 3 mm	1
Step terminating transverse bending with *languette* ≥ 3 mm (starting from the back or the cutting edge)	3
Burination ≥ 3 mm (starting from a surface)	1
Base	
Spin-off	1
Edge scars	1
Total fractures	**8**
Déjeté curved-backed monopoint points (n=72)	
Apex	
Step terminating bending with *languette* ≥ 3 mm	4
Feather terminating transverse bending with *languette* ≥ 3 mm (starting from the back or the cutting edge)	4
Step terminating transverse bending with *languette* ≥ 3 mm (starting from the back)	1
Burination ≥ 3 mm (starting from the cutting edge)	3
Burin-like spin-off ≥ 3 mm	3
Base	
Feather terminating transverse bending with *languette* ≥ 3 mm (from the back)	1
Step terminating bending with *languette* ≥ 3 mm	1
Edge scars	7
Total fractures	**25**
Rectilinear backed point (n=18)	
Apex	
Step terminating transverse bending with *languette* ≥ 3 mm (starting from the back)	1
Burinations ≥ 3 mm (starting from a surface)	2
Burin-like spin-off ≥ 3 mm	2
Edge scars	1
Total fractures (n=4)	**6**

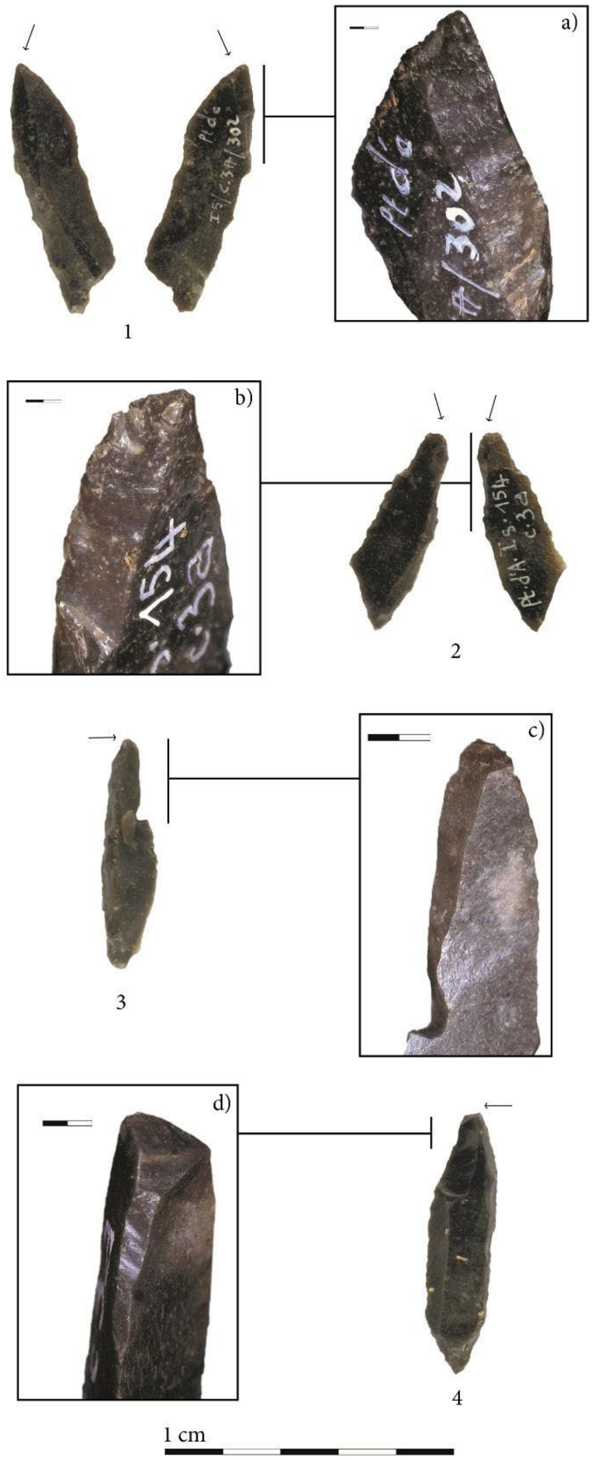


Figure 1.19 – 1-2: Curved-backed point with retouched base and a *déjeté* apex; 3: Rectilinear backed points; 4: Curved backed points with retouched base and an axial apex. Arrows indicate the beginning of the fracture.

1.2.3. Layer 2 - Early Laborian

Artefacts analysed from layer 2 are 226 (Tab. 1.22). The assemblage is composed by the entire collection of complete and almost complete *Malaurie* points (backed truncated points) and *rectangles* (backed bi-truncated bladelets), a sample of generic backed truncated fragments and pieces abandoned under construction. Apical fragments were excluded from the analysis in order to avoid the accidental examination of Azilian backed points resulting from mixing processes with the uppermost layers.

Table 1.22 - Composition of the archaeological assemblage analysed.

	n
Malaurie points	103
Backed bi-truncated bladelets	55
Basal *Malaurie* points/backed bi-truncated bladelets	24
Pieces under construction	44
Fragments	34
Entire	10
Total	226

1.2.3.1. Malaurie points

1.2.3.1.1. Blank selection

Blanks selected for the production of *Malaurie* points are regular and elongated full debitage products characterized by sub-parallel edges, a rectilinear profile, a calibrated thickness of around 3-5 mm and a rather variable width. Cross-sections are flat and equally triangular and trapezoidal. Butts are never preserved. Although short distal negatives coming from an opposite striking platform were sometimes observed, a clear preference of blanks extracted by a unidirectional debitage sequence is recorded. A major exploitation of bladelets (51,33%; length > 35 mm) compared to blades (23,89%; length > 59 mm) was attested (Tab. 1.23).

Table 1.23 - Blank dimensional categories selected for *Malaurie* points production.

	n	%
Microbladelets	-	-
Bladelets	58	51.33
Blades	27	23.89
Microbladelets/bladelets	5	4.42
Bladelets/blades	22	19,47
Blades/laminar flakes	1	0,88
Total	113	100

1.2.3.1.2 Retouch methods

1.2.3.1.2.1 Backed retouch

The backing process has the main purpose to reach a width ranging from 8 mm to 12 mm and to create an apex. The back can be total (n=93), partial (n=12) or even absent (n=2; e.g. Fig. 1.22 a, the first one on the left) depending on the original blank width and morphology. In case of a naturally pointed blade the backed retouch modifies exclusively the basal portion (Fig. 1.22 a, the first one on the right).

The back is equally applied on the right and left side of the blank by deep, crossed and abrupt retouches (33,63%), followed by deep, direct and abrupt (25,66%) or marginal, direct and abrupt ones (25,66%) (Tab. 1.24). A crossed backed retouch is visible exclusively on those points with a thickness ≥ 3 mm (mean value 4,7 mm) and in which the back reaches partially or totally one of the main dorsal ridges. Inverse detachments are more frequently located on apical and mesial portions, rarely on the base. Their distribution tends to be chaotic and each negative or short sequence of negatives is isolated from each other suggesting the punctual use of inverse retouches exclusively to remove protuberances formed during the direct retouch.

Table 1.24 - Backed retouch extent, position and angle.

	n	%
Deep direct abrupt	29	25.66
Deep direct semi-abrupt	3	2.65
Deep crossed abrupt	38	33.63
Marginal direct abrupt	29	25.66
Marginal direct semi-abrupt	1	1.64
Marginal crossed abrupt	3	2.65
Marginal bifacial	1	0.88
Absent	2	1.77
N.D.	1	0.88
Total	103	100

Several back delineation modalities were observed according to blank cross-section (Fig. 1.20): in case of triangular blanks the back generally stops before the main dorsal ridge and it converges with this latter to shape a “convergent” tip or otherwise it crosses the main dorsal ridge delineating a secant tip. On the contrary, *Malaurie* points produced on trapezoidal blanks have a back mostly positioned over the 1st ridge and a tip shaped by the convergence between the 2nd dorsal ridge and the back or by a back that crosses the 2nd dorsal ridge to design a secant tip (Tab. 1.25 and 1.26). Rarely the back reduction process reached the half of the original blank width.

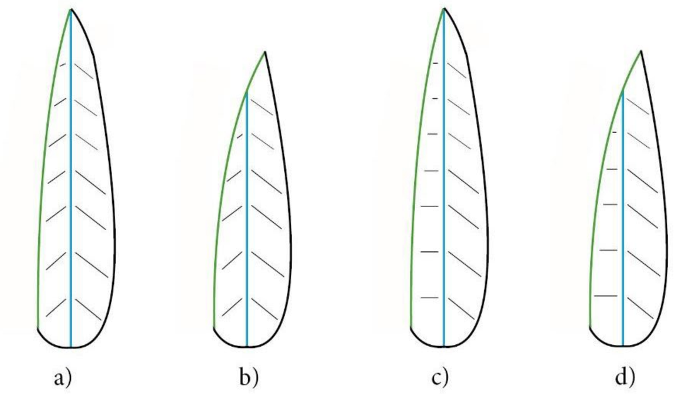


Figure 1.20 – Different modalities of delineating a back according to cross-section blank: a: the back stops before reaching the main dorsal ridge and it converges with this latter in the apical portion; b: the back stops before reaching the main dorsal ridge and it crosses this latter to shape a tip over it; c: the back is positioned over the 1st dorsal ridge and converge with the 2nd dorsal ridge to form the tip; d: the back is positioned over the 1st dorsal ridge and it crosses the 2nd one to shape a tip over.

Table 1.25 - Relation between back and main dorsal ridge according to cross-section blank.

Triangular/unidentified	n	%
Before the ridge	44	74.58
Adjacent to the main ridge	6	10.17
Over the main ridge	5	8.47
N.D.	4	6.78
Total	59	100
Trapezoidal	n	%
Before the 1st ridge	11	20.37
Adjacent to the 1st ridge	9	16.67
Over the 1st ridge	32	59.26
Adjacent to the 2nd ridge	1	1.85
N.D.	1	1.85
Total	22	100

Table 1.26 - Relation between back and main dorsal ridge in the apical portion in backed points according to cross-section blank.

Triangular/unidentified	n	%
Over the ridge	4	6.78
Secant	21	35.59
Convergent	18	30.51
Break	11	18.64
Naturally pointed.	5	8.47
Total	59	100
Trapezoidal		
Convergent 1st ridge	3	5.56
Over the 1st ridge	1	1,85
Convergent 2nd ridge	15	27,78
Secant to 2nd ridge	23	42.59
Total	22	100

The back delineation varies from rectilinear to slightly convex and angular (i.e. a rectilinear back in basal and mesial portion and oblique on the tip), while the cutting edge is rectilinear or slightly convex. Apex orientation tends to follow the morphological axis of the blank, namely with an apex located on the distal portion and the truncation on the proximal one (53,98%). An opposite orientation reached a percentage of 31,86%. Any particular evidence (e.g. blank size, profile, cross-section, etc.) clarified the reason to locate the apex on the distal portion rather than the proximal one.

1.2.3.1.2.2. Complementary retouch

Complementary retouches are applied on 27,43% of the assemblage. They consist of an extremely short sequence of removals (5-6 mm) useful to thin the apex or to slightly modify the functional edge near the base (Tab. 1.27). Hardly ever a *Malaurie* point has both an apical and basal complementary retouch (n=3). Complementary retouches are marginal direct semi-abrupt and occasionally inverse and flat, but never particularly invasive (Tab. 1.28).

Table 1.27 - Complementary retouch localization.

	n	%
Apical	17	48.57
Basal	17	48.57
Mesial	1	2.86
Total	35	100

Table 1.28 - Complementary retouch extent, position and angle.

	n	%
Marginal direct semi-abrupt	21	60.00
Marginal inverse flat	7	20.00
Marginal direct abrupt	4	11.43
Deep direct abrupt	1	2.86
Direct flat	2	5.41
Marginal inverse semi-abrupt	1	2.86
Deep inverse semi-abrupt	1	2.86
Total	37	100

1.2.3.1.2.3. Truncations

Malaurie points are systematically produced by a basal truncation. Their localization is both proximal and distal depending on the apex orientation. Proximal truncations tend to be deep, direct and abrupt (58.82%) or semi-abrupt (11,76%), rarely crossed (2,94%) and they were applied with the aim to remove the butt and part of the bulb. If this latter is absent or diffuse, proximal truncation can be marginal with an abrupt (7.35%) or semi-abrupt (14.71%) angle (Tab. 1.29). Distal truncations are equally marginal and deep and sometimes useful to reduce blanks characterised by a slightly concave distal profile in order to reach a more rectilinear silhouette.

Truncations delineation varies from transverse and rectilinear or transverse and slightly concave to more seldom oblique. Except for some artefacts (n=20) in which a high length reduction index is attested, truncations seem not to reduce significantly the original blank length. Eight pieces show a basal truncation covering a previous fracture. It is interesting to note how truncations have not the main purpose to standardise blanks length (Tab. 1.30). Their function must be research in the hafting modalities and into the relationship with backed bi-truncated bladelets.

Table 1.29 - truncations extent, position and angle according to the blank portion.

	Distal		Proximal		N.D.	
	n	%	n	%	n	%
Marginal direct abrupt	5	19.23	5	7.35	1	50.00
Marginal direct semi-abrupt	7	26.92	10	14.71	-	-
Marginal inverse abrupt	-	-	2	2.94	-	-
Deep direct abrupt	12	46.15	40	58.82	1	50.00
Deep direct semi-abrupt	2	7.69	8	11.76	-	-
Deep crossed abrupt	-	-	2	2.94	-	-
Piquat-trièdre resumed	-	-	1	1.47	-	-
Total	26	100	68	100	2	100

Malaurie points length ranging between 20 mm to 75 mm (interquartile range: 33.25 mm – 45 mm), whereas width and thickness are more standardised showing a Standard Deviation respectively of 1.537 and 1.189. If the second one is controlled by the selection of blanks that generally do not overpass 5 mm (3rd interquartile value) the first one is managed by a highly flexible backing process. Interquartile range of width varying between 9 mm and 10 mm (Tab. 1.30; Fig. 1.21).

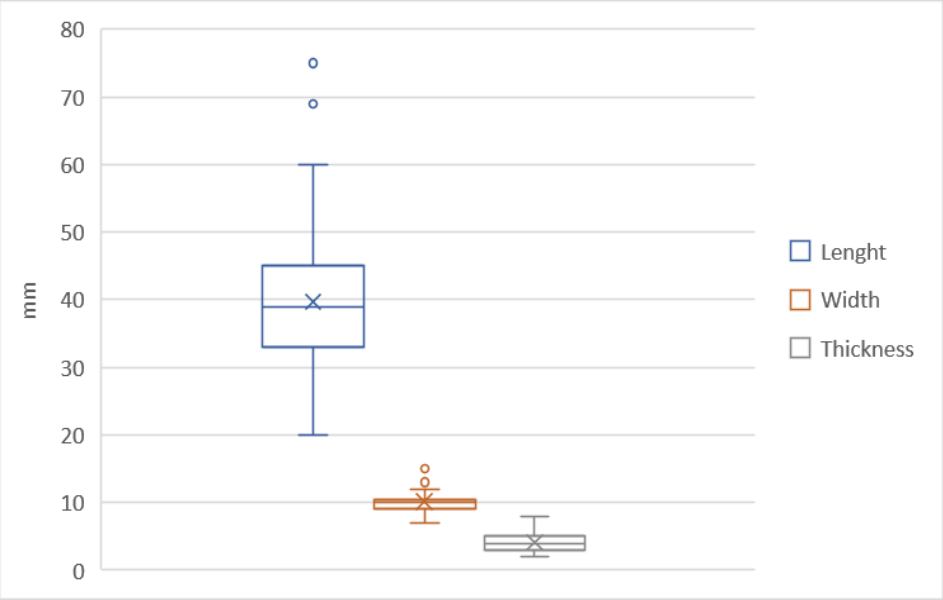


Figure 1.21 – Malaurie points size.

Table 1.30 - Backed points dimensional classes of length, width and thickness.

	Len.	Wid.	Th.
Min. value	20	7	2
1st quartile	33.25	9	3
Median	39	10	4
Medium value	39.7	10.1	4
3rd quartile	45	10	5
Max. value	75	16	8
SD	9.977	1.537	1.189
Total	106	106	106

1.2.3.1.3. Morpho-types

The delineation of the back and the cutting edge as well as the apex position according to the morphological axis of the blank define two main morpho-types of *Malaurie* points: axial *Malaurie* points and *déjeté Malaurie* points (Fig. 1.22). The former is the most sought-after morphology (Tab. 1.31).

- **Axial *Malaurie* points** (Fig. 1.22 a) are commonly produced on bladelets. The apex is mainly shaped out in correspondence with the distal portion of the blank. The back is generally rectilinear, sometimes slightly convex. It shapes, together with a slightly curved cutting edge, an apex located axially with respect to the blank morphological axis. The backing process is carried out by a deep or marginal direct abrupt retouch (rarely crossed) depending on the original blank width. The back was located mostly before the main dorsal ridge in triangular cross-section blanks or over the 1st dorsal ridge in trapezoidal cross-section ones and the apex is delineated by the convergence between the back, one of the ridges and the functional edge. Secondary retouches are occasionally applied to delineate the tip as well as the base.
- ***Déjeté Malaurie* points** (Fig. 1.22 b) are equally produced from blades and bladelets. The back is systematically curved. In case of triangular cross-section blank the backed retouch tends to follow the main dorsal ridge in the basal and mesial portion crossing it in the apical portion in order to shape out a "secant" tip. If the blank has a trapezoidal cross-section the back reduction stops over the 1st ridge in the basal and mesial portion crossing the 2nd one to shape a secant tip. 76% are produced by a crossed backed retouch. Inverse retouches are located on the mesial or apical portion depending on which position the back crosses one of the main dorsal ridges. The cutting edge is almost systematically rectilinear. The apex is equally located on the distal and proximal blank portion. Complementary retouches are occasionally applied to modify the cutting edge on the basal extremity, whereas the apex is delineated exclusively by the backing process.

As far as these two morpho-types are concerned, the main question regards the significance of this morphological variability: are they distinct morpho-types reflecting different hafting modalities ? or are they merely variants of the same idea of armatures influenced by the original blank morphology? Looking at the cutting edge and the backed retouched a strong connection between their delineation can be observed: when the cutting edge is rectilinear the back is systematically convex or angular forming a *Déjeté Malaurie* point. Conversely, if the cutting edge is slightly convex the back is more flexible, varying from rectilinear to slightly convex or even angular in order to shape Axial *Malaurie* points. Thus, different morpho-types seem to largely depend on the cutting edge delineation of the original blank.

To these main two morpho-types must be added a third one composed by artefacts characterized by a distal extremity not particularly pointed and thus more referable to a backed single truncated bladelet. They were considered by previous studies as *Malaurie* points but the clear intentionality to manufacture an apical extremity is lacking. They are systematically produced on bladelets and the proximal portion is shaped out by a transverse truncation. Their position on the shaft is likely lateral instead of distal.

Table 1.31 - Morpho-types attested at Pont d'Ambon layer 2 and relative frequency.

	n	%
Axial *Malaurie* points	68	60.18
Déjeté Malaurie points	26	23.01
Backed single truncated bladelets?	9	7.96
Unidentified	10	8.85
Total	113	100

1.2.3.2. Backed bi-truncated bladelets (*rectangles*)

1.2.3.2.1. Blank selection

Blanks selected for producing backed bi-truncated bladelets (Fig. 1.23) are basically the same of *Malaurie* points: regular full debitage blades and bladelets characterised by a triangular or trapezoidal cross-section, a rectilinear profile and a calibrated thickness that hardly ever exceeds 5 mm. The only difference compared to *Malaurie* points is a lower blades exploitation (Tab. 1.32) and probably a more normalised width value reflected in a more standardised back reduction.

Table 1.32 - Blank dimensional categories selected for *rectangles* production.

	n	%
Microbladelets	-	-
Bladelets	39	70.91
Blades	4	7.27
Microbladelets/bladelets	-	-
Bladelets/blades	12	21,82
Blades/laminar flakes	-	-
Total	55	100

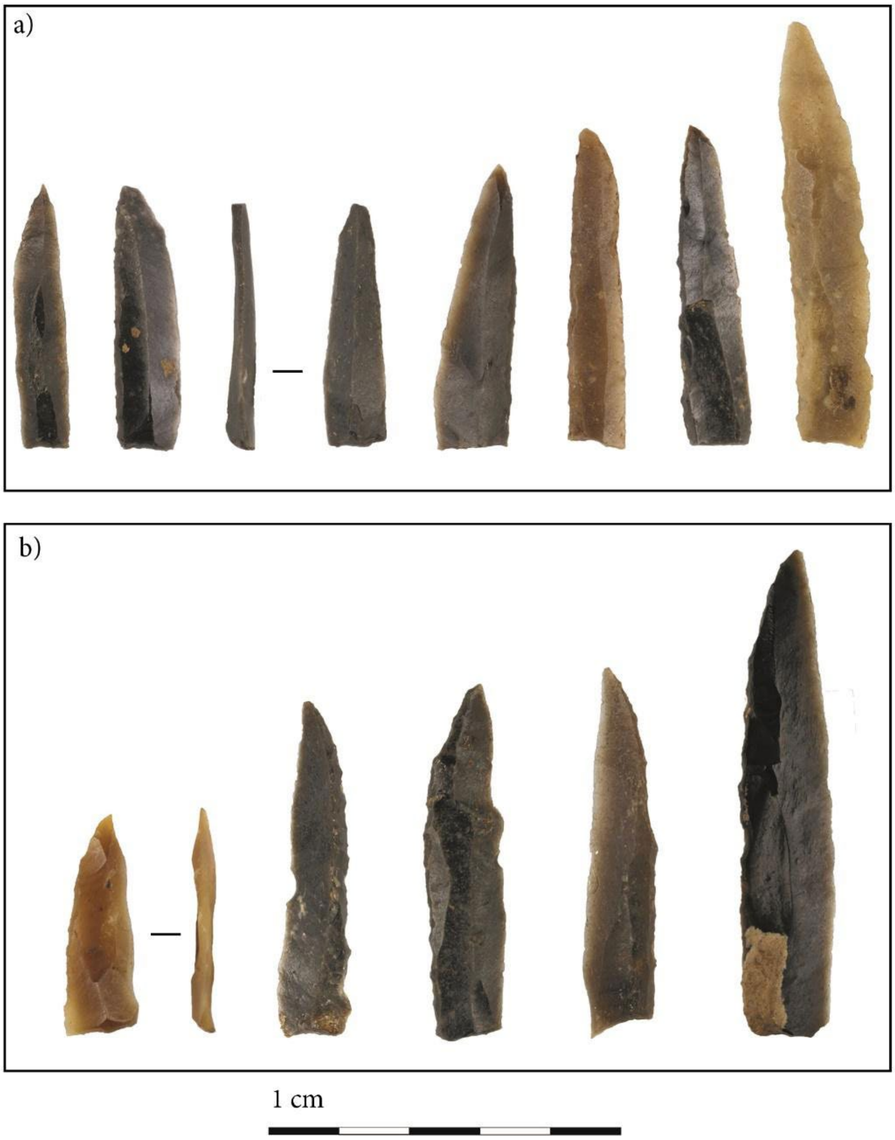


Figure 1.22 – Malaurie points. a: Axial Malaurie points; b: *Déjeté* Malaurie point.

1.2.3.2.1. Retouch methods

1.2.3.2.1.1 Backed retouch

Backs are more frequently located on the right side of the blank (80%) with respect to the left (20%). As well as for *Malaurie* points the back reduction has the purpose to produce artefacts with a width ranging between 8 mm and 12 mm. Backs are generally produced by deep, direct and abrupt retouches (60,00%). Deep, crossed and abrupt and marginal and direct retouches are poorly attested (Tab. 1.33). The backing process only occasionally achieves the main dorsal ridge on triangular cross-section blanks, whereas with trapezoidal ones the back tends to overpass partially or totally the 1st dorsal ridge. Blank width is normally reduced by less than half of their initial size. Both backs and cutting edges are systematically rectilinear with this latter that is seldomly modified by complementary retouches.

The lower exploitation of crossed backed retouch compared to Maluarie points depends on

Figure 1.23 – Backed bi-truncated bladelets from layer 2.

a different delineation of the back. For producing an apex, especially in *déjeté Malaurie* points, the back retouched often overpass one of the main dorsal ridges of the blank (on the mesial or apical portion) increasing the opportunities (i.e. the formation of an angle lower or equal than 90° between the dorsal face and the backed retouch surface) to applied inverse retouches.

Table 1.33 - Backed retouch extent, position and angle.

	n	%
Deep direct abrupt	33	60.00
Deep crossed abrupt	4	7,27
Marginal direct abrupt	12	21.82
Marginal direct semi-abrupt	5	9.09
Marginal crossed abrupt	1	1.82
Total	55	100

1.2.3.2.1.2. Truncations

Rectangles are manufactured by a double transverse truncation with a rectilinear or less frequently slightly concave delineation. Proximal truncations are mainly deep, direct and abrupt aiming to remove the butt and bulb. On the contrary, distal portions reveal a more equal percentage between marginal and deep truncations (Tab. 1.34).

Concerning their size, width and thickness are highly controlled presenting a low Standard Deviation, whereas length shows more fluctuating values (Tab. 1.35), due to an important variability of blanks length selected (bladelets vs blades) and deepness of truncations. It is impressive the nearly equal rates of thickness (interquartile range: 3-4,5 mm) and width (interquartile 9,5-11 mm) with *Malaurie* points (Fig. 1.24 and 1.21).

Table 1.34 - truncations extent, position and angle according to the blank portion.

	Distal		Proximal		N.D.	
	n	%	n	%	n	%
Marginal direct abrupt	19	36,54	5	9.62	1	16.67
Marginal direct semi-abrupt	8	15.38	1	1.92	1	16.67
Marginal inverse semi-abrupt	-	-	1	1.92	-	-
Deep direct abrupt	21	40.38	44	84.62	4	66.67
Deep direct semi-abrupt	2	3.85	1	1.92	-	-
Deep crossed abrupt	2	3.85	2	-	-	-
Total	52	100	52	100		100

Table 1.35 - Backed bi-truncated dimensional classes of length, width and thickness.

	Len.	Wid.	Th.
Min. value	12	8	2
1st quartile	21.5	9,5	3
Median	25	10	4
Medium value	27.6	10.3	4
3rd quartile	32,5	11	4.5
Max. value	58	16	7
SD	9.044	1.533	1.013
Total	55	55	55

1.2.3.3 Pieces under construction

By considering *Malaurie* points abandoned before reaching the sought-after morphology (n=7), three main back production modalities were observed: the first one provides a backing process starting from the apex and then a retouch phase that continues progressively along the longitudinal axis of the blank by one or more sequences of direct detachments depending on blanks width. The basal truncation is shaped for last (Fig. 1.25 a). The second option required firstly a basal truncation and then the back reduction that however began from the apex (Fig. 1.25 b). A third option provides the use of inverse detachments. The overlapping between back negatives attests a continuous alternation between direct and inverse retouches for back reduction.The entire assemblage of unfinished *Malaurie* points present an irregular cutting edge which might be the reason for their abandonment before finishing the backing process. Their original width ranges between 12 and 18 mm. Any backed bi-truncated bladelet abandoned during construction was detected. However, analysing overlapping between back and truncations was possible to find out how truncations were equally shaped out before or after the back reduction.

Among diagnostic backing fractures, apical Krukowski microburins are the most represented (Tab. 1.36). The important number of this accidental breakage is likely related to the intention to point the apex before finishing the back (as seen on pieces under construction).

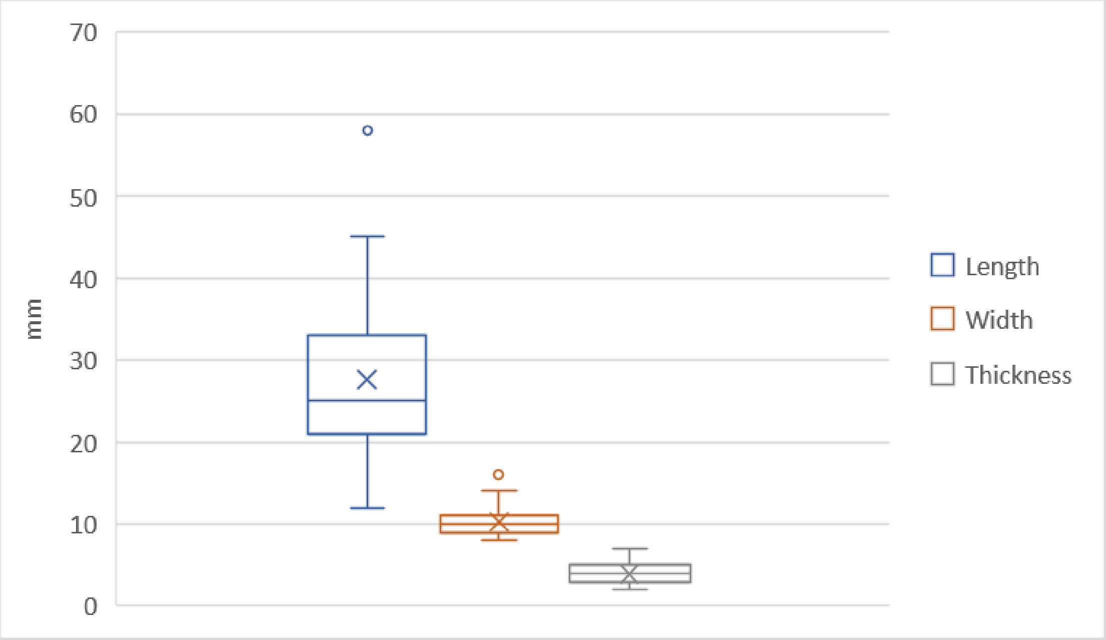


Figure 1.24 – Backed bi-truncated bladelets size.

Table 1.36 - Diagnostic backing fractures.

Type of fracture	n
Krukowski microburin	28
Distal apical	15
Proximal	6
Distal	5
N.D.	1
With truncation	1
Snap in notch	1
Snap termination bending fractures	4
Cone fractures	1
Total	34

1.2.3.4. Retouch techniques

1.2.3.4.1. Low power approach

Considering the entire assemblage of complete and almost complete *Malaurie* points and backed bi-truncated bladelets a major exploitation of pressure by organic tool was documented. This technique was detected on thin blanks shaped by marginal retouches as well as on thick blanks reduced by deep retouches. In fact, backs are often characterised by a regular sequence of removals composed by elongated, flat and sub-parallel negatives and a linear longitudinal profile (Fig. 1.26 a-b). The edge tends to be "fresh" with scars characterised by large impact points (sometimes even bending) and a diffused or absent bulb negative (Fig. 1.26 c-d). Several artefacts present sharp residual indentations (as seen from the ventral face) as well as extremely invasive removals on the dorsal surface (micro-overshots), highly diagnostic of this technique.

Although few items present a regular sequence of removals associated to a slightly rounded edge and punctiform negative initiations, the use of a pressure technique applied by a lithic retoucher is uncertain. Lithic armatures from layer 2, being frequently higher than 3 mm are not suitable to be shaped by this technique (see Chapter 3.2.1.2.1 Part 1). In this specific case the use of a high-power approach is recommended to confirm the use of a stone compressor.

Features diagnostic of soft stone percussion on anvil were also recorded. Some artefacts present a retouch sequence characterised by deep fan-shaped negatives with pronounced bulbs (Fig. 1.26 e), micro-step terminations and single or grouped incipient cones located far from the edge (Fig. 1.26 f). However, its exploitation seems to be occasional and related to the accomplishment of specific tasks:

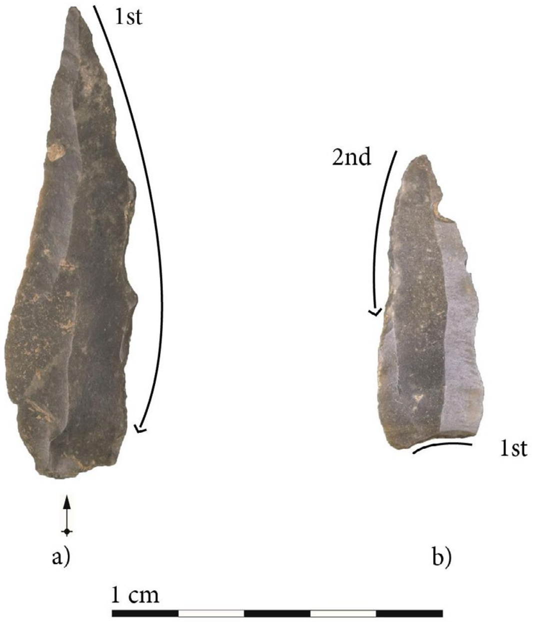


Figure 1.25 – Malaurie points abandoned during construction. a: backing process starts from the apex and the basal truncation has not yet been applied; b: the basal truncation is shaped first and then the back.

- the shaping of some extremely thick backs
- the removal of residual protuberans that prevent the prosecution of the back reduction by direct or inverse blows
- the first steps of reduction on wide blanks. The dimensions of some blades and the number of retouch sequences required to shape out the back, make it difficult to believe in the systematic use of pressure by an organic tool throughout the entire *façonnage* process being an extremely slow technique. Therefore, it is likely the use of a mixed technique that provides an initial stage of back reduction by soft stone percussion on anvil shifting to pressure by organic tool in the end of the process. This hypothesis is confirmed by four *Malaurie* points abandoned after few reduction sequences carried out by soft stone percussion on anvil and by a good amount of Krukowski microburins

showing evidence (e.g., pronounced bulb and a clear hertzian cone formation) of a break generated by a percussion blow (n=10).

1.2.3.5. Diagnostic impact fractures

A detailed use-wear analysis was carried out on the entire assemblage presented in Table 1.22. 50 artefacts yielded diagnostic impact fractures: 15 *Malaurie* points, 11 backed bi-truncated bladelets and 24 backed truncated fragments (Tab. 1.37).

As far as *Malaurie* points are concerned, DIF's fractures were recorded both on the apical and basal portions. Apical fractures are burinations, step or feather-terminating *languette* and spin-off fractures. Basal fractures are mainly burinations that start from the truncation and develop along the cutting edge or the ventral face (Fig. 1.27 a-b). If fractures removing the apex are consistent with a distal position on the shaft, basal burinations may be the result of compression forces related to the presence of one or more backed bi-truncated bladelets forming a continuous cutting edge (Fig. 1.27 n. 1). Also the edge scars distributribution suggests an active role of the unretouched edge in *Malaurie* points. Unfortunately, current data cannot clarify whether *déjeté* and axial *Malaurie* points reflect different hafted modalities, e.g. an oblique latero-distal hafting for the former and a more "axial" one for the latter and even if the totality of Maluarie points are actually apical points or in some cases lateral implements (head item of backed bi-truncated bladelets row? see Fig. 1.27 n. 2)

Burination fracture developing from one of truncations (Fig. 1.27 c-d) is the main represented DIF recorded on backed bi-truncated bladelets. This type of breakage, together with artefacts morphology (i.e. double transverse truncation, calibrate thickness, standardised width and variable length), led to assume a hafting modality which provide at least one row of more than one backed bi-truncated bladelets positioned parallels with respect to the shaft.

As regards backed truncated fragments, features allowing to distinguish basal fragments of *Malaurie* points from broken backed bi-truncated bladelets exist, such as presence of basal complementary retouches, thickness values higher than 5 mm, slightly convex back delineation and a backed retouch locates on the left side of the blank. Following these criteria, among 24 backed truncated fragments presenting DIF, 16 were considered as *Malaurie* points fractured, whereas 8 as backed bi-truncated bladelets. Although any differences regarding fracture typology were recorded, secondary detachments (namely, spin-off and burin-like spin-off) and *languettes* are generally much longer on basal *Malaurie* points.

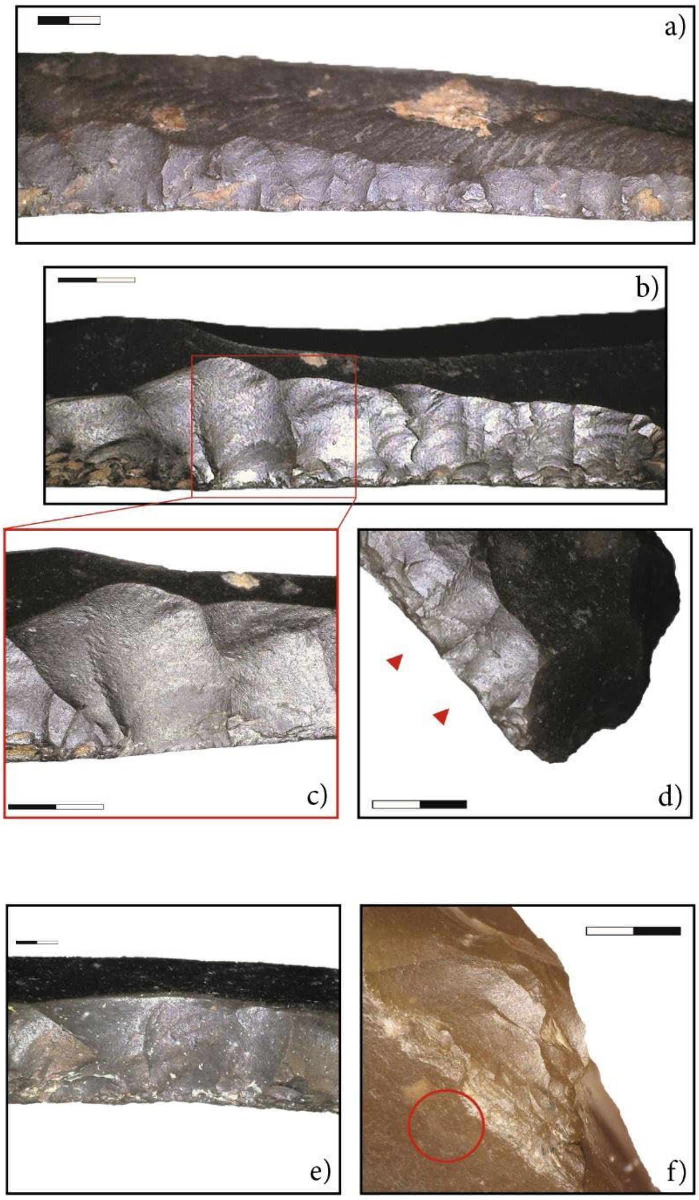


Figure 1.26 – Backs produced by pressure by an organic tool (a-d) and soft stone percussion on anvil (e-f). a-b: regular sequence of removals; c-d: negatives with large initiation; e: fan-shaped negative with pronounced bulbs; f: micro-step terminations and a single incipient cone located far from the edge (red circle).

Table 1.37 - Diagnostic impact fractures according to armature type.

***Malaurie* points**	**n**
Feather terminating bending with *languette* ≥ 4 mm	2
Step terminating bending with *languette* ≥ 4 mm	1
Double step terminating bending with *languette* ≥ 4 mm	1
Feather terminating transverse bending with *languette* ≥ 4 mm	2
Step terminating transverse bending with *languette* ≥ 4 mm	1
Spin-off ≥ 4 mm	1
Apical burination ≥ 4 mm	3
Basal burination ≥ 4 mm	4
Edge scars	4
Total fractures	**19**
Backed bi-truncated bladelets (*rectangles*)	
Feather terminating bending with *languette* ≥ 4 mm	1
Burination ≥ 3 mm	4
Edge scars	2
DIF - resumed	4
Total fractures	**11**
Backed truncated fragments	
Step terminating bending with *languette* ≥ 4 mm	5
Double step terminating bending with *languette* ≥ 4 mm	1
Feather terminating bending with *languette* ≥ 4 mm	4
Double feather terminating bending with *languette* ≥ 4 mm	1
Feather terminating transverse bending with *languette* ≥ 4 mm	1
Burin-like spin-off ≥ 4 mm	9
Spin-off ≥ 4 mm	1
Burination ≥ 4 mm	1
Edge scars	6
DIF - resumed	1
Total fractures	**30**

1.2.3.6. Recycling pieces

Observing Early Laborian armatures two main morphological groups were recognized according to the length reduction (Tab. 1.38). 38,18% of backed bi-truncated bladelets and 81,13% of *Malaurie* points are produced exploiting approximately the entire blank length (Fig. 1.22; Fig. 1.23). Their truncations are not very deep, sometimes even marginal, with a retouch angle ranging approximately between 40° to 65°. On the other hand, 18,87% of *Malaurie* points and even 61,82% of backed bi-truncated bladelets shows a major length reduction

(Fig. 1.28) evidenced by their considerable thickness compared to length along with remarkably deep and abrupt (around 70°-90°) truncations. Such truncations are normally applied after the back and a significant number of them (Tab. 1.28) cover a previous fracture. Four fractures are clearly diagnostic of a projectile function (e.g., Fig. 1.28 d), whereas the others are bending fractures with *languettes* not particularly developed (Fig. 1.28 a-c). However, the latter have a direction (initiation-termination) which tends to be from the retouch platform to the opposite surface. Since the experimental tests showed that bending fractures generated by a backing process normally have an opposite direction (see 1st experiment Chapter 3.2.1.2.6. Part 1) these fractures may have been caused by an impact.

By putting all this evidence together seem possible to assume a strong recycling process of projectile implements that appears into three different modalities:

- re-shaping of backed bi-truncated bladelets previously fractured

- re-shaping of apical fragments into complete *Malaurie* points

- re-shaping of basal fragments of *Malaurie* points into backed bi-truncated bladelets confirmed by the presence of several backed bi-truncated bladelets (n=9) with features normally attested on *Malaurie* points

Moreover, three artefacts show undoubted features of multiple re-shaping and re-using phases: a *Malaurie* point with a basal truncation covering a previous breakage and a following diagnostic impact fracture (Fig. 1.29 n. 1); a backed truncated fragment characterised by a DIF partially covered by truncation and a successive fracture linked again to projectile function on the opposite extremity (Fig. 1.29 n. 2); a Krukowski microburin removing a portion with a well-developed feather terminating bending fracture attesting, perhaps, a second re-shaping phase (Fig. 1.29 e).

Table 1.28 - Number of *Malaurie* points and backed bi-truncated bladelets showing a strong length reduction. Pieces abandoned during construction were not counted.

	n	%
***Malaurie* points not reduced**	86	81.13
***Malaurie* points reduced**	20	18.87
Visible resumed fracture	8	
Any fracture visible	12	
Total	106	100
Backed bi-truncated bladelets not reduced	21	38.18
Backed bi-truncated bladelets reduced	34	61.82
Visible resumed fracture	17	
Any fracture visible	17	
Total	55	100

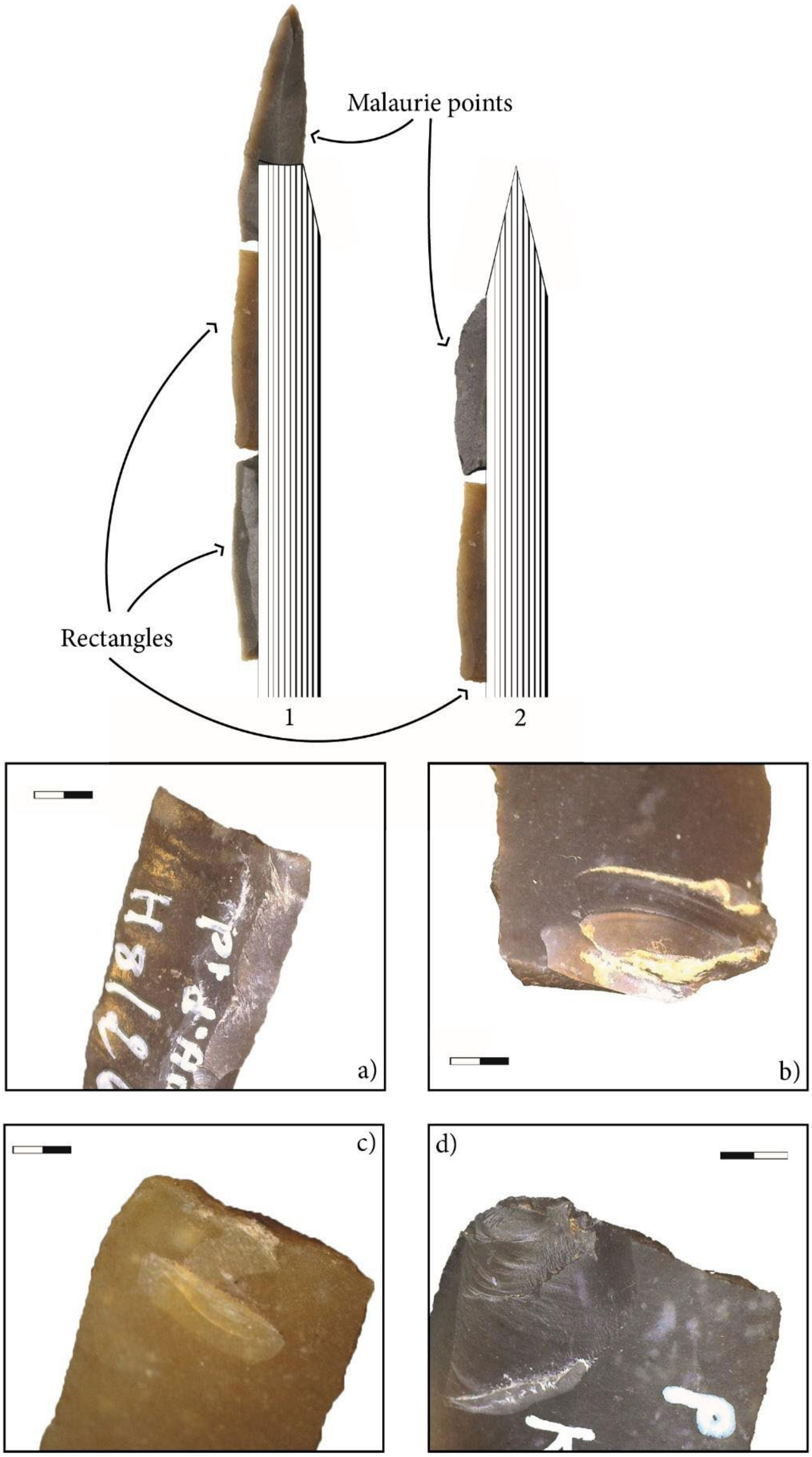


Figure 1.27 - 1-2: reconstruction of the projectile head design. a-b: burination starting from the basal truncation of Malaurie point; c-d: burination starting from one of the truncations of the *rectangle*.

Figure 1.28 – 1-4: recycled Malaurie points; 5-9: recycled backed bi-truncated bladelets; a-c snap fracture partially covered by truncation; d: burin-like fracture developed along the back resumed by truncation.

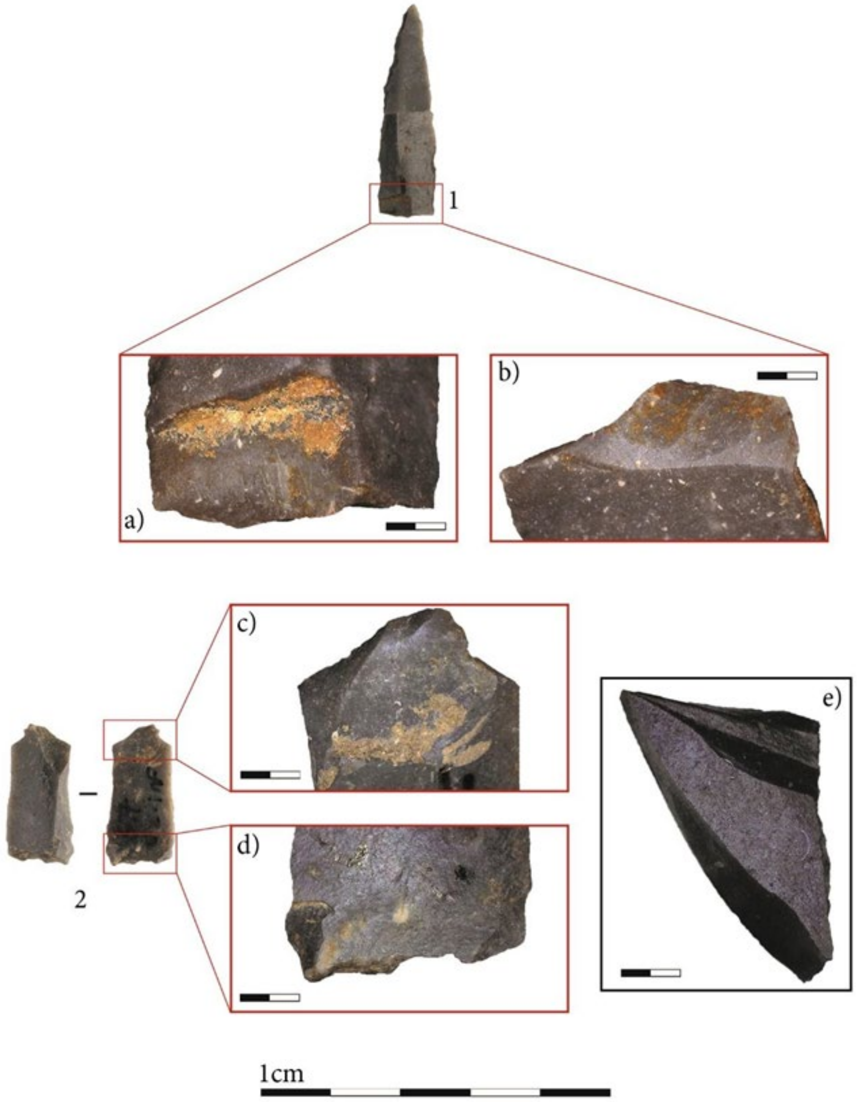


Figure 1.29 – 1: Malaurie points with an inverse basal truncation covering a previous breakage (b) and a following step terminating bending fracture (a) 2: a backed truncated with a burin-like fractures resumed by truncation (d) and a successive(?) DIF on the opposite extremity (c); e: Krukowski microburin opposite to a feather terminating bending fracture.

Chapter 2 - The *grotte-abri* du Moulin (Toubat)

2.2. Site introduction

The site of Troubat is located on the right slope of the Ourse valley at 541 m. a.s.l. in the municipality of Troubat-en-Barousse. The rock-shelter/cave, known also with the name of *grotte-abri du Moulin*, develops in the Mesozoic limestone deposits forming the northern border of the Pyrenees. The site was discovered between 1868 and 1870, but the first interventions were carried out by É. Lartet and A. Clot only in 1967 (San Juan, 1997). After several abusive excavations, especially on the external part of the sheltered area, M. Barbaza (University of Toulouse – Le Mirail) began in 1986 a systematic excavation until 2002. At the beginning the research was focused on the external part over an area of 20 m^2 and a depth of around 3 m. In 1995, fieldworks were extended to the inner zone of the cave (about 40 m^2) (Fig. 2.1). The stratigraphic sequence was divided into three main phases (Fig. 2.1):

- Phase I: Middle Magdalenian levels (from L.13 to L.11)
- Phase II: Upper Magdalenian – Azilian transition (from L.10 to L.6)
- Phase III: Early Laborian/Mesolithic levels (from L.5 to L.3)

Phase I corresponds to occasional and sporadic occupations that led to the formation of thin archaeological levels with few lithic and bone artefacts. Diagnostic of the Early Middle Magdalenian is the presence of some Lussac-Angles points from layer 12.

Phase II shows a more intensive human occupation. Layer 10 to 8 yielded artefacts characteristic of the Upper Magdalenian tradition, such as elongated scalene triangles and harpoon. Layer 7 attests to a lithic industry clearly ascribable to the Upper Magdalenian, but radiocrbon dates are referred to the Bølling-Allerød interstadial (Tab. 2.1). M. Barbaza based on this evidence claimed the existence of a Terminal Magdalenian in the Pyrenean area during the Allerød period, thus contemporaneous with Early Azilian sites documented in the rest of France (Barbaza, 2011, 2009, 1997). Layer 6 differs from layer 7 by a much darker colour, likely due to organic remains and red pigments impregnation (Barbaza, 2009). The human frequentation is dated to the beginning of the Younger Dryas (Tab. 2.1) and presents all elements of the "*Azilien Classique*" as it was defined by M. Barbaza (1997), such as backed points, unguiform endscrapers, flat and pine-like harpoons and painted pebbles.

Phase III is characterised by an enormous anthropogenic snail shells deposit, which is a recurrent phenomenon on the Pyrenean sites during the Mesolithic. Human occupation is sparse, and the periods of occupation are probably short and repetitive (Heinz and Barbaza, 1998). Layer 5 yielded evidence of some mixing of Late Azilian, Early Laborian and Sauveterrian materials. Layers 4 and 3 are referred to the Sauveterrian.

To sum up, from the top to the bottom the sequence is as follows:

- SU 1: Rework layer

- SU 2: Rework layer. Fireplace referred to the Bronze Age.
- SUs 3-4: Sauveterrian
- SU 5: Azilian / Early Laborian / Sauveterrian
- SU 6: Late Azilian
- SU 7: Terminal Magdalenian
- SUs 8-10: Upper Magdalenian
- SUs 11-13: Middle Magdalenian

Table 2.1 – Radiocarbon dates

Sample type	**Layer**	**BP**	**Cal BP (2 sigma 95.4% probability)**	**Facies**	**Laboratory Identifier**	**Reliability**
Charcoal	3C (bottom)	8620 ±80	9476-9888	Sauveterrian	Ly-5273	Yes
Charcoal	4	8880±75	10199-9706	Sauveterrian	Ly-5271	Yes
Charcoal	5b	8890±75	10206-9708	Sauveterrian	Ly-5274	Yes
Charcoal	5c	9700±75	11244-10782	Late Azilian / Early Laborian / Sauveterrian	Ly-6405	Yes
Cervus elaphus	6	10225±45	12115-11766	Late Azilian	Ly-9968	Yes
Charcoal	6 (bottom)	10770±100	12878-12439	Late Azilian	Ly-5275	Yes
Charcoal	7a	9530±195	11277-10256	Terminal Magdalenian	Ly-6404	No
Charcoal	7b	11320±410	14301-12239	Terminal Magdalenian	Ly-5272	No
Charcoal	7	11520±100	13552-13156	Terminal Magdalenian	Ly-913	Yes?
Harpoon	7	11990 ± 70	14077-13675	Terminal Magdalenian	Poz 73863 (AMS)	Yes?
Cervus elaphus	8	12860±60	15601-15146	Upper Magdalenian	Ly-9969	Yes
Rangifer tarandus	8	13040±60	15847-15336	Upper Magdalenian	Ly-9970	Yes
Charcoal	11	11450±95	13462-13109	Middle Magdalenian	Ly-914	No
Charcoal	13	14270±135	17770-16981	Middle Magdalenian	Ly-956	Yes

The site of Troubat allows providing the first long charcoal sequence in the central Pyrenees that gave important information concerning vegetational changes during the Late Glacial and the beginning of the Holocene (Barbaza and Heinz, 1992; Heinz and Barbaza, 1998). Evidence shows a transition from an open environment and a dry mountain or even subalpine climate of layer 10-7b (the end of GS-2), to warmer temperature during layer 7a (Bølling-Allerød. The increase of *Rhamnus* and Rosaceae in Layer 6 might be a response of the vegetation to the Younger Dryas cooling. At the beginning of the Holocene charcoals indicate a climatic amelioration and the establishment of deciduous oak forests (Heinz and Barbaza, 1998).

Archaeozoological analysis were carried by three different researchers: C. Costamagno (Costamagno, 2001, 1999) focused her efforts on macromammals remains, whereas V. Laroulandi (2007) and O. Le Gall (unpublished) on the avifauna and on the ichthyofauna respectively. The most ancient layers (L.13 to L.11) show a predominance of large ungulates: horse and especially large bovid (e.g., bison), followed by *Capra* cf. *pyrenaica* and reindeer. In the Upper Magdalenian levels (especially layer 7 - external zone) the faunal composition changes. Woodland species, such as red deer, roe deer and wild boar appearance. In layer 6 any significant changes are attested compared to layer 7. Medium-size ungulates (especially *capra* cf. *pyrenaica* and red deer) remain the most pursued prey. Except for snail shells consumption, no data concerning the last occupation phase (L.5 to L2) are available. Fishing activity is well documented during the Upper Magdalenian-Azilian transition, especially on layers 8, 7 and 6.

The lithic assemblage was studied from a typological viewpoint by M. Barbaza (Barbaza, 1996, 1989). Lately, S. Lacombe (1998) and C. Fat-Cheung (2015) developed a technological and raw material analysis on the Upper Magdalenian (L. 8) and Late Azilian (L. 6) assemblages from the external zone and on the Late Azilian layer (L. 6) of the internal zone. As far as the raw material concerned, during the Upper Magdalenian both local (Flysch, and Tertiary) and allochthonous flint (Charophytes, Chalosse, Grain de mil, Sénonien, Bergeracois and Verdier) was exploited. During the Late Azilian the raw material was almost entirely local including Flysch and tertiary flint and other local rocks such as radiolarite, microquartzite, quartzite and quartz.

2.2. Composition of the studied sample

The collection analysed comprised 391 elements (Tab. 2.2). They correspond to the entire armatures assemblage from Middle and Upper Magdalenian layers (both internal and external zone) and a sample of Late Azilian backed points of the inner zone (qq. G17, G18, G19, H17, H18 and H19). The entire lithic assemblage belonging to these squares were previously analysed by C. Fat-Cheung during her Ph.D thesis (Fat Cheung, 2015).

Table 2.2 - Armatures analysed according to stratigraphic layers.

Layers	Backed points	Backed bladelets and generic backed fragments	Scalene triangles	Backed truncated bladelets	Snap in notch and Mbk	Truncated bladelets	Total
13-11	-	21	1	-	1	-	23
10-8	-	112	14	14	2	-	142
7	-	125	1	10		2	138
6	87	-	-	-	1	-	88
Total	87	258	16	24	4	2	391

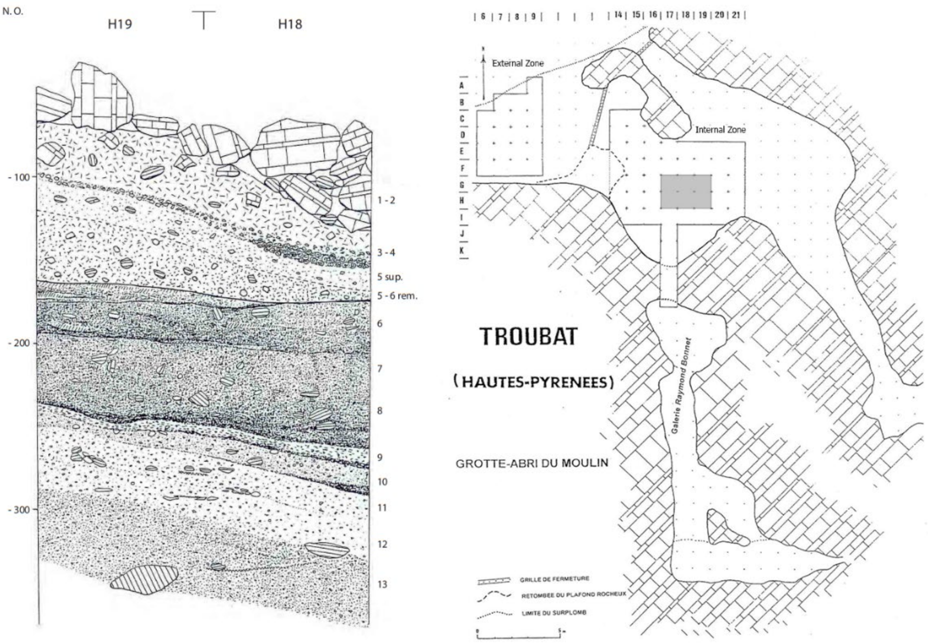


Figure 2.1 – The stratigraphic sequence and the planimetry of the site (from Fat-Cheung 2015 modified).

2.2.1. Magdalenian projectile implements

From a typological viewpoint three main types were attested: backed bladelets (LD), backed truncated bladelets (DT) and scalene triangles (Gm3). Following Laplace (1964) typology the former type can be attributed to the typological group of deep backed bladelets (LD2) and marginal backed bladelets (LD1), whereas the second one to the group of backed truncated bladelets with a single transverse truncation (DT1), a single acute truncation (DT3), a single obtuse truncation (DT4) or a double asymmetric truncation (DT5).

The integrity of the sample is severely compromised, only 31 armatures are complete. The rest of the items are fractured (Tab. 2.3).

In order to highlight diachronic variations along the stratigraphic sequence, the Magdalenian assemblage was divided into three groups according to the cultural attribution of each layer and the analysis was developed through comparison between them:

- 1st group: layer 13-11 (Middle Magdalenian)
- 2nd group: layer 10-8 (Upper Magdalenian)
- 3rd group: layer 7 (Terminal Magdalenian)

Moreover, since the high fracture index of the archaeological material and therefore the impossibility to systematically discern backed bladelets from backed truncated bladelets, these two categories of items were considered as a unique assemblage. Scalene triangles were analysed separately.

Table 2.3 – Integrity of the studied sample from Magdalenian layers.

Fractured armatures	n
LD prox.	67
LD dist.	45
LD mes.	115
LD n.d.	1
DT	22
Gm3	6
Complete/almost complete armatures	
DT	3
LD	18
Gm3	10

2.2.1.1. Backed bladelets and backed truncated bladelets

2.2.1.1.1 Blank selection

The low number of complete artefacts in addition to the lack of precise dimensional data of debitage products from each Magdalenian layer do not allow to systematically reconstruct the blank dimensional category for every item. However, considering complete artefacts the main exploitation of full debitage microbladelets (length < 36 mm) is attested. Among them two main morphologies were identified:

- **Banks Category (A)**, which includes blanks characterised by width higher than 5 mm and a flat cross-section probably related to a frontal or semi-tournant debitage of pyramidal or prismatic cores (Lacombe, 1998).
- **Blanks Category (B)**, which includes narrow blanks of 3-5 mm with a width-thickness ratio of around 2:1. They probably come from a burin-like exploitation of thick flakes or from the exploitation of narrow surfaces of the core. Among them, on edge blanks, naturally backed blanks, naturally double backed blanks and burin spalls are often documented.

Cross-sections are more often triangular than trapezoidal and profiles are both rectilinear and slightly curved, although the former are more frequently attested. Rarely negatives of the previous removals, visible on the dorsal face, indicate the use of blanks extracted by a bidirectional sequence. Butts, when preserved, are punctiform and plain, whereas the distal portion is often naturally pointed. At a general level, blanks selected are extremely regular in both their edges (almost systematically rectilinear) and thickness. Blanks with a thickness of 3 mm or more are rarerly documented.

The size of backed bladelets and backed truncated bladelets are presented in Table 2.4 dividing according to blanks selected (A vs. B). Any important variation is recorded along the sequence with the exception of slight increase of width of finished items and thickness of blanks belonging to the (A) category. Lengths include only complete and almost complete pieces. It is important to note that backed truncated bladelets are produced exclusively from the (A) blank category.

Table 2.4 - Backed bladelets and backed truncated bladelets size divided between artefacts produced on blanks belonging to the (B) category and those belonging to the (A) category.

LD (B category)	(L.13-11)			(L.10-8)			(L. 7)		
	Len.	Wid.	Th.	Len.	Wid.	Th.	Len.	Wid.	Th.
Minimum value	-	2	1	12	2	1	10	2	1
1° quartile	-	2	1	14	3	1	10	3	1
Median	-	2	1	16	3	1.5	13	3	1
Medium value	-	2.4	1.6	16.7.	2.8	1.5	14	2.8	1.3
3° quartile	-	3	2	20	3	2	16	3	2
Maximum value	-	3	3	21	3	3	21	3	2
SD	-	0.548	0.894	3.638	0.420	0.567	4.637	0.428	0.479
Total	-	5	5	7	32	32	5	47	47
LD/DT (A category)	(L.13-11)			(L.10-8)			(L. 7)		
	Len.	Wid.	Th.	Len.	Wid.	Th.	Len.	Wid.	Th.
Minimum value	-	4	1	12	4	1	17	4	1
1° quartile	-	4	1	18.75	4	1	20	4	1.25
Median	-	4	2	22.5	5	2	22	5	2
Medium value	-	4.4	1,9	23.8	4.9	1.9	23	5.1	2
3° quartile	-	4.25	2	28.75	5	2	24	6	2
Maximum value	-	7	3	38	10	3	41	9	5
SD	-	0.892	0.719	7.802	1.150	0.657	5.871	1.201	0.779
Total	-	16	16	20	94	94	18	90	90

2.2.1.1.2. Retouch methods

2.2.1.1.2.1. Backed retouch

Backs can be shaped exclusively by a single sequence of marginal and direct retouches with both an abrupt and semi-abrupt angle (Fig. 2.2 a) or adding a second and deeper sequence (Fig. 2.2 b and 2.4). Sometimes, this 2nd sequence of removals does not reach the distal extremity, due to the fact that blank edges tend to naturally converge (Fig. 2.2 and 2.4). A crossed retouch is well documented in the 1st group, while strongly decreases in Upper/Terminal Magdalenian layers (Tab. 2.5). The low percentage of crossed retouches in the 2nd and 3rd group is related to the thickness and width (and probably backing technique adopted; see Chapter 2.2.1.3.) of blank selected that rarely need the use of deep and inverse retouches to regularise the back delineation. On the contrary, the higher percentage of crossed retouches in the 1st group depends to the higher number of deep backs. As a matter of fact, marginal retouches gradually increase along the sequence reaching a percentage of around 70% in the 3rd group. The back delineation is almost systematically rectilinear and it is equally located on the right and the left side. The cutting edge is more frequently rectilinear than slightly convex.

Table 2.5 - Backed retouch extent, position and angle.

	1st gr.		2nd gr.		3rd gr.	
	n	%	n	%	n	%
Deep direct abrupt	7	33.33	39	30.71	45	33.33
Deep direct semi-abrupt	1	4.76	13	10.24	9	6.67
Marginal direct abrupt	3	14.29	29	22.83	33	24.44
Marginal direct semi-abrupt	3	14.29	37	29.13	45	33.33
Deep crossed abrupt	6	28.57	3	2.36	2	1.48
Marginal crossed abrupt	1	4.76	1	0.79	-	-
Marginal inverse semi-abrupt	-	-	1	0.79	1	0.74
Deep inverse semi-abrupt	-	-	2	1.57	-	-
Inverse flat	-	-	1	0.79	-	-
Total	21	100	127	100	135	100

The relationship between the main dorsal ridges and the back according to the blank cross-section reflects a high blank standardisation and a fairly normalised back reduction. In fact, only two main modalities were recorded. When blanks selected have a triangular cross-section the back stops before the main dorsal ridge all along the longitudinal axis (Fig. 2.3 a). Backs that reached partially or totally the main dorsal ridge are well documented only in the 1st group, whereas they are rare in the 2nd and 3rd ones. If the blank has a trapezoidal cross-section the backed retouch overpasses the 1st dorsal ridge (Fig. 2.3 b).

2.2.1.1.2.2. Complementary retouch

The use of a complementary retouch occurs in about 30% of the assemblage. Its function is to regulate the delineation of the cutting edge by marginal, direct and semi-abrupt detachments. Other types of retouches are rarely employed (Tab. 2.6). It is mostly applied on the mesial and distal portion, sometimes even all along the cutting edge contributing to regularize the artefact width and forming a sort of second back. The use of a complementary retouch decreases going up the sequence.

Table 2.6 - Complementary retouch extent, position and angle.

	1st gr.		2nd gr.		3rd gr.	
	n	%	n	%	n	%
Marginal direct abrupt	1	16.67	2	5.88	7	21.88
Marginal direct semi-abrupt	4	66.67	23	67.65	16	50.00
Marginal inverse semi-abrupt	-	-	1	2.94	3	12.50
Direct flat	-	-	3	8.82	-	-
Inverse flat	-	-	3	8.82	2	6.25
Deep direct abrupt	1	16.67	1	2.24	3	9.38
N.D.	-	-	1	2.94	-	-
Total	6	100	34	100	32	100

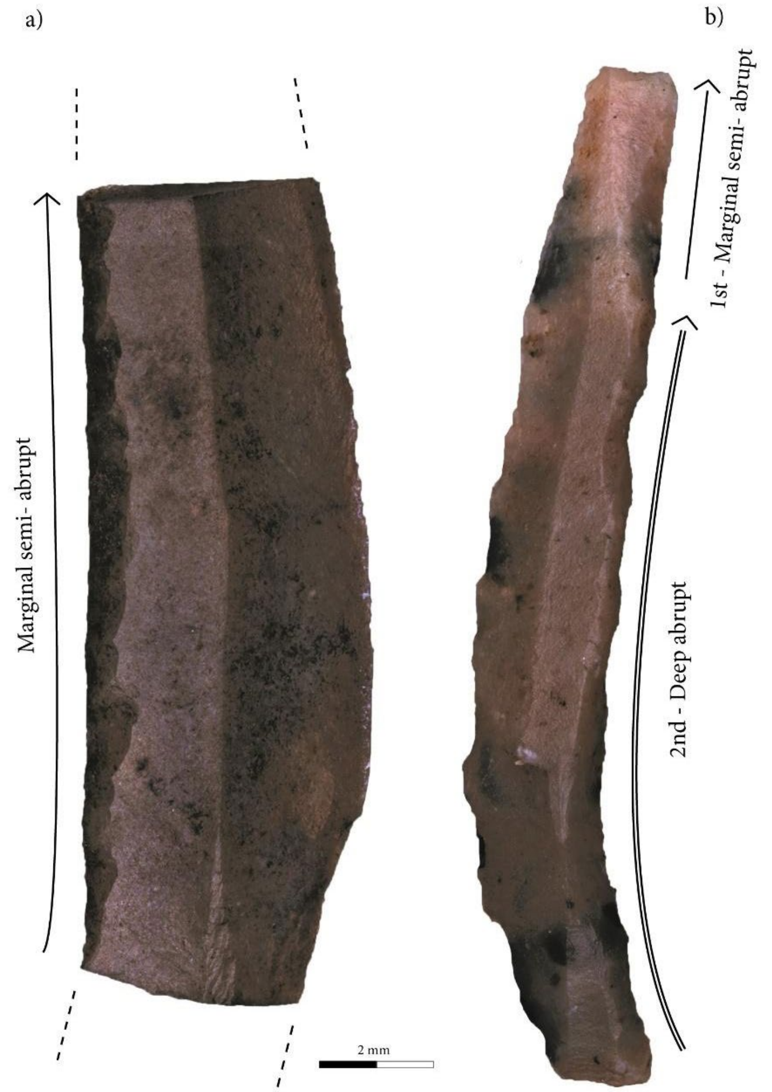


Figure 2.2 – Backed bladelets. a: back shaped by a single sequence of marginal, direct and semi-abrupt retouch; b: back shaped by a first sequence of marginal, direct and semi-abrupt retouch and then by a second one deeper and abrupt.

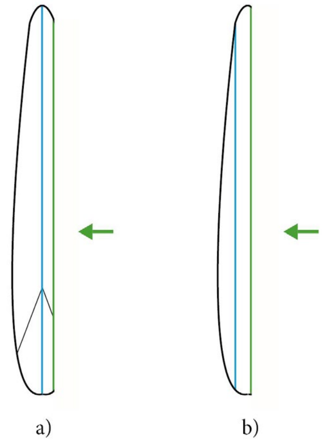


Figure 2.3 - – Different modalities of delineating a back. a: the back stops before reaching the main dorsal ridge; b: the back is positioned over the 1st dorsal ridge. Blue lines=dorsal ridges. Green line=backs.

2.2.1.1.2.3. Truncations

Items presenting a truncation counting a total of 25 (Fig. 2.4 d). Only three of them are complete. Two have a single truncation (one proximal and one distal) and they measure 12 x 6 x 2 mm and 36 x 10 x 3 mm respectively. The third one has a double asymmetric truncation and its dimension is 27 x 6 x 2 mm. Backed truncated fragments are both distal (n=7) and proximal (n=11). Four are indeterminable. The retouch is mainly marginal, direct and abrupt when applied in the proximal portion, whereas it tends to be semi-abrupt if located in the distal extremity. Deep truncations are rarely recorded. Their orientation tends to be transverse. By analysing the overlapping between the back and truncations, the latter is applied at the beginning of the shaping process (Fig. 2.5). The identification of two microbladelets characterised by a single truncation but without a backed retouch could be interpreted as backed truncated bladelets abandoned under construction.

2.2.1.1.3. Morpho-types

As far as the backed bladelets concerned, three morpho-types were identified according to the blank category selected (A vs. B) and the morphology of the distal portion (pointed vs. not pointed). Backed bladelets produced on blanks belonging to the B category present systematically a pointed distal portion and often a curved profile (Fig. 2.4 a), whereas those produced on blanks of the A category have both a pointed (Fig. 2.4 b) or not pointed extremity (Fig. 2.4 c). In this case profiles are more frequently rectilinear. Most of the time the pointed morphology of the distal portion merely depends on the convergence between a convex cutting edge and a rectilinear back. Only in a few cases a marginal complementary retouch is applied to point an apex.

2.2.1.2. Scalene triangles

Scalene triangles count a total of 16 items (Fig. 2.6). The majority of them come from the 2nd group, especially from layer 8 (Tab. 2.2). Blanks selected are the same attested for backed bladelets and backed truncated bladelets (see Chapter 2.2.1.1.1.). From a dimensional point of view those triangles produced from blanks belonging to A category have a lower length/width ratio (length: 11-19; width 4-6; thickness: 1-2), while the others are characterised by an extremely elongated shape (cf. *pointes à troncature oblique*) (length: 8-13 mm; width 2-3 mm; thickness: 1-2 mm). The backing process involves firstly the manufacture of a back and then of the basal truncation aimed at pointing two tips: a distal one (1st apex) and a lateral one (2nd apex). Truncations are systematically proximal with an obtuse or sometimes a more transverse orientation. The butt and the bulb are removed without the use of the microburin blow technique. In fact, any *piquent trièdre* or microburin was observed. Only one element does not present a 1st apex (Fig. 2.6, the first one on the left; c.f. *lamelles scalène*). The backed retouch is applied by deep, direct and abrupt retouch, sometimes marginal and semi-abrupt. The functional edge is left unretouched.

Figure 2.4 – Morpho-types. a: narrow pointed backed bladelets; b: pointed backed bladelets; c: not pointed backed bladelets; d: backed truncated bladelets.

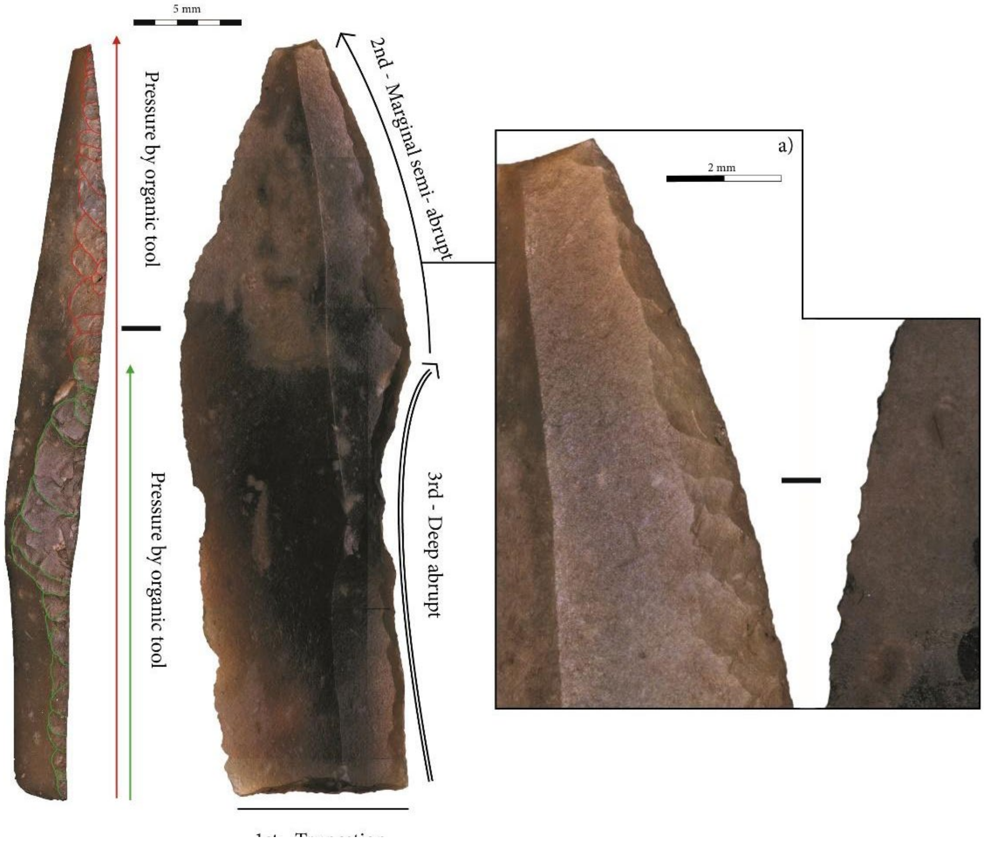


Figure 2.5 – Backed truncated bladelet (perhaps abandoned during construction) shaped by firstly a basal truncation, then a marginal semi-abrupt backed retouch sequence partially resumed by a successively deeper and abrupt retouch sequence. The a) box shows the detail of a marginal retouch applied by a pressure by organic tool with diagnostic residual indentations as seen from the ventral face.

Figure 2.6 – Scalene triangles.

2.2.1.3. Backing techniques

2.2.1.3.1. Low power approach

In order to identify the backing technique applied to shaped Magdalenian armatures a morpho-scopic analysis through a stereomicroscope has been carried out on the entire assemblage presented in Table 2.3. The majority of backs are characterised by elongated, flat and sub-parallel detachments with a diffused bulb negative and a regular depth. Such features are consistent with a backing technique applied by a pressure gesture. Evidence of large initiations (Fig. 2.7 a) and residual indentations visible from the ventral face (Fig. 2.5 a), associated to fresh edges, suggests the use of an organic compressor. Sometimes, these three elements are missing, giving way to slightly rounded edges and negatives with punctiform initiations diagnostic of a stone retoucher. Since stone retouchers are easily collectable and do not require any investment in their shaping, pressure by soft stone may be an occasional solution related to an immediate need.

A small assemblage of thick armatures (> 2 mm) is characterised by a completely different backed retouch. Negatives have a fan-shaped outline (Fig. 2.8 a) and sometimes clear incipient cones far from the retouched edge are visible on the ventral face. These morphologies are highly diagnostic of soft stone percussion on anvil. The absence of traces related to the recoil effect indicates that the anvil was probably made by organic material.

Focusing on the 2nd and 3rd group (the 1st one counts a too low number for highlighting specific trend), the only significant variation regards a slight increase of soft stone percussion on anvil due to the selection of some irregular and thicker blanks.

The use of a mixed technique was occasionally attested (Fig. 2.9). Percussion was used to reduce thicker portions, generally the proximal ones, and pressure was applied to shape the distal ones.

The low thickness values of selected blanks and the brief transformation process through one or at most two retouch sequences explain the major exploitation of a pressure technique rather than percussion.

2.2.1.4. Fractures analysis

Among the huge number of fractured pieces, only 27 yielded diagnostic impact fractures (Tab. 2.7). They are two geometrics, three backed truncated fragments, six pointed backed bladelets and 16 generic backed fragments. In six cases they are associated with edge scars. 15 artefacts show lateral impact scars morphologically attributable to those attested by experimental throwing of Magdalenian microliths (category n°1 and category n° 2 in Roux et al., 2020), but they are not associated with DIF. All these damages attest the use of these armatures as projectile implements.

Backed bladelets and backed truncated bladelets were probably placed laterally with respect to the shaft. Going further into interpretations is complicated since previous studies were unable to identify fracturing patterns according to the projectile head design (Roux et al., 2020). However, the high number of burin-like spin-off and spin-off fractures (Fig. 2.10 a, d, e), related to compression forces, may be the results of microlithics hafted in multiple rows with a sub-parallel or oblique position (Duches, 2011). As suggested by Pétillon et al. (2011), in order to avoid failure in penetration, backed bladelets with a pointed extremity and a slightly convex functional edge (Fig. 2.4 b) could have been located as the head item of the microlithics row, followed by not pointed backed bladelets and backed truncated bladelets. It would be interesting to find out if the different morphology of pointed backed bladelets pro-

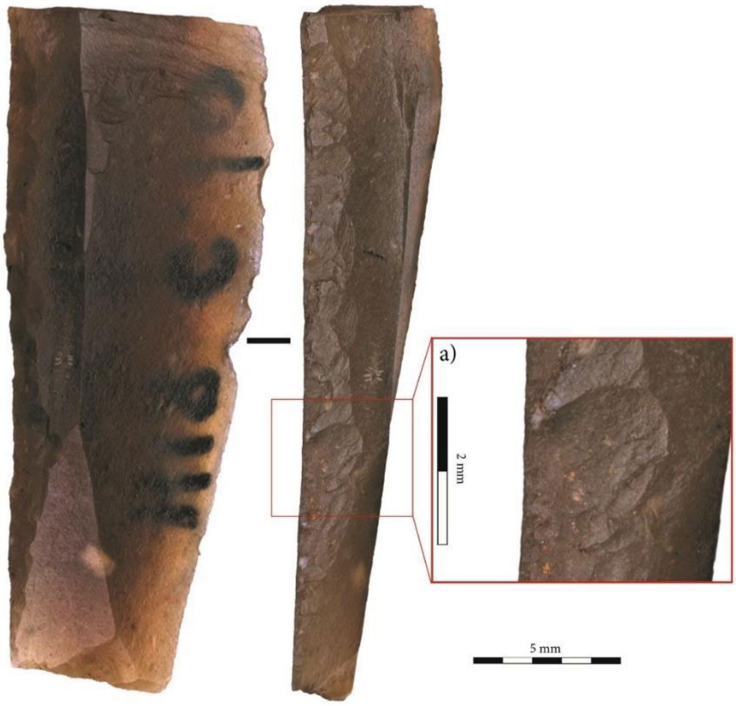


Figure 2.7 – Marginal and semi-abrupt back produced by pressure by an organic tool. a: negative with large initiation.

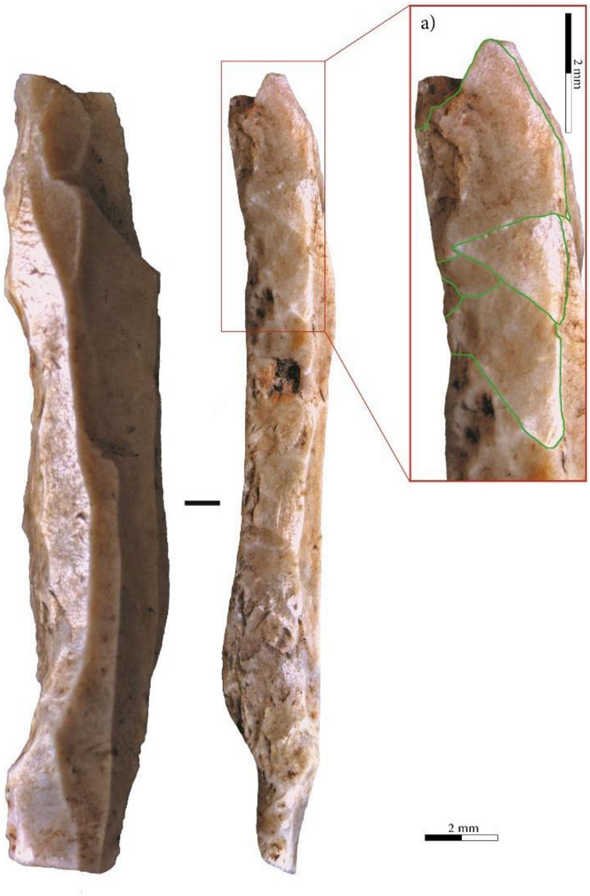


Figure 2.8 – Deep and abrupt back produced by soft stone percussion on anvil. a: Negatives with a fan-shaped outline.

Figure 2.9 – backed bladelets shaped using soft stone percussion on an anvil on the proximal portion and a pressure technique on the distal one. a: incipient cones (some of them far from the retouch edge) visible from the ventral face diagnostic of soft stone percussion on anvil.

duced on blanks of the B category (Fig. 2.10 g, i), compared to other armatures, corresponds also to a different hafted method (axially with a perforating apex? Bars with an apex playing a retentive role?).

As far as scalene triangles concerned, the two identified fractures are diagnostic of a latero-distal position (Chesnaux, 2014): the step terminating transverse bending fracture in correspondence with the 1st apex indicates a perforeting function (Fig. 2.10 h), while a burination on the 2nd apex suggests a retentive role (Fig. 2.10 f).

The number of artefacts that yielded non-diagnostic impact fractures is relatively high and comprised 260 microliths. Christensen and Valentin (2004) proposed in the site of Étiolles an intentional blanks breakage during the façonnage phase without using the microburin blow technique. However, basing on our experimental results (Chapter 3.2.3. Part 1), such a practice is not consistent with fractures observed in Magdalenian layers of Troubat. Fractures are mostly bending with a snap termination, a vertical profile and a rectilinear delineation (n=207). During our experimentation this morphology was attested exclusively with the “double foothold bending" technique which is, in our opinion, ineffective because fracture orientation and location are difficult to control. Being associated with complete backs, these backed fragments can not even be ascribed to the manufacturing process. The thinness and fragility of Magdalenian microlithics makes them easily vulnerable to post-depositional mechanical alterations which should be considered as the principal cause of the high fracture index of the assemblage. A refitting activity has been conducted but only 8 backed fragments were matched.

Table 2.7 - Diagnostic impact fractures variability and edge scars according to each type of armatures.

Backed fragments	n
Step terminating bending with languette ≥ 2 mm	5
Feather terminating bending with languette ≥ 2 mm	1
Step terminating transverse bending	2
Feather terminating transverse bending	3
Burin-like spin-off ≥ 2 mm	5
Edge scars	10
Total fractures	26
Pointed backed bladelets	
Step terminating transverse bending	1
Feather terminating transverse bending	1
Burination ≥ 2 mm	1
Burin-like spin-off ≥ 2 mm	2
Spin-off ≥ 2 mm	1
Edge scars	7
Total fractures	13
Backed truncated bladelets	
Step terminating bending with languette ≥ 2 mm	1
Burin-like spin-off ≥ 2 mm	1
Spin-off ≥ 2 mm	1
Edge scars	2
Total fractures	5
Scalene triangles	
Burination ≥ 2 mm	1
Step terminating transverse bending	1
Edge scars	2
Total fractures	4

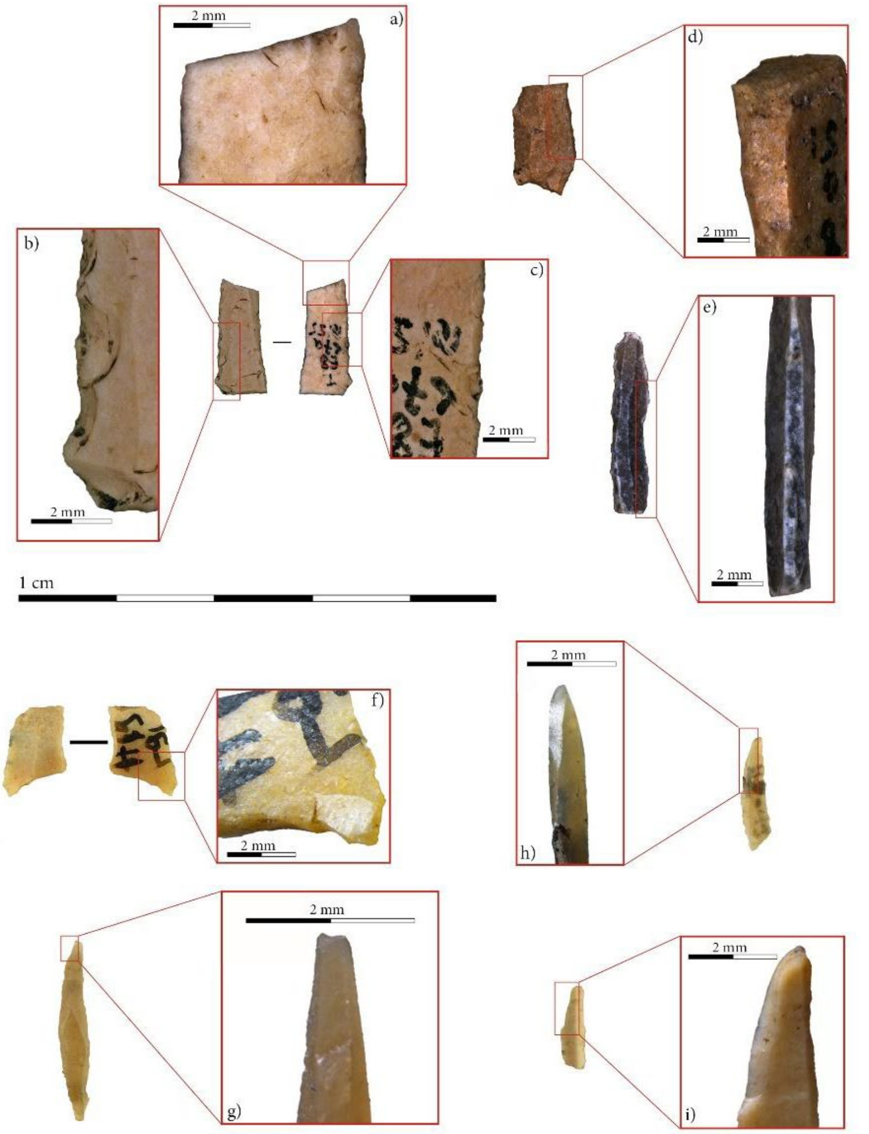


Figure 2.10 – Diagnostic impact fractures. a, d, e, g: burin-like spin-off fractures; b-c: edge scars; h, i: transverse bending fractures.

2.2.3. Late Azilian backed points from layer 6

The selected sample is composed of 35,23% of complete pieces, 47,73% of almost complete and 17,05% of fragments (11 are apical and 4 are basal). Nearly the entire assemblage is consistent with the PD4 (total backed points) type of Laplace (Tab. 2.8). Eight are PD2 (partial backed points), three PDD4 (double total backed points) and three DT7 (backed truncated points). One artefact has a double point (PPD4). As we already claimed, backed points here analysed are a selected sample and do not represent the totality of Late Azilian backed points of Troubat. The presence of mixing process with both the uppermost and lower layers is confirmed by the presence of Magdalenian backed bladelets and Early Laborian backed bi-truncated bladelets that were excluded from the analysis. Raw material selected for the production of backed points is represented by tertiary flint and Flysch, which outcrops at the base of the Northern slope of Pyrenees, not far from the site (around 50 km). Four artefacts were manufacture on allochthonous flint (i.e. Chalosse) and two items in microquartzite.

Table 2.8 - Composition of backed points assemblage according to Laplace's typology (1964). PD2 = partially retouched backed point; PD4 = total backed point; PPD4 = backed point with double tip; PDD4 = double backed point; DT7= Backed point with a transverse truncation; f = fragments.

	n	%
PD2	8	9.20
PD4	50	51.47
PDD4	3	3.45
PPD4	1	1.15
DT7	4	4.60
fPD4	21	24.14
Total	87	100

2.2.3.1. Blank selection

According to C. Fat Cheung (2015), who analysed the entire lithic assemblage from layer 6 (inner zone), reduction schemes were aimed at producing heterogeneous, wide and thick microbladelets (length < 35 mm) by unidirectional sequences resulting sometimes in elongated flakes. These two blanks dimensional categories (i.e. irregular microbladelets and elongated flakes) are the main supports transformed into backed points (Tab. 2.9) as suggested by thickness values (Tab. 2.10; interquartile range 3-4 mm) that perfectly fits into unretouched products variability (interquartile range: 2-5 mm). Regarding the nature of the original blank, beside full debitage laminar/lamellar products, a wide set of by-products were chosen. Among them the most attested ones are naturally backed blanks (n=10) and cortical blanks (n=5). Butts are sometimes preserved (n=32) showing a majority of plain and linear/punctiform morphology. Profiles are mainly rectilinear and occasionally slightly curved. Within this great morphological variability, the thickness seems to be the most important parameter that drives blanks selection (Standard Deviation of 1.256). Length and width of original blanks are more flexible and controlled by the backing process (Tab. 2.10; Fig. 2.11).

Table 2.9 - Blank dimensional categories selected for backed points production.

	n	%
Microbladelets	47	54.02
Bladelets	9	10.34
Elongated flakes	16	18.39
Flakes	6	6,90
Microbladelets/bladelets	5	5.75
N.D.	4	4.60
Total	87	100

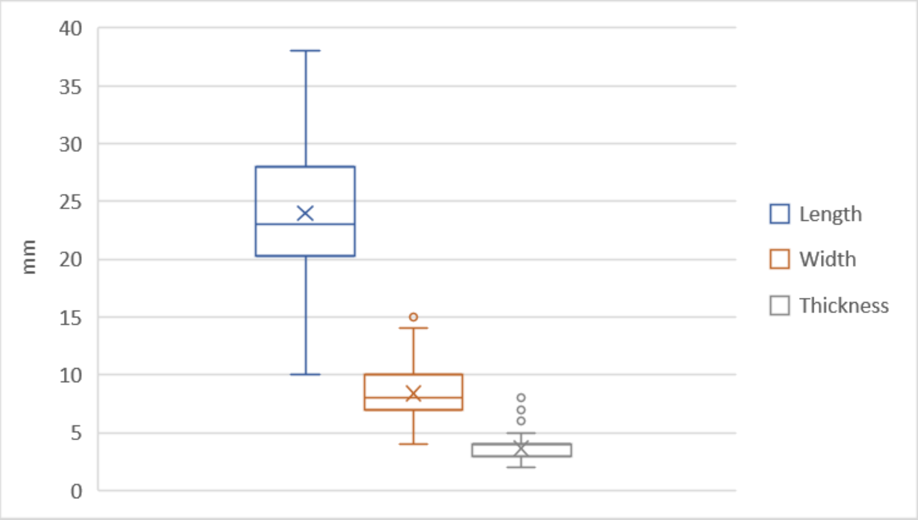


Figure 2.11 - Backed points size.

Table 2.10 - Backed points and backed truncated points dimensional classes of length, width and thickness.

	Len.	Wid.	Th.
Min. value	10	4	1
1st quartile	20.75	7	3
Median	23	8	4
Medium value	24	8.4	3.7
3rd quartile	28	10	4
Max. value	38	15	8
SD	5.411	2.059	1.256
Total	72	87	87

2.2.3.2. Retouch methods

2.2.3.2.1. Backed retouch

The backed retouch delineation is mainly curved, rarely rectilinear, as well as the cutting edge. In triangular cross-section blanks the back follows the main dorsal ridge in the mesial and basal portion crossing it for shaping a secant apex (Fig. 2.12 a). Backs located over the ridge all along the morphological axis are less frequent (Fig. 2.12 b). An important part of these latter are the result of the selection of lamino-lamellar products characterised by a triangular cross-section and an off-centre ridge or naturally backed blanks rather than a more intensive backed retouch. In case of trapezoidal cross-section blanks the back is positioned over the 1st dorsal ridge crossing the 2nd one to shape the apex (Fig. 2.12 c). Rarely the backing process reached the half of the original blank width as seen from the ventral face. The blank length reduction depends on the convexity of the back: more it is curved, higher is the reduction.

The backed retouch is deep, direct and abrupt in 41,38% of backed points and deep, crossed and abrupt in 47,38% (Tab. 2.11). Observing the overlapping between retouch negatives, it was possible to identify in several artefacts the use of two independent retouch sequences, one starting from the apical portion towards the mesial one, the other with an opposite direction (Fig. 2.13). When the back overpasses the main dorsal ridge of blanks thicker than 3 mm, a last sequence of inverse retouches is applied in the apical portion to thin the apex (Fig. 2.14 b). If blanks are thinner than 4 mm the back is shaped exclusively using direct retouches (Fig. 2.13 and 2.14 a).

Generally, the delineation of the back (as seen from the dorsal face) is more regular in the apical portion compared to mesial/basal one. This is related to:

- an inverse retouch applied to regulate the delineation of the back exclusively on the apical portion
- a change in backing technique adopted during the manufacture process (see Chapter 2.2.3.4)

Points are almost exclusively orientated following the morphological axis of the blank, thus with an apex located in the distal portion and the base on the proximal one (74,71%), which is often left unretouched. An opposite orientation is sometimes attested (13,79%). Two backed points are positioned transversally on large flakes. The apex can be shaped in an axial position by the convergence between two slightly curved edges or can be *déjeté* and therefore shaped by a curved backed retouch and a rectilinear functional edge or occasionally vice versa.

Table 2.11 - Backed retouch extent, position and angle.

	n	%
Deep direct abrupt	36	41.38
Deep crossed abrupt	41	47.13
Marginal direct abrupt	8	9.20
Deep inverse abrupt	1	1.15
Total	87	100

2.2.3.2.2. Complementary retouches and truncations

Almost half backed points (48%) present an additional retouch phase. This retouch can be longitudinal (i.e. complementary retouch) or transverse (i.e. truncation). Dividing the cutting edge in apical, mesial and basal portion we can observe a retouch mostly used to point the apex (Tab. 2.12). Among basal retouches, seven are employed to shrink the base, whereas four are transverse truncations applied to strengthen the distal extremity of proximal backed points. 43.48% of complementary retouches are marginal, direct and semi-abrupt (Tab. 2.13). Sometimes, they are deeper and abrupt and they modify the entire or at least 2/3 of the cutting edge forming a sort of second back.

Table 2.12 - Additional retouch localization.

	n	%
Apical	21	42.86
Basal	11	22.45
Mesial	4	8.16
Apical and mesial	7	14.29
Entire edge	5	10.20
N.D.	1	2.04
Total	49	100

Table 2.13 - Complementary retouch/truncation extent, position and angle.

	n	%
Marginal direct semi-abrupt	20	43.48
Marginal direct abrupt	6	13.04
Deep direct abrupt	11	23.91
Marginal crossed abrupt	2	4.35
Marginal inverse semi-abrupt	7	15.22
Total	46	100

2.2.3.3. Morpho-types

After presenting the production methods according to the entire assemblage, in order to better characterise Late Azilian backed points, technological data are displayed following the

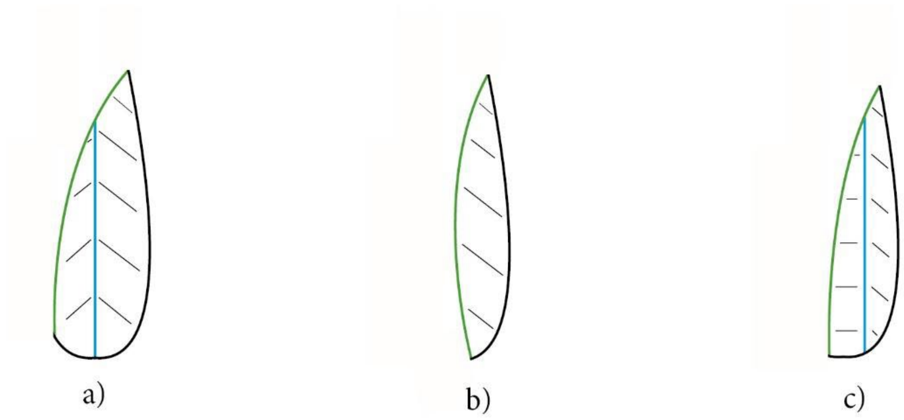

a) b) c)

Figure 2.12 - Relationship between the back and the main dorsal ridge according to blank cross-section. In a triangular cross-section blank the back follows the main dorsal ridge in the basal and mesial portion crossing it to shape a “secant” (a) or the back is entirely over the ridge (b). In a trapezoidal cross-section blank the back is located over the 1^{st} dorsal ridge and the apex is shaped by crossing the 2^{nd} dorsal ridge (c).

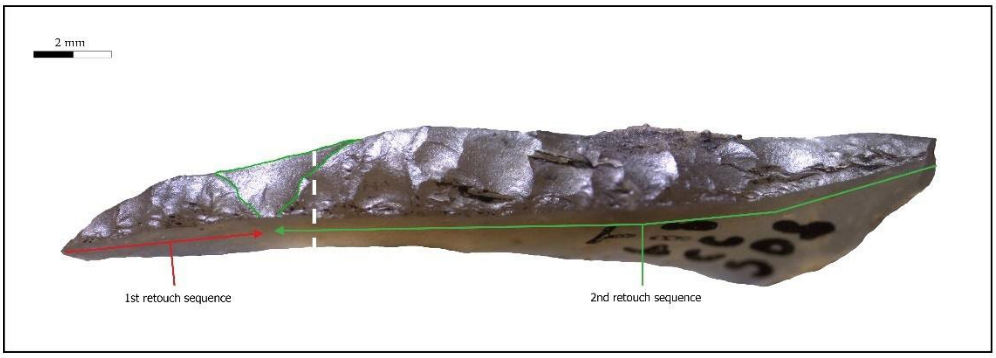


Figure 2.13 – Two opposite retouch sequences, one from the apex towards the mesial portion, the other from the base. The trace over negative is the last applied and corresponds to the point in which the two sequences merge.

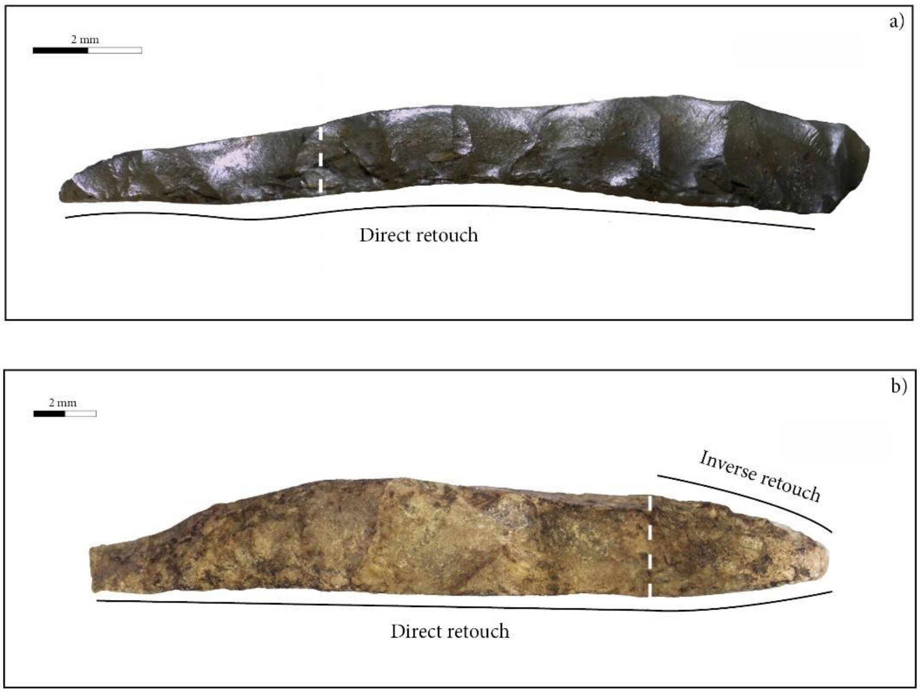


Figure 2.14 – a: backed point thinner than 3 mm produced by direct retouch; b: backed point thicker than 3 mm produced by an apical crossed retouch. Inverse retouches are applied oncethe back overpasses the main dorsal ridge (dotted white line).

subdivision into four morpho-types (Fig. 2.16) proposed by previous Authors (Barbaza, 1997; Fat Cheung, 2015). Their distinction is based on several technological parameters, such as blanks selection (microbladelets vs. elongated flakes/flakes), edges delineation (rectilinear vs. curved), apex position (*déjeté* vs. axial) and number of points (single vs. double):

- **Fusiform backed points** (Fig. 2.15 n. 1-11) are manufactured on microbladelets (sometimes naturally backed), elongated flakes and even flakes which is why they are often wide and short (width-length ratio lower than 1:3). When they are shaped on microbladelets they are more elongated (width-length ratio higher than 1:3). Length varies between 11-37 interquartile range: 20-26 mm), width between 6-13 mm (interquartile range: 7.5-10 mm) and thickness between 2-5 mm (interquartile range: 3-4.5 mm). This type of backed point has a symmetric shape with an apex and a base having an axial position compared to the morphological axis of the blank. The symmetry is achieved through two different methods. The first one consists of retouching the back following the delineation of the opposite edge and if the latter has a regular convexity, the symmetry is achieved without the use of any complementary retouches. The second method, which is the most frequent one, provides the use of an additional retouch phase, opposite to the back retouch, in the basal, mesial and/or apical potion (i.e. deep or marginal complementary retouch or even second back). One artefact has a basal transverse truncation.

- **Curved backed points** (Fig. 2.15 n. 12-22) are manufacture on thick lamino/lamellar blanks (mainly microbladelets), length 16-38 mm (interquartile range: 22-30 mm), width 4-11 mm (interquartile range: 7-9 mm), thickness 2-6 mm (interquartile 3-5 mm). This morpho-type presents an asymmetric shape delineated by a curved backed retouch and a rectilinear (or sinuous) cutting edge. The apex is located in correspondence with the functional edge (i.e. *déjeté*). At a general level, curved backed points have a width-length ratio higher or equal to 1:3. Sometimes marginal complementary retouches are applied to delineate the apex, rarely the base. Three of them have a basal transverse truncation.
- **Rectilinear backed points** (Fig. 2.15 n. 23-26) are manufacture on lamino/ lamellar blanks (mainly microbladelets), length 14-31 mm (interquartile range: 20-26 mm), width 4-9 mm (interquartile range: 6-8 mm), thickness 2-4 mm (interquartile 3-4 mm). The back is rectilinear opposite to a slightly convex cutting edge and it is located over the main dorsal ridge. Complementary retouches are exclusively employed to point the apex.
- **Curved backed bipoints** (Fig. 2.15 n. 27) are represented by one single item. Its dimension is 28 x 7 x 3 mm. Morphological and technological similarities can be detected with Early Azilian curved backed bipoints well documented in the rest of the French territory (Célérier, 1993a; Fat-Cheung et al., 2014; Mevel, 2013b; Naudinot et al., 2017a; Valentin, 2006). This morpho-type is rarely attested in the Pyrenees. Only few specimens are recorded in Isturitz layer Ia (Langlais, 2010) and in Rhodes II foyer 5 and 6 (Fat-Cheung, 2015 p.126).

Table 2.14 - Morpho-types attested at Troubat layer 6 and relative frequency.

	n	%
Fusiform backed points	42	48.28
Curved backed points	33	37.93
Rectilinear backed points	10	11.49
Curved backed bipoints	1	1.15
N.D.	1	1.15
Total	87	100

2.2.3.4. Backing techniques

2.2.3.4.1. Low power approach

A low magnification analysis allowed to attest to an important change in backing techniques compared to Magdalenian layers. The majority of backs present features related to soft stone percussion on an anvil (Fig. 2.16 a-b). Furthermore, on the dorsal face of several backed points we could observe several incipient cones associated to unintentional, isolated and short inverse retouches located on the mesial or basal portion (Fig. 2.16 b). These traces are the result of the recoil of a stone anvil. This was used to reduce thick blacks (> 4 mm) and to remove protuberances formed during the direct retouch. Points thinner than 3-4 mm do not present any of these features suggesting a shift from a stone anvil to an organic one.

The comparison between archaeological and experimental materials allowed also to hypothesise the use of a second backing technique: pressure by soft stone (Fig. 2.16 c). This technique was occasionally used as an independent technique to transform thin (1-3 mm) blanks (Fig. 2.16 c) and in association with soft stone percussion on anvil. In this case pressure was applied to shape the tip and percussion on an anvil to modify the mesial and basal portions (Fig. 2.16 b).

2.2.3.5. Fractures analysis

The low number of fractured pieces analysed do not allow a proper evaluation of breakages related to manufacturing process and those diagnostics of hunting activity. Both are poorly attested within the selected assemblage. Backing fractures are a total of four: cone fractures generated by a direct (n=2) or inverse (n=1) backed retouch and one Krukowski microburin. Diagnostic impact fractures amount to a total of 12. Although it is possible to hypothesis a different hafting modality according to morpho-type (based on their morphology), i.e. an axial position for fusiform backed points and rectilinear backed points and a latero-distal for curved backed points and bipoints, fractures observed do not permit to confirm it.

Table 2.17 - Diagnostic impact fractures and edge scars.

Fusiform backed points	**n**
Step terminating bending with *languette* ≥ 3 mm	3
Step terminating transverse bending	1
Burin-like spin-off ≥ 2 mm	2
Edge scars	3
Curved backed points	
Burination	1
Burin-like spin-off	1
Cuved backed bipoints	
Burin-like spin-off	1
Total fractures	12

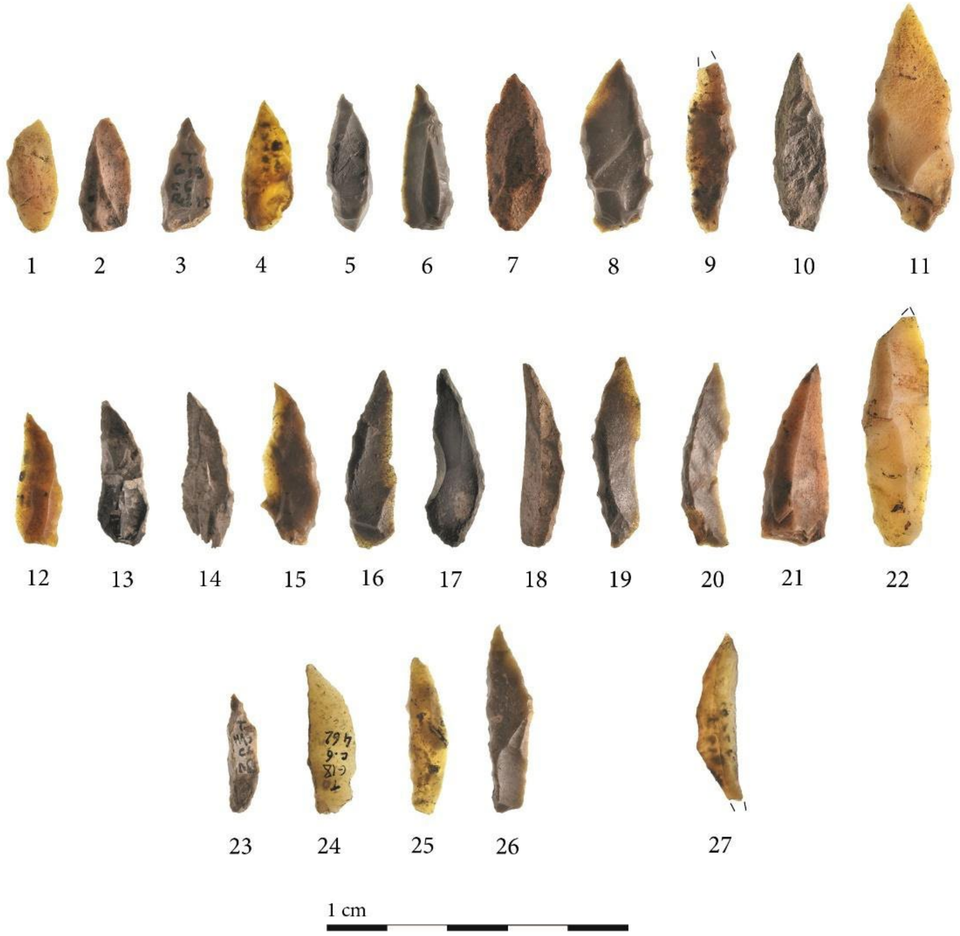


Figure 1.15 – Morpho-types. 1-11: Fusiform backed points; 12-22 Curved backed points; 23-26: Rectilinear backed points; 27: Curved backed bipoints.

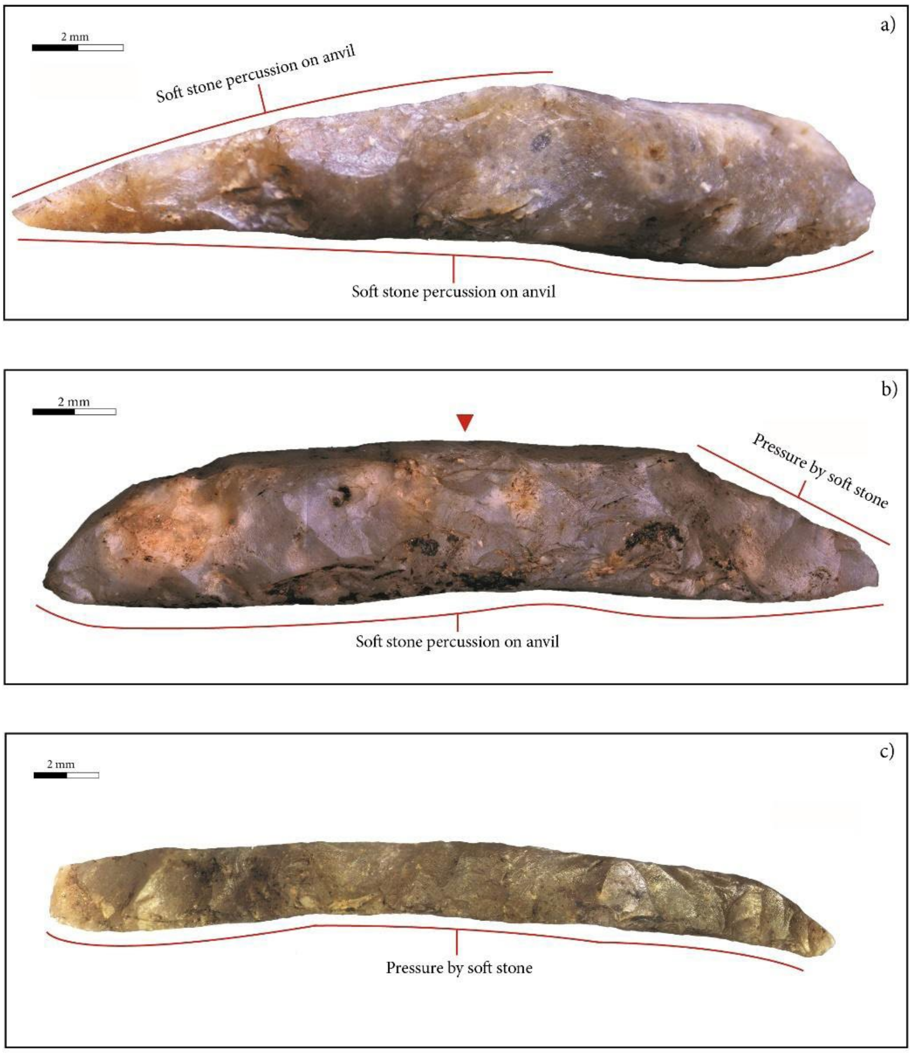


Figure 1.16 – Backing techniques. a: backed points manufactured by soft stone percussion of anvil; b: backed points manufactured by a mixed technique. The red triangle indicates an inverse removal resulting from the recoil of a stone anvil; c: backed points manufactured with pressure by soft stone.

Chapter 3 - Riparo Tagliente

3.1. Site introduction

Riparo Tagliente (VR, Italy) is located on the left slope of the Valpantena, one of the main valleys of the Lessini pre-Alpine massif, at 226 m a.s.l. It is considered a key-deposit for the Middle and Upper Palaeolithic in Italy. The site was discovered in 1958 (Zorzi, 1962) and initially investigated by the Museo Civico di Storia Naturale of Verona until 1967, then by the University of Ferrara under the direction of several Professors (P. Leonardi, A. Broglio, A. Guerreschi, F. Fontana). Researchers are still ongoing.

During the 1970s a stratigraphic trench running transversally to the rock-shelter and a smaller one located in the most internal area (southern sector) was excavated in order to investigate the entire archaeological sequence (Fig. 3.1) (Bartolomei et al., 1982). The stratigraphy (4.60 m thick) is characterised by two main deposits separated by a fluvial erosion. The lower one is attributed to the Mousterian (MIS 4-3; Arnauld et al., 2016; Bartolomei et al., 1982). A thin layer detected only in the internal area was referred to the Aurignacian. The upper deposit (layer 17-4) is dated to the Late Epigravettian, between 17.219-16.687 cal BP and 14.535-13.472 cal BP, which corresponds to the latest part of GS-2 and the first half of GI-1 (Fontana et al., 2018, 2009a). The most recent layers (7-4) are not dated (Tab. 3.1).

At the end of the 1970s, fieldworks in the Late Epigravettian series were extended to the whole northern sector over a total surface of around 45 m^2. This sector has been divided in 4 phases, then grouped in two macro-phases. The macro-phase 1 is composed of several occupation layers (SUs 13a *beta*, 301, 302, 303, 304, 307) and some hearth-pits (SUs 250, 264, 266, 310, 376, 305). The macro-phase 2 comprised occupation layers as well (SUs 13a *alpha*, 13a interno, 13a, 300, 369, 299, 313, 371), layers formed by the accumulation of different materials (SUs 357, 358) and hearth-pits (SUs 308, 232). For a detailed description of accumulation processes, relationship between layers, and sequence of deposition see Fontana et al. (2018).

The Late Epigravettian sequence shows an irregular thickness. It is thinner and more compact in the sheltered area and thicker in the external one, mainly due to a different spatial organisation adopted by Late Epigravettian groups. In this outer zone, over the river erosive surface, the Epigravettian deposit is constituted by a loess matrix mixed to a coarse breccia in the lowermost levels (layers 18-15), whereas breccia decreases in the uppermost ones (layers 14-5). An intense human occupation is suggests not only by numerous lithic artefacts (Bartolomei et al., 1982; Cremona, 2008; Falceri, 2014; Fontana et al., 2015; Gajardo, 2014; Liagre, 2005), faunal remains (Bartolomei et al., 1982; Capuzzi and Sala, 1980; Berto et al., 2017; Rocci Ris et al., 2007, 2005) and hard animal tissue industries (Cilli et al., 2006;), but also by mobile art (Veronese, 2006), ochre exploitation (Cavallo et al., 2017) and human remains (Bartolomei et al., 1982; Bortolini et al., 2021; Gazzoni et al., 2013). The oldest Late Epigravettian layers attests the earliest evidence of human recolonization in the Southern Alps after the Late Glacial Maximum.

Table 3.1 - Radiocarbon dates of layers analysed.

Layer	Sample type	Laboratory identifier	BP	Cal BP	Period	Reliable	Sample position
8-10	Charcoal	R-371	12040±170	14572-13430	Bølling-Allerød	Yes	Trench
419	Bone	Lyon-10034 (SacA 32399)	12.430±70	14966-14175	Oldest Dryas / Bølling	Yes	Northern sector (Ext.)
10a	Charcoal	OxA-3530	12650±160	15632-14111	Oldest Dryas / Bølling	Yes	Trench
13	Bone	Lyon-10033 (SacA 32398)	13.250±80	16186-15684	Oldest Dryas	Yes	Trench
13*a*	Bone	Lyon-10031 (SacA 32396)	13450±70	16438-15941	Oldest Dryas	Yes	Northern sector (Int.)
352	Bone	OxA-29834	13.600±60	16638-16179	Oldest Dryas	Yes	Northern sector (Ext.)
10c	Charcoal	OxA-3531	13070±170	16596-15117	Oldest Dryas	Yes	Trench
10e	Charcoal	OxA-3532	13270±170	16785–15273	Oldest Dryas	Yes	Trench
15	Charcoal	R-605	13.330±160	16851-15297	Oldest Dryas	Yes	Trench
15-16	Charcoal	R-605a	13.430±180	16932-15495	Oldest Dryas	Yes	Trench
300	Bone	Lyon-10030 (SacA32395)	13920±80	17160-16555	Oldest Dryas	Yes	Northern sector (Int.)
13a *alpha*	Charcoal	LTL4441A (Cedad)	13.986±60	17219-16687	Oldest Dryas	Yes	Northern sector (Int.)
Burial	Human bone	OxA-10672	13190±90	16634-15286	Oldest Dryas	Yes	Southern Sector
13a beta	Bone	Lyon-10032 (SacA 32397)	>45.000			No	Northern sector (Int.)

Figure 3.1 – Riparo Tagliente. A) the trench and the stratigraphic sequence.

3.2. Composition of the studied sample

The archaeological assemblage analysis counts a total of 437 armatures coming from the stratigraphic trench excavated in the 1970s and more precisely from layers 17÷4 (Tab. 3.2). In addition to 25 unidentified backed fragments, 59 pieces interpreted as abandoned during construction, 86 Krukowski microburins, 5 ordinary microburins and 21 snap in notch have been analysed. All these elements were previously studied by A. Guerreschi (Bartolomei et al., 1982) from a typological point of view and a selection of them by C. Montoya (2004).

Table 3.2 - Composition of the archaeological assemblage analysed. K.Mb=Krukowski microburin; Mb=Microburin; S in N= Snap in notch.

	Backed points	**Backed truncated points**	**Backed bladelets**	**Backed truncated bladelets**	**Geometrics**	**Pieces in const.**	**K. Mb.**	**Mb.**	**S. in N.**
	n	n	n	n	n	n	n	n	n
1st gr.	40	4	14	20	-	-	15	-	5
2nd gr.	35	9	9	8	1	-	40	-	5
3rd gr.	74	11	11	16	7	-	23	1	4
4th gr.	103	18	23	42	2	-	25	4	7
Total	252	42	57	86	10	59	83	5	21

In order to detect differences from a diachronic perspective along the Late Epigravettian sequence, layers were subdivided into 4 groups according to similarities in sediments formation processes (Bartolomei et al., 1982), palynological content (Bartolomei et al., 1982) and micro- and macrofaunal remains (Bartolomei et al., 1982; Berto et al., 2017; Capuzzi and Sala, 1980; Sala, 1985) and typology of lithic artefacts (Bartolomei et al., 1982). From a chronological point of view, the 1st (L. 17-14) and 2nd group (L. 13-11) can be referred to the latest part of GS-2, the 3rd (L. 10-8) is dated to the first half of GI-1 (Bølling), whereas the 4th group (L. 7-4) is undated, but probably refers to the beginning of the Allerød (Bertola et al., 2007). For a detailed discussion on available radiocarbon evidence see Fontana et al. (2018).

It should be pointed out that with respect to the original publication (Bartolomei et al., 1982) the total number of armatures is lower due to the exclusion of some artefacts that from a typological viewpoint (Laplace, 1964) has been considered as projectile implements, but they are not from a techno-functional one.

Raw materials selected for the production of armatures are mostly attributable to the Lower Cretaceous Maiolica Formation, which outcrops extensively in the Lessini area. This type of chert was the most used in the entire Late Epigravettian sequence. Chert from Scaglia Variegata and Scaglia Rossa Formation were flaked with a lower percentage. Few artefacts are made of Scaglia Rossa of the Umbria-Marche Apennines attesting to displacements of more than 250 km (Bertola et al., 2018).

3.2.1. Backed points

The analysed sample includes only complete (45,63%) or almost complete backed points (55,37%). Apical fragments were not taken into consideration. According to Laplace's typology (1964), backed points from Riparo Tagliente can mostly be attributed to the group of totals backed points (PD4). Backed bipoints (PPD4), double backed points (PDD4), partially retouched points (PD2) and marginal backed points (PD1) are also attested along the sequence.

Shouldered points (PD5 and PD6) are present only in the 1st and 2nd group. The presence of a concave partial backed point (PD3) is likely referable to pieces abandoned during construction (Tab. 3.3).

Table 3.3 - Composition of backed points assemblage according to Laplace's typology (1964). PD1 = marginal backed point; PD2 = partially retouched backed point; PD3 = concave partial backed point; PD4 = total backed point; PD5 and PD6 shouldered point; PPD4 = backed point with double tip; PDD4 = double backed point.

Stratigraphic groups	Total	PD1	PD2	PD3	PD4	PD5/6	PPD4	PDD4	
1st group (l. 14-17)	40	10	2	-	14	3	10	1	Ancient phase (last phase of GS-2)
2nd group (l. 11-13)	35	9	5	-	15	1	5	-	
3rd group (l. 8-10)	74	13	3	1	46	-	11	-	Recent phase (first half of GI-1)
4th group (l. 4-7)	103	8	9	-	61		24	1	
Total	252	2	19	1	174	4	50	2	

3.2.1.1. Blank Selection

As regards the assessment of the nature of the original blank, in most cases it was not possible to go further a generic elongated blank because of the invasiveness of the backing process. In others it was possible to appreciate the use of full debitage laminar/lamellar blanks. In some cases cortical and naturally backed blanks and elongated flakes (especially in the 4th group) are also attested. Blanks with double naturally backed edges (extracted from very narrow debitage surfaces) were identified mostly in the oldest layers (17÷10). In the ancient phase (1st and 2nd group) naturally backed pieces were retouched on the side opposed to the natural back, while from layer 10 onwards on the same one.

Butts are rarely preserved. Blank profiles are mostly straight, sometimes slightly curved. Twisted profiles are generally rare, although showing an increasing trend along the sequence (from 5% to 12.62%). The distinction between triangular and trapezoidal cross-sections was quite difficult and not always possible to carry out. The division between blank categories (blades, bladelets or microbladelets) was based on the value of thickness between the 1st and the 3rd quartile of microbladelets, bladelets and blades of previous studies (Tab. 3.4). Subtracting 15% (LRI calculated during 1st experiment, see Chapter 3.2.1. Part 1) of each blank category length we obtained that:

- backed points with length between 10-30 mm and thickness of maximum 3 mm come from microbladelets
- backed points with length between 31-50 mm and thickness between 3-5 mm come from bladelets
- backed points with length more than 50 mm and a thickness of more than 4 mm come from blades

In the case of ambiguous artefacts (dimensions attributable to different classes) the choice was based on the morphology of the piece or mixed categories were used.

Table 3.4 - Thickness of each blank category coming from SSUU 13a, 13a alfa, 13a beta, 300, 301, 307, 367 and 369.

Thickness	Microbladelets (length: 10-35 mm)	Bladelets (length: 36-59 mm)	Blades (length: > 60 mm)
Minimum value	1 mm	1 mm	3 mm
1st quartile	2 mm	3 mm	5 mm
Medium value	3 mm	4 mm	7 mm
3rd quartile	3 mm	5 mm	8 mm
Maximum value	6 mm	13 mm	15 mm
Total blanks	473	270	37

Blank dimensional category (blades, bladelets or microbladelets) has been evaluated only for elongated and wide backed points (cf. morpho-typological categories) (Tab. 3.5). Asymmetric curved backed monopoints were excluded since the LRI was calculated during the experimental production of standardised types. At a general level microbladelets were the most exploited type of blank. Nonetheless, changes along the Late Epigravettian sequence are visible: in the most ancient layers (1st and 2nd group) microbladelets are clearly dominant, while in the 3rd and 4th group bladelets increase significantly as well as elongated flakes.

Table 3.5 - Blank dimensional categories selected for asymmetric and symmetric backed points production.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Microbladelets	23	69.70	19	70.37	35	50.72	43	46.24
Bladelets	9	27.27	8	29.63	28	40.58	36	38.71
Blades	-	-	-	-	-	-	3	3.23
Bladelets/Blades	-	-	-	-	2	2.90	1	1.08
Elongated flakes	1	3.03	-	-	4	5.80	10	10.75
Total	33	100	27	100	69	100	93	100

As to backed points size the sequence attests a gradual increase of mean values for all the 3 dimensions: from 27.7 mm to 30.2 mm in length, from 5.2 mm to 6.4 mm in width and from 1.8 mm to 2.9 mm in thickness (Fig. 3.2). Focusing on the degree of homogeneity, length presents inconsistent changes, while the standard deviation (SD) of width and thickness tends to increase, attesting a reduction of homogeneity along the sequence (Tab. 3.6).

With the aim of better clarifying the changes in backed points size, the statistical significance of the metric differences between groups was tested through a non-parametric test, namely Wilcoxon test. The comparison between lengths yielded negative results. The increase of width values is inconsistent when comparing the mean values of the sample subdivided in different length classes (Fig. 3.3 a). Furthermore, the Wilcoxon test detected a significant statistical difference only between the 1° and the 4° group (w = 1407; p-value 0.002917) and the 2° and the 4° group (w = 1333; p-value = 0.02031). The thickness increase seems to be the most significant parameter as testified both by a graphic comparison of mean values per length class (Fig. 3.3 b) and by the Wilcoxon test that identified significant differences between the

1st and the 3rd group (w = 627; p-value = 0.0009282), the 2nd and the 3rd (w = 962.5; p-value = 0.02414) and finally between the 2nd and the 4th one (w = 1132.5; p-value = 0.0007059).

Table 3.6 - Backed points dimensional classes of length, width and thickness.

	1st gr.			2nd gr.			3rd gr.			4th gr.		
	Len.	Wid.	Th.	Len.	Wid.	Th.	Len.	Wid.	Th.	Len.	Wid.	Th.
Min. value	14	3	1	15	2	1	12	2	1	13	1	1
1st quartile	22	4	1	22.2	4	1	25	4.5	2	25	5	2
Median	27	5	2	28	5	2	30	6	2	30	6	3
Med. value	27.7	5.2	1,8	27.5	5.4	2	29.8	5.9	2.6	30.2	6.4	2.9
3rd quartile	34	6	2	30.5	7	3	35	7	3	34	7.5	4
Max. value	45	11	5	58	11	6	50	14	10	59	12	7
SD	8.010	1.716	0.911	9.065	2.214	1.055	7.429	2.402	1.445	8.711	2.315	1.358
Total	40	40	40	35	35	35	74	74	74	103	103	103

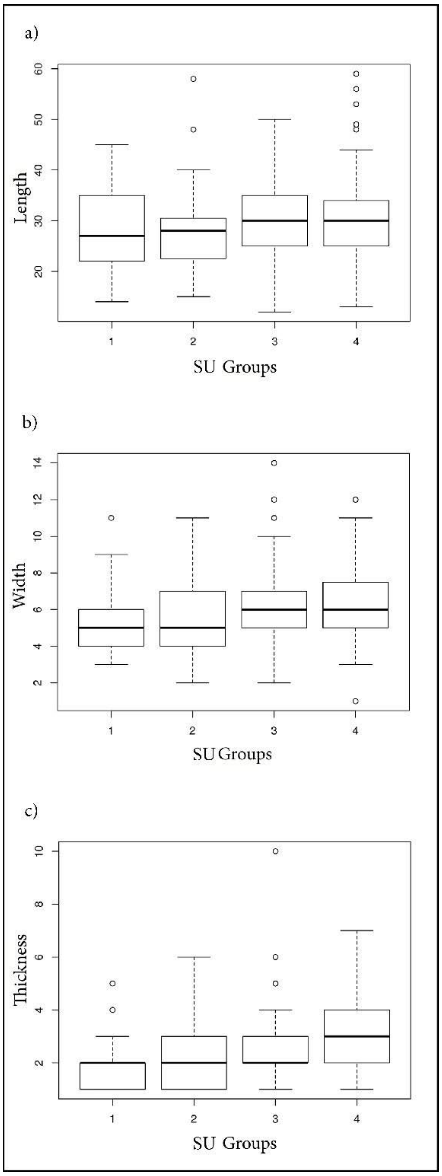


Figure 3.2 – Changes on backed points size according to SU groups. a) length. b) width. c) thickness.

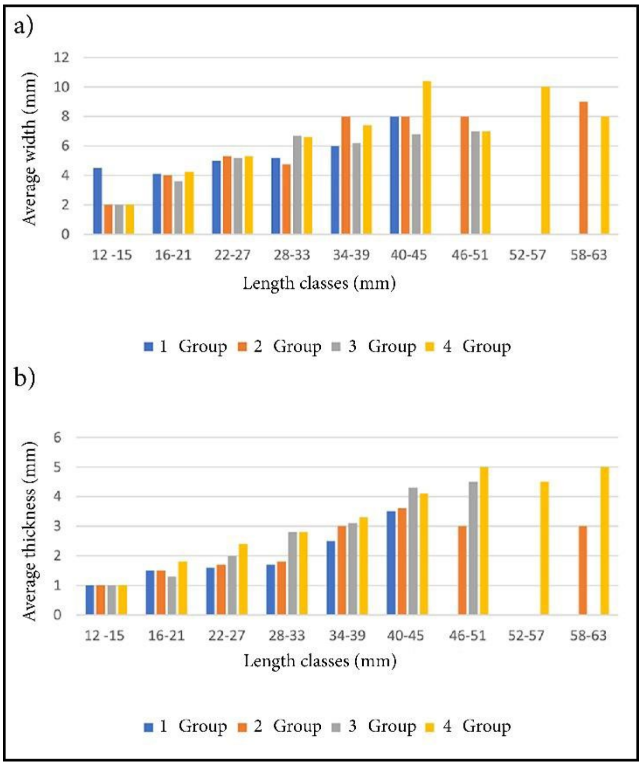


Figure 3.3 – Distribution of width and thickness average values according to length classes.

3.2.1.2. Retouched methods

3.2.1.2.1. Backed retouch

Backed points from Riparo Tagliente are characterised by a rectilinear or slightly convex back delineation. The first one was dominant during the ancient phase (1st and 2nd group), while the second one was more frequent in recent one (3rd and 4th group). The cutting edge delineation tends to be slightly convex along the entire sequence and backs are equally located on the left and right side of the blank.

The relation between back and main dorsal ridge in the basal and mesial portion was evaluated according to the blank cross-section. On triangular and unidentified cross-section blanks, the backed retouch generally reaches totally or partially the main dorsal ridge (62%) which seems to be a guideline for back delineation. A significant difference between the ancient and the recent phase is reflected by the position of the back with respect to the main ridge (Tab. 3.5): both in the 1st and 2nd group backs are mostly located over it whereas in the 3rd and 4th before or close to it. The decrease of backs located over the main ridge is to be connected to the higher width values of selected blanks more than to a lower retouch intensity.

Table 3.5 - Relation between back and main dorsal ridge in the basal and mesial portion of blanks with triangular and unidentified cross-section.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Over the main ridge	14	42.42	12	41.38	13	22.41	14	17.50
Before the main ridge	8	24.24	7	24.14	24	41.38	26	32.50
Adjacent to the main ridge	9	27.27	10	34.48	18	31.03	35	43.75
Unidentified	2	6.06	-	-	3	5.17	5	6.25
Total	33	100	29	100	58	100	80	100

Backed points manufactured from blanks with trapezoidal cross-sections, counting a total of 52 elements, are too few to highlight significant trends. Nonetheless, a tendency of the back to be located over the 1st ridge was observed.

To shape out the main back, deep direct or crossed retouches along with marginal were applied. Their respective percentages are not stable along the Late Epigravettian sequence: in the 1st group backs were delineated by deep direct retouch, while in the 2nd one direct and crossed retouch were equally used. In the recent phase, deep, direct and abrupt retouches are attested with a percentage of 48% and crossed abrupt retouches between 32% and 43%. A marginal retouch was observed only on backed points characterised by a thickness of maximum 2 mm and a width of maximum 6 mm. Its use strongly decreases along the sequence (Tab. 3.6).

Table 3.6 - Backed retouch extent, position and angle.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Deep direct abrupt	22	55.00	14	40.00	36	48.65	50	48.54
Deep direct semi-abrupt	-	-	2	5.71	-	-		-
Marginal direct abrupt	8	20.00	8	22.86	8	10.81	7	6.80
Deep crossed abrupt	8	20.00	10	28.57	24	32.43	45	43.69
Marginal crossed abrupt	2	5.00	1	2.86	5	6.76	1	0.97
Marginal inverse abrupt	-	-	-	-	1	1.35	-	-
Total	40	100	35	100	74	100	103	100

Inverse backed retouches are generally attested on those points in which the back is reached partially or totally the main dorsal ridge. Indeed once the dorsal ridge is reached, the angle formed by the dorsal surface and the backed edge is generally lower than 90° (Pelegrin, 2004) and thus it is advantageous turning the piece over and proceeding with an overlapping inverse retouch. Subsequently, pieces are only occasionally turned around again. More than half of the artefacts shaped out with the back over or adjacent to the ridge were produced by applying an inverse retouch. Inverse (crossed) retouches were generally applied on pieces characterised by a thickness ≥ 3 mm and they were limited to 3 or 4 detachments on restricted areas of the mesial or proximal portion of the blank where the thickness is higher. Starting from the recent phase (3rd and 4th group) a crossed retouch was seldomly exploited to thin the apex (n=10).

Also the relation between the back and the main dorsal ridge in the apical portion was evaluated according to the cross-section of selected blanks. As illustrated in Table 3.7, backed points manufactured from blanks with triangular or unidentified cross-sections in which the back is located adjacent to or before the main dorsal ridge, present a tip shaped out by the convergence between the back, the main ridge and the functional edge. The use of this technical solution increases along the sequence, while backed points in which the back is already located over the main dorsal ridge decrease. In both cases (convergent and over the ridge) the intent of placing the apical extremity on the same transversal axis of the thickest point of the blank appears clear.

Table 3.7 - Relation between back and main dorsal ridge in the apical portion in backed points and bipoints coming from blanks with triangular or undefined cross-section.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Convergent	16	36.36	15	44.12	28	45.90	47	48.96
Secant	6	13.64	5	14.71	14	22.95	21	21.88
Before the ridge	-	-	-	-	1	1.64	2	2.08
Over the ridge	21	47.73	12	35.29	16	26.23	20	20.83
Break	1	2.27	2	5.88	2	3.28	6	6.25
Total	44	100	34	100	61	100	96	100

By contrast, in backed points coming from trapezoidal/polygonal cross section blank, tip tends to be created at the convergence between the back, the second dorsal ridge and the functional edge.

Considering the relationship between backed retouch and dorsal ridge along the entire longitudinal axis of the artefacts, six main modalities were identified as illustrated by Figure 3.4. In the first and second group, modality "a" is the most attested, while "b" and "c" were rarely used. In the 3rd and 4th group modality "a" decreases significantly and modalities "b" and "c" become dominant. As concerns backed points obtained from blanks with trapezoidal/polygonal cross-sections, modalities "e" and "f" are the most attested along the entire Late Epigravettian sequence.

Backed points orientation follows the morphological axis of the blank, namely the apex is located on the distal portion and the base on the proximal one. Only in the most recent layers (4th group) artefacts with distal and proximal apex are equally shaped out.

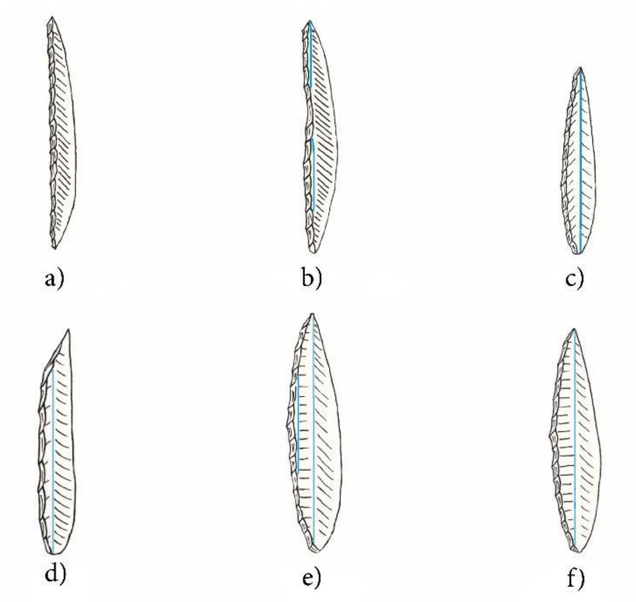


Figure 3.4 – Different modalities of delineating a backed point: a) the back is located over the main dorsal ridge along the entire longitudinal axis; b) the back reaches partially the main dorsal ridge in the basal and mesial portion converging with it to shape up the tip; c) the back stops before reaching the main dorsal ridge and it converges with this latter in the apical portion; d) the back follows the main dorsal ridge and it crosses this latter to shape a tip over it; e) the back is located adjacent to the 1st dorsal ridge and the apex is shaped through the convergence between the backed retouch and the 2nd dorsal ridge; f) the back is positioned over the 1st dorsal ridge and converge with the 2nd dorsal ridge to form the tip.

3.2.1.2.2. Complementary retouch

More than half backed points presented a complementary retouch (from 70% to 50% depending on groups). Mostly complementary retouches were functional to point the apex or to shape the base out (especially in recent layers); less frequently to regularise the mesial portion of the cutting edge (Tab. 3.8). Complementary retouches tend to be either direct semi-abrupt or inverse flat. The first type gradually decreases in favour of the second one (Tab. 3.9). This latter was employed to thin the apex or the base by eliminating the bulb or regularising the natural twisted profile of the blank, with the probable purpose of facilitating the artefact hafting.

Most often, inverse flat retouches were applied from the cutting edge, very rarely from the back side. A gradual intensification of the degree of transformation (i.e. the presence of a complementary retouch on more than one area of the same backed point) is attested, in particular in the 4th group more than half of backed points (53%) attests the presence of a second or even a third complementary retouch.

Table 3.8 - Complementary retouch localization.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Apical	26	72.22	20	71.43	29	63.04	58	63.04
Basal	5	13.89	6	21.43	15	32.61	27	29.35
Mesial	3	8.33	1	3.57	1	2.17	4	4.35
Entire edge	-	-	-	-	-	-	3	3.26
Unidentified	2	5.56	1	3.57	1	2.17	-	-
Total	36	100	28	100	46	100	92	100

Table 3.9 - Complementary retouch extent, position and angle.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Marginal direct semi-abrupt	23	54.76	11	37.93	18	36.73	26	26.53
Deep direct semi-abrupt	-	-	-	-	-	-	2	2.04
Marginal direct abrupt	3	7.14	3	10.34	2	4.08	13	13.27
Deep direct abrupt	-	-	-	-	4	8.16	5	5.10
Direct flat	3	7.14	3	10.34	5	10.20	3	3.06
Marginal inverse semi-abrupt	5	11.90	-	-	1	2.04	12	12.24
Marginal inverse abrupt	-	-	-	-	1	2.04	-	-
Deep inverse abrupt	-	-	-	-	-	-	2	2.04
Inverse flat	6	14.29	11	37.93	17	34.69	33	33.67
Marginal bifacial semi-abrupt	1	2.38	-	-	-	-	-	-
Bifacial flat	-	-	1	3.45	-	-	-	-
Marginal alternate semi-abrupt	1	2.38	-	-	-	-	-	-
Alternate flat	-	-	-	-	1	2.04	2	2.04
Total	42	100	29	100	49	100	98	100

3.2.1.3. Morpho-types

By associating different technological parameters (morphology and typometry of the original blank, width-length ratio, delineation of the retouched edge, location of the apex, inclination and invasiveness of the backed retouch, presence/absence of complementary retouches) five main morpho-typological categories were identified. A detailed description is presented below:

- **Elongated backed points, type A** (Fig. 3.5 a). They are manufactured on microbladelets, length 12-33 mm (interquartile range: 22-28 mm), width 2-6 mm (interquartile range: 3.25-5 mm), thickness 1-3 mm (interquartile 1-2 mm). The width-length ratio is equal or higher than 1:5. The backed retouched edge is rectilinear while the cutting edge is slightly convex, rarely the opposite, designing an asymmetrical morphology. Occasionally they present a more symmetric shape delineated by a slightly convex backed retouch and cutting edge. The apex is generally located in the distal portion. Bipoints are well attested. The back reduction is carried out by deep, direct (less frequently crossed) and abrupt retouches, sometimes marginal; it reaches totally (over) or partially (adjacent) the main dorsal ridge and in this last case the backed retouch converges with the main dorsal ridge to shape out the apex. Frequently (59%) secondary retouches are applied to delineate the apex and occasionally the base.

- **Elongated backed points, type B** (Fig. 3.5 b). They are manufactured on bladelets, length 29-59 mm (interquartile range: 35-40 mm), width 4-9 mm (interquartile range: 5-6 mm), thickness 2-6 mm (interquartile 2-3 mm). The width-length ratio is equal or higher than 1:5. The backed retouched edge is rectilinear while the cutting edge is slightly convex, rarely the opposite, designing an asymmetrical morphology. Only occasionally they present a symmetric shape. The apex is generally in the distal portion. Few bipoints are attested. Back reduction is carried out by deep crossed (seldom direct) abrupt retouch and achieves totally (over) or partially (adjacent) the main dorsal ridge; in this last case the backed retouch converges with the main dorsal ridge to shape the apex. Frequently (69%) secondary retouches are applied to shape out the tip, less frequently the base.
- **Wide backed points, type A** (Fig. 3.5 c). They are manufactured on microbladelets, length 14-30 mm (interquartile range: 20.5-29 mm), width 3-9 mm (interquartile range: 4.25-6 mm), thickness 1-3 mm (interquartile 2-2 mm). The width-length ratio is lower than 1:5. Backed retouch is convex or slightly convex, rarely rectilinear, as well as the cutting edge. Apex and base have an axial position compared to the morphological axis of the blank. Frequently this type of backed point has a symmetric shape. The apex is located on the distal portion. Normally the back reduction is conducted by deep direct abrupt retouches, sometimes crossed, it stops before the main dorsal ridge or adjacent to it at most and the back converges with the main dorsal ridge to shape the apex. Frequently (66%) secondary retouches are applied to figure out the tip and occasionally the base.
- **Wide backed points, type B** (Fig. 3.5 d**).** They are manufactured from thick and often irregular bladelets, sometimes on elongated flakes, length 22-53 mm (interquartile range: 30-37.5 mm), width 5-14 mm (interquartile range: 7-10 mm), thickness 1-10 mm (interquartile 3-4 mm). The width-length ratio is lower than 1:5. The back is either slightly convex or convex, rarely rectilinear, as well as the functional edge, shaping out a fairly symmetric backed point. The tip has an axial position compared to the morphological axis of the blank and it is more often located in the distal portion. Proximal apexes are also well attested. In case of triangular cross-section blank the back was produced by deep, direct and abrupt retouches and located mostly before the main dorsal ridge; it converges with this latter to shape out the apex. Wide backed points type B were

also produced from trapezoidal cross-section blanks. In this case the backed reduction reaches partially or totally the 1st dorsal ridge by applying crossed abrupt retouches and it converges with the 2nd one to shape out the apex. Frequently (61%) secondary retouches are applied to delineate the tip as well as the base.

- **Asymmetric curved-backed monopoint:** they are manufactured from bladelets and microbladelets, length 15-58 mm (interquartile range: 25-33 mm), width 2-11 mm (interquartile range: 6-9 mm), thickness 1-6 mm (interquartile 2-4 mm). The back is convex while the opposed edge is rectilinear or slightly concave. Apex is asymmetric (almost *déjeté*) with respect to the blank morphological axis. The backed retouch tends to follow the main dorsal ridge in the basal and mesial portion crossing it in the apical portion in order to shape out a "secant" tip over the main dorsal ridge.

From a morpho-typological point of view, elongated backed points (type A and B) can be defined as Microgravettes (G.E.E.M., 1972), while wide backed points (type A and B) have affinities with some *Pointes d'Istres simple and Pointes de Valorgues*, according to the absence or presence and to the location of complementary retouches (Escalon de Fonton, 1972). *Pointes d'Istres* are described by Escalon de Fonton as wide and thick backed points with a symmetric shape and an apex located either on the distal or proximal portion. Morphological and technological similarities can be detected also with some curved-backed monopoints referred to the Late Azilian, especially as regards blanks selection (thick elongated flakes and irregular lamino/lamellar blanks) and the curve delineation of the back (Fat Cheung et al., 2014; Naudinot et al., 2019).

The frequency index of these categories is not stable along the Late Epigravettian sequence of Riparo Tagliente (Tab. 3.10). In the layers dated to the GS-2 elongated backed points on microbladelets were primarily produced, followed by elongated backed points on bladelets. Wide backed points (type A and type B) were an occasional target. From layer 10 (GI-1) the situation changed: in the 3rd and 4th group wide backed points became more frequent, in particular those produced on bladelets and on elongated flakes (type B), whereas elongated backed points decreased. The presence of asymmetric curved-backed monopoints is more anecdotic and they have a minor role along the entire Late Epigravettian sequence.

Table 3.10 - Morpho-types attested at Riparo Tagliente and relative frequency along the sequence.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Elongated backed points, type A	22	55.00	17	48.57	22	29.73	31	30.10
Wide backed points, type A	2	5.00	1	2.86	14	18.92	14	13.59
Elongated backed points, type B	8	20.00	8	22.86	13	17.57	11	10.68
Wide backed points, type B	1	2.50	1	2.86	20	27.03	38	36.89
Shouldered points	3	7.50	1	2.86	-	-	-	-
Asymmetric curved backed monopoint	1	250	3	8.57	4	5.41	5	4.85
Others	1	2.50	1	2.86	-	-	1	0.97
Unidentified	2	5.00	3	8.57	1	1.35	3	2.91
Total	40	100	35	100	74	100	103	100

3.2.1.4. Resumed backed points

Backed points interpreted as pieces resumed after an unintentional breakage are totally 23. 11 show a *piquant-trièdre* (i.e. the counter-part of a Krukowski microburin) resumed by a marginal direct retouch. 4 of them preserve a successive burination fracture suggesting their use as projectile elements after the initial breakage. An example is shown in Figure 3.6. On the one hand this evidence suggests that the accidental occurrence of a Krukowski microburin does not prevent at all the prosecution of the backing process. On the other it could be surmised that the Krukowski microburin fracture could represent an intentional breakage to reduce blanks length. Backed points characterised by an extremity with a *piquant-trièdre* are relatively frequent in 3rd and 4th group (n=18), much rarer in the ancient layers (n=6).

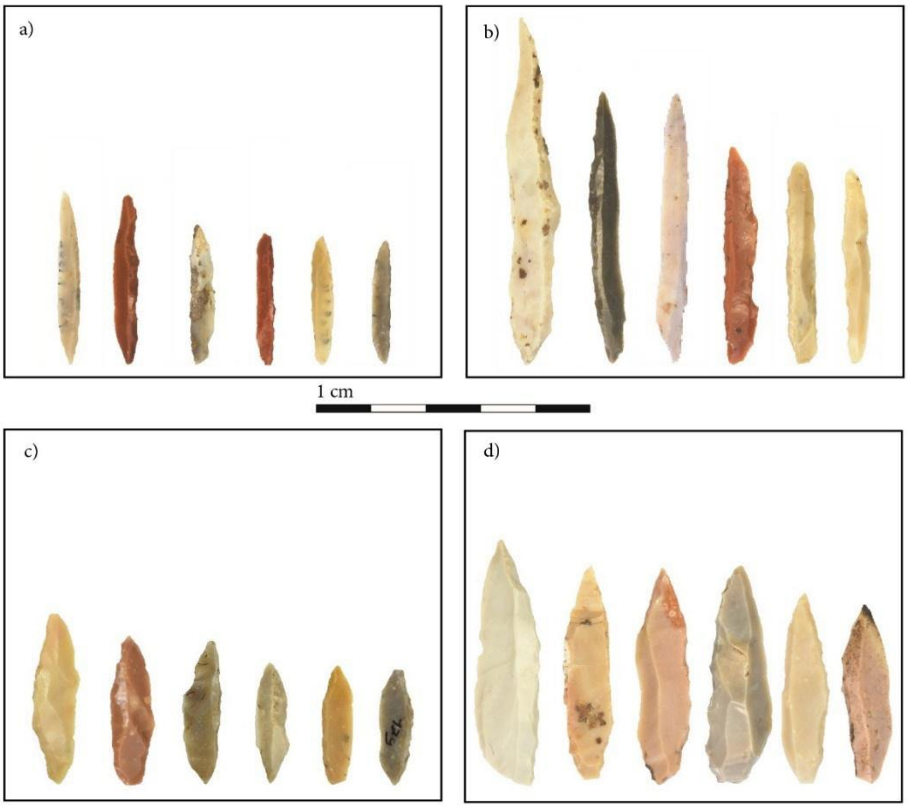


Figure 3.5 – Backed points morpho-types. a: Elongated backed points Type A. b: Elongated backed points Type B. c: Wide backed points Type A. d: Wide backed points Type B.

In layers 7 to 4 backed points characterised by limited length, relevant thickness and a fracture covered by an inverse abrupt or semi-abrupt complementary retouch are attested (n=11; Fig. 3.7). This retouch had the double purpose to resume the fracture and shape out the apex. In most cases it was not possible to establish whether these backed points were fractured during the manufacturing process or after their use as projectile implement, except for two of them characterised by a resumed step terminating bending fracture (Fig. 3.7 b) and burin-like spin-off (Fig. 3.7 c). During the experimental activity the use of an inverse abrupt or semi-abrupt complementary retouch proved to be a functional way to resume broken backed points by allowing to delineate an apex characterised by an acute angle between backed edge and the complementary retouch (cf. Modality 1; 1st experiment). The sharp increase of this practice starting from layers 7, especially on wide backed points type B, may suggest an intentional fracturing to standardise length.

3.2.2. Backed truncated points

Backed truncated points are armatures characterised by a transverse or oblique retouch opposite to an apex. They count a total of 42 items. From a typological viewpoint (Laplace 1964) they can be attributed to DT8 (backed point with an oblique truncation) and DT7 (backed point with a transversal truncation). Several fractured pieces marked by A. Guerreschi as fractured DT1 (n=7) and fractured DT4 (n=1) were interpreted as backed truncated points with an apical damage and therefore included in this category. Backed truncated points increase along the

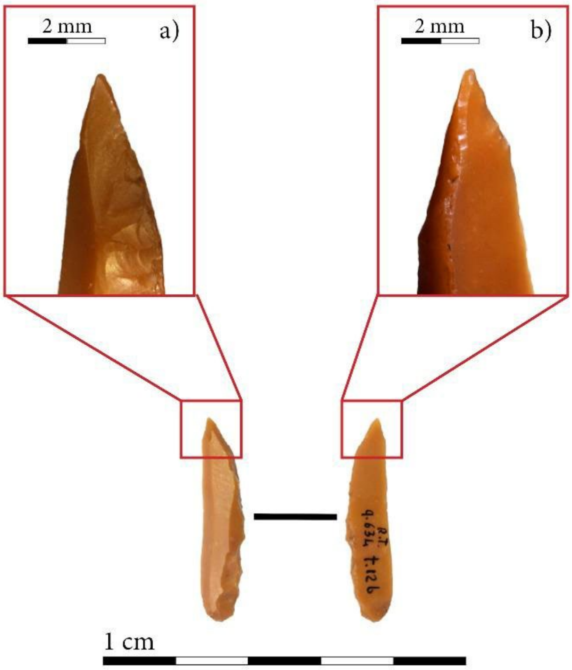


Figure 3. 6 – Riparo Tagliente, backed point from layer 12 (3rd group). a) Detail of the *piquant-trièdre* related to cone initiation fractures resumed by a marginal direct retouch. b) Burination fracture diagnostic of projectile function.

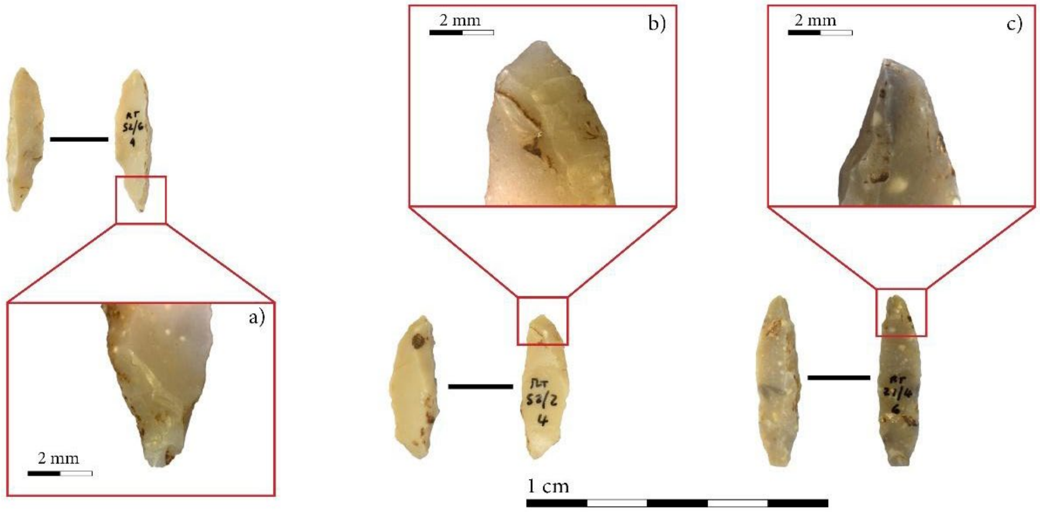


Figure 3.7 – Riparo Tagliente, backed points from layers 4 and 6 (4th group). a) Fracture resumed by an inverse abrupt retouch. b) Step terminating bending fracture resumed by an inverse semi-abrupt retouch. c) Burin-like spin-off fracture resumed by a semi-abrupt inverse retouch.

Late Epigravettian sequence (Tab. 3.2).

3.2.2.1. Blank selection

Blank cross-sections are more frequently triangular than trapezoidal and profiles are both rectilinear and slightly convex. From a diachronic viewpoint, blanks selected reveal strong connections with those of backed points. In fact, an augmentation of bladelets is recorded starting from the 3rd and 4th group (Tab. 3.11), whereas in the 1st and 2nd group microbladelets are the most represented dimensional class. Such a trend reflects in backed truncated points size with an increase in width and thickness along the sequence (Tab. 3.12): mean values of thickness gradually grow from 2.2 mm (1st group) to 3.4 mm (4th group); width from 5.2 mm to 6.7 mm. Length mean values of backed truncated points from the recent phase (3rd and 4th group) are perfectly comparable with those of backed points.

Table 3.11 - Blank dimensional categories selected for asymmetric and symmetric backed points production.

	1st gr.		2nd gr.		3rd gr		4th gr.	
	n	%	n	%	n	%	n	%
Baldes	1	25.00	-	-	1	9.09	1	5.56
Bladelets	-	-	2	22.22	5	45.45	7	38.89
Microbladelets	3	75.00	6	66.67	4	36.36	8	44.44
Microbladelets/bladelets	-	-	1	11.11	-	-	1	5.56
Bladelets/Blades	-	-	-	-	-	-	1	5.56
Elongated flakes	-	-	-	-	1	9.09	-	-
Total	4	100	9	100	11	100	18	100

Table 3.12 - Backed truncated points dimensional classes of length, width and thickness.

	1st gr.			2nd gr.			3rd gr.			4th gr.		
	Len.	Wid.	Th.	Len.	Wid.	Th.	Len.	Wid.	Th.	Len.	Wid.	Th.
Min. value	15	5	2	13	3	1	15	4	1	20	4	2
1st quartile	15	5	2	18.5	4	2	25.5	4.5	2	24.7	6	2.2
Median	15	5	2	22	5	2	28	7	4	28.5	6	3
Med. value	15	5.2	2,2	20.8	4.5	2.3	29.8	6.8	3.3	29.2	6.7	3.4
3rd quartile	15	5.2	2,2	22.5	5	3	33	9	4	30	7.5	4
Max. value	15	6	3	29	6	4	51	10	6	41	11	8
SD	-	0.5	0.5	5.01	0.88	0.87	9.40	2.31	1.50	6.18	1.64	1.46
Total	1	4	4	7	9	9	11	11	11	16	18	18

3.2.2.2. Retouched methods

3.2.2.2.1. Backed retouch

Also retouch methods show several similarities with those of backed points: the back is deep and tends to reach partially or totally the main dorsal ridge in case of triangular cross-section blank or to be located over the 1st ridge when the cross-section is trapezoidal. Backed retouch is deep, direct or crossed and abrupt depending on blank thickness and back position with respect to the dorsal ridge. Thicker artefacts (mean value of 3.4 mm) shaped out by a back over or adjacent to one of the main dorsal ridges are produced by applying a crossed retouch. Inverse retouches are mostly located on the mesial or basal portion. Sometimes in the recent phase they are used to thin the apex. Backed truncated points produced by a direct retouch have a mean value of 1.8 mm.

In case of a back not located completely over the main dorsal ridge, the tip is shaped by the convergence between backed retouch, functional edge and main ridge in triangular cross-section blank. By contrast, when the cross-section is trapezoidal, tips are pointed out by the convergence between backed retouch, second dorsal ridge and functional edge. Backs that cross the main dorsal ridge to point a secant apex the increase along the sequence.

Back delineation is mostly rectilinear in the ancient phase (1st and 2nd group), becoming slightly curved or even curved in the recent phase (3rd and 4th group). Apex orientation is variable, it can be both on the proximal or distal portion.

3.2.2.2.2. Complementary retouch

Complementary retouches are applied with the aim to modify the functional edge especially in the apical portion in more than half of the assemblage (62%). Any changes concerning their localization were attested along the sequence. They are marginal, direct and semi-abrupt and occasionally flat and inverse.

3.2.2.2.3. Truncations

With the term truncation we consider any type of retouch (direct or inverse, deep or marginal and from flat to abrupt) with a transverse orientation compared to the longitudinal axis of the blank. Frequently, truncations were employed to cover a previous fracture (Fig. 3.8 d), especially in the ancient phase. The main variation along the Late Epigravettian sequence is represented by truncation localization (Tab. 3.14) and deepness (Tab. 3.13), namely how much of the original blank length was removed. In the 1st and 2nd group truncations are equally distal and proximal and mostly marginal. Starting from layer 10, truncations become more frequently deep and proximal. This variation seems to be related to a change in purpose according to stratigraphic group: in the 1st and 2nd one truncations do not have a clear objective except for resuming fractures, whereas in the 3rd and 4th group besides resuming fractures become useful to reduce length and to remove the bulb/butt portion or more rarely to strengthen the distal portion in case of proximal points. One item attests a blank length reduced by a proximal intentional cone fracture perfectly comparable with those attested to during the 3rd experiment (see Chapter 3.2.3. Part 1) using the “percussion on an edge” fracturing technique (Fig. 3.8 e).

Table 3.13 - Truncation extent, position and angle.

	1st gr.		2nd gr		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Marginal direct abrupt	2	50.00	4	44.44	1	9.09	1	5.56
Deep direct abrupt	1	25.00	1	11.11	4	36.36	5	27.78
Deep inverse abrupt	-	-	-	-	1	9.09	1	5.56
Marginal inverse abrupt	-	-	-	-	1	9.09	-	-
Marginal direct semi-abrupt	1	25.00	2	22.22	1	9.09	5	27.78
Marginal inverse semi-abrupt	-	-	1	11.11	-	-	1	5.56
Deep direct semi-abrupt	-	-	1	11.11	2	18.18	3	16.67
Inverse flat	-	-	-	-	1	9.09	2	11.11
Total	4	1	9	100	11	100	18	100%

Table 3.14 - Truncation localization and orientation.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Distal	2	50.00	4	44.44	3	27.27	4	22.22
Proximal	2	50.00	5	55.56	7	63.64	13	72.22
Indeterminable	-	-	-	-	1	9.09	1	5.56
Total	4	100	9	100	11	100	18	100.
Trans. rectilinear	3	75.00	5	55.56	2	18.18	6	33.33
Oblique > 90°	1	25.00	1	11.11	1	9.09	-	-
Oblique < 90°	-	-	2	22.22	2	18.18	2	11.11
Convex	-	-	-	-	4	36.36	6	33.33
Concave	-	-	1	11.11	2	18.18	1	5.56
N.D.	-	-	-	-	-	-	3	16.67
Total	4	100	9	100	11	100	18	100

3.2.2.3. Morpho-types

Morpho-types are the same describe for backed points, the only difference is the presence of a basal truncation. Elongated backed truncated points are dominant in the ancient phase (1st and 2nd group), whereas wide backed truncated points strongly increase starting from the 3rd group. The former rather than being a sought-after morphology are the result of reclycling backed points fracturated. The only exception are two items coming from layer 15 and 13 that present an enigmatic shape (Fig. 3.8 a). They recall the "*lamelles/triangles scalènes"* from Magdalenian techno-complexes. Wide backed truncated points are fairly standardised (Fig. 3.8 b). Looking at their thickness, the mean value is even higher than backed points, suggesting the selection of thicker and probably longer blank that need to be reduced by truncation to reach the sought-after morphology. Such a trend is perfectly in line with the increase along the sequence of the degree of transformation (i.e. number of complementary retouches and back invasiveness) documented in backed points. Wide backed truncated points with a convex basal truncation have strong similarities with the *Pointe d'Istres à base arrondie* (Escalon 1972) attested in association with *microgravettes* during the Allerød period in several

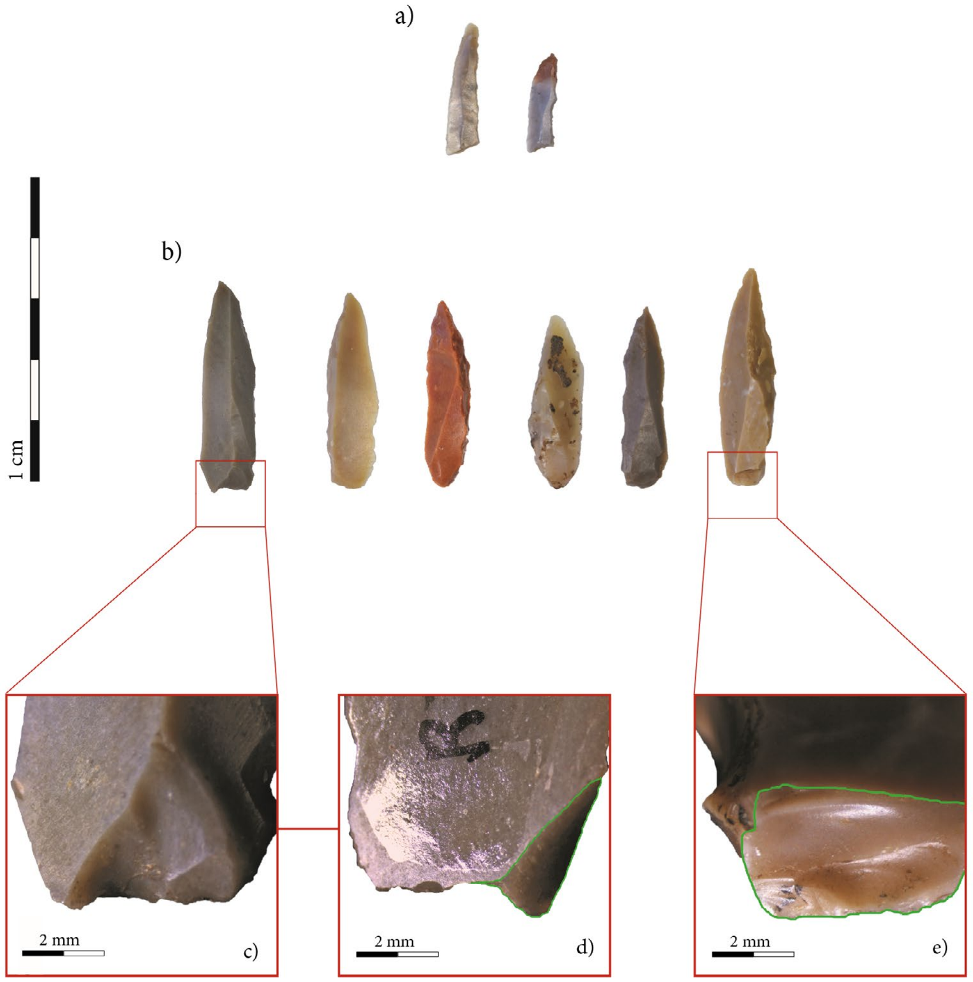


Figure 3.8 – Backed truncated points. a: Backed truncated points from layers 15 and 13; b) Wide backed truncated points from the recent phase (layers 10-4); c: detail of truncation; d: resumed fracture; e: intentional fracture starting from the dorsal face.

South-Eastern French sites.

3.2.3. Backed bladelets

Backed bladelets from the trench count a total of 198 elements (Bartolomei et al. 1982). After a first necked eye analysis we realised a strong heterogeneity of the assemblage. Among them, only 57 were morphologically attributable to projectile implements (Fig. 3.9). The others, previous considered by A. Guerreschi as LD (*lamelles à dos*) following Laplace typology (1964), were actually characterised by a major fracture (n=25), by an unfinished aspect not suited to achieve one of the sought-after morphologies (n=30) or even by a too big size for being interpret as hunting gears. The latter were excluded from the analysis. Qualitative and quantitative data were evaluated according to the entire assemblage. Only when relevant changes are recorded results are presented according to the four stratigraphic groups. The assemblage is composed almost exclusively by LD2 (namely backed bladelets with a total deep back retouch).

3.2.3.1. Blank selection

Full debitage lamino/lamellar blanks were certainly identified in 32.20% of the sample. Except for naturally backed blanks (6.78%), other types of blanks, such as cortical blanks, on-edge blanks and generic flakes, achieve a percentage lower than 4%. The rest of the assemblage was marked as a generic elongated blank. Blank profile is equally rectilinear and slightly curved and the thickness rarely exceeds 4 mm (Tab. 3.15). Butts are often preserved showing a dominance of plains morphologies. A higher exploitation of trapezoidal blanks compared to triangular ones was also attested. Except for a few pieces produced on bladelets, microbladelets are the most selected blanks in the entire Late Epigravettian sequence. Remarkably high is the percentage of hinged lamino/lamellar blanks (35%). Backed bladelets length remains quite

Figure 3.9 – Backed bladelets from the trench.

stable along the sequence. On the contrary, width and thickness slightly increase (Tab. 3.15).

Table 3.15 - Backed bladelets dimensional classes of length, width and thickness

	1st gr.			2nd gr.			3rd gr.			4th gr.		
	Len.	Wid.	Th.	Len.	Wid.	Th.	Len.	Wid.	Th.	Len.	Wid.	Th.
Min. value	19	4	1	20	4	1	16	4	1	14	3	1
1° quartile	23,3	4	2	22	4	2	21,5	4,5	2	22,8	5	2
Median	29,5	5	2	24	5	2	26	6	3	27	6	2,5
Med. value	28,9	5,3	2,2	23,9	4,9	2,1	28,6	5,8	2,9	27,1	6,3	2,7
3° quartile	33,5	5,5	3	25	5	2	34,5	6	3,5	30,5	7	3
Max. value	41	8	3	28	6	3	46	10	5	42	15	6
SD	10,5	2,1	0,9	2,5	0,8	0,6	14,3	1,7	1,1	8,5	2,6	1,3
Total	14	14	14	9	9	9	11	11	11	23	23	23

3.2.3.2. Retouched methods

3.2.3.2.1. Backed retouch

Backs are mostly produced by a deep, direct and abrupt retouch (Tab. 3.16). The only variations attested along the sequence is a decrease of marginal retouches from the 1st group to the 4th (as observed in backed points) which can be related to the increase of blanks width selected.

The backing process tends to achieve the maximum transverse thickness as proved by the location of backs compared to dorsal ridges. Triangular or indeterminable cross-section blanks have a backed retouch that achieves partially or totally (73.53%) the main dorsal ridge. Ony in a few cases it stops before (26.47%). Trapezoidal cross-section blanks are characterised by a backed retouch that overpasses the first ridge (52.14%) or at least achieves it partially (34.78%) (Tab. 3.17). Among backed bladelets shaped out by a back over or adjacent to ridge only 19.57% were produced by applying a crossed backed retouch (mean thickness 3,08 mm). Backs are equally located on the right and the left side. The delineation of both the back and the functional edge is not carefully curated. Backs can be rectilinear, slightly curved or even sinuous as well as the functional edge.

Table 3.16 - Backed retouch, extent position and angle.

	n	%
Marginal direct abrupt	10	17.54
Deep crossed abrupt	8	14.04
Deep direct abrupt	32	56.14
Marginal direct semi-abrupt	7	12.28
Total	57	100

Table 3.17 - Relation between back and main dorsal ridge according to cross-section blank.

Triangular/unidentified	n	%
Over the main ridge	8	23.53
Before the ridge	9	26,.47
Adjacent to the main ridge	17	50.00
Total	34	100
Trapezoidal	n	%
Over the 1st ridge	12	52.17
Before the 1st ridge	3	13.04
Adjacent to the 1st ridge	8	34.78
Total	23	100

3.2.3.2.2. Complementary retouch

Only 24,56% of backed bladelets attest the use of complementary retouches. They were applied on the distal, mesial, or proximal portion without any specific trend. 40.00% are marginal, direct and abrupt. Semi-abrupt and flat retouches are rarer (Tab. 3.18).

Table 3.18 - Complementary retouch extent, position and angle.

	Entire sequence	
	n	%
Marginal direct abrupt	6	40.00
Marginal direct semi-abrupt	3	20.00
Marginal inverse semi-abrupt	4	26.67
Inverse flat	2	13.33
Total	15	100.00

3.2.4. Backed truncated bladelets

The typological list published in Bartolomei et al. (1982) counts a total of 405 backed truncated items from the trench, including both backed truncated bladelets and backed truncated points. The latter were analysed separately and results were presented above. Among backed truncated bladelets selected by A. Guerreschi, a good number of them were excluded:

- some backed truncated bladelets were too big in size to be use as projectile implements
- after a carefully revaluation several DT3 and DT4 were considered as backed points
- DT6 type was interpreted as a piece abandoned during the backing process due to an unintentional Krukowski microburin fracture and not as finished tool.

Finally, the sample analysed reached a total of 84 items divided between complete (27,91%), almost complete (58,14%) and fractured pieces (12,79%). As already noted by A. Guerreschi (Bartolomei et al., 1982), backed truncated bladelets strongly increase along the sequence. This growth is testified not only from a merely numeric perspective, but also by a comparison with the entire armatures assemblage from the trench (Tab. 3.1).

Following Laplace typology, a high typological variability is recorded in the first three stratigraphic groups. By contrast, starting from the 4th group, the DT5 type (backed truncated bladelet with a double asymmetric truncation) became dominant (Tab. 3.19).

Table 3.19 - Composition of the archaeological assemblage according to Laplace's typology (1964). DDT1 = double backed truncated bladelet with a single transversal truncation; DDT2 = double backed truncated bladelet with a double symmetric truncation; DT1 = backed truncated bladelet with a single transversal truncation; DT2 = backed truncated bladelet with a double symmetric truncation ; DT3 = backed truncated bladelet with a single acute truncation; DT4 = backed truncated bladelet with a single obtuse truncation; DT5 = backed truncated bladelet with a double asymmetric truncation; f = fragment.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
DDT1	1	5.00	-	-	-	-	-	-
DDT2	-	-	-	-	-	-	1	2.38
DT1	4	20.00	1	12.50	2	12.50	5	11.90
DT2	3	15.00	2	25.00	2	12.50	6	14.29
DT3	5	25.00	1	12.50	5	31.25	3	7.14
DT4	-	-	1	12.50	4	25.00	2	4.76
DT5	1	5.00	2	25.00	2	12.50	22	52.38
fDT1	3	15.00	-	-	-	-	2	4.76
fDT3	1	5.00	1	12.50	1	6.25	-	-
fDT4	2	10.00	-	-	-	-	1	2.38
Total	20	100	8	100	16	100	42	100

3.2.4.1. Blank selection

Since during the manufacture of backed truncated bladelets blank length is systematically reduced by one or two truncations, blank dimensional category was calculated only through the comparison between thickness of full lamino/lamellar blanks (Tab. 3.20) and of backed truncated bladelets. Based on this comparison, a higher exploitation of microbladelets is attested all along the sequence (Tab. 3.20). Full debitage laminar/lamellar blanks are the most exploited. Only a few natural backed blanks were recorded. Concerning cross-section blank, trapezoidal one is the most selected in all groups. Blanks with a rectilinear profile became clearly dominant exclusively in the 4th group.

Table 3.20 - Blank dimensional categories selected for backed truncated bladelets production.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Microbladelets	15	75.00	5	62.50	8	50.00	22	52.38
Bladelets	3	15.00	1	12.50	6	37.50	9	21.43
Microbladelets/bladelets	2	10.00	2	25.00	2	12.50	9	21,43
Bladelet/blades	-	-	-	-	-	-	2	4.76
Total	20	100	8	100	16	100	42	100

Backed truncated bladelet is the only armature type that does not show a progressively increase of thickness along the sequence (Tab. 3.21). Moreover, looking at the 4th group is remarkable the high-level of homogeneity of width (SD values of 1,2) and thickness (SD values of 0,9) compared to backed points (Tab. 3.4), backed truncated points (Tab. 3.12) and backed bladelets (Tab. 3.15). These values are the result of a stricter blank selection and a backing process more standardised aimed at producing items with a calibrated thickness and a control width. Length varies from 12 mm to 42 mm.

Table 3.21 - Backed truncated bladelets dimensional classes of length, width and thickness.

	1st gr.			2nd gr.			3rd gr.			4th gr.		
	Len.	Wid.	Th.	Len.	Wid.	Th.	Len.	Wid.	Th.	Len.	Wid.	Th.
Min. value	12	3	1	18	4	2	15	5	1	14	4	1
1st quartile	17	4	2	22	5	2,5	16,5	5	2	18	6	2
Median	22	5	2	25	5,5	3	24	6	2	23	6	2,5
Med. value	23,5	5,6	2,4	24,1	5,5	2,9	22,9	6,4	2,6	24,2	6,2	2,6
3rd quartile	25	5,25	3	25,7	6	3	2	7,25	3,25	28	7	3
Max. value	31	10	5	22	6	3	33	9	4	42	9	6
SD	9,55	1,9	0,8	4,1	0,9	0,6	6,4	1,4	1,1	7,3	1,2	0,9
Total	12	20	20	8	8	8	9	16	16	34	42	42

3.2.4.2. Retouch methods

3.2.4.2.1. Backed retouch

Backs are equally located on the right and on the left side. The delineation is rectilinear, whereas the cutting edge tends to be slightly convex. The relation between the back and the main dorsal ridge do not highlight significant trends along the sequence. Considering all stratigraphic groups, trapezoidal cross-section blanks are modified by a back retouch located over the 1st ridge. By contrast, triangular cross-section blanks reveal a back generally located before the ridge, followed by a back adjacent to or over it.

Backs were shaped out by a deep, direct and abrupt retouch (Tab. 3.22). Crossed and abrupt retouches were also recorded, especially in the 2nd and 4th group, in association with blank characterised by a back over the main dorsal ridge and a thickness ranging from 2 mm to 4 mm (mean value: 3.07 mm). Inverse detachments are mainly located on the mesial portion where the blank is thicker in order to thin and regulate the back. In two items an inverse retouch is applied all along the back.

Table 3.32 - Backed retouch extent, position and angle.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Deep direct abrupt	7	35.00	3	37.50	5	31.25	19	45.24
Deep crossed abrupt	4	20.00	3	37.50	3	18.75	13	30.95
Marginal direct abrupt	6	30.00	2	25.00	4	25.00	8	19.05
Marginal inverse semi-abrupt	1	5.00	-	-	-	-	-	-
Marginal direct semi-abrupt	1	5.00	-	-	3	18.75	-	-
Deep inverse semi-abrupt	1	5.00	-	-	1	6.25	-	-
Marginal crossed abrupt	-	-	-	-	-	-	2	4.76
total	20	100	8	100	16	100	42	100

3.2.4.2.2 Truncations

Observing trunction variability a clear separation between the first three groups and the 4th one has been highlighted:

- a double truncation was almost entirely attested in the 4th group (Tab. 3.24).
- backed truncated bladelets from the 1st, 2nd and 3rd group are mainly characterised by single marginal and direct truncations which feebly modify blank length. Some of them are so marginal that speculations of a specific functionality are problematic. In the 4th group deep truncations increase (Tab. 3.25).
- the uppermost layers (6-4) are characterised by several items with an inverse and semi-abrupt or even flat retouch (Tab. 3.25) opposed to a distal and direct truncation.
- in the 1st, 2nd, and 3rd group backs seem to be delineated before truncations. In the 4th group an opposite overlapping was observed (Fig. 3. 10). Truncations are shaped at the beginning of the reduction process. The only exceptions are flat or semi-abrupt and inverse “truncations” which were systematically applied for last.

At a general level truncations orientation is extremely variable. It can be transverse and oblique, both forming an obtuse or acute angle with the back.

On a high number of backed truncated bladelets a fracture resumed by truncation was detected (Fig. 3.13). They count a total of 29 elements. Table 3.26 shows a decrease of these pieces along the sequence. In the 1st and 2nd group they represent around half of backed truncated bladelets, whereas they become 37.50% in the 3rd group and 23.81% in the 4th. Some of them (n=10) seem to be a basal fragment of backed point transformed into backed truncated bladelets (Fig 3.13 a, b). Except for three artefacts characterised by a resumed step terminating bending fracture (Fig. 3.13 b), it was not possible to establish whether they were fractured during the manufacturing process or after their use as projectile implements. Among others resumed backed truncated bladelets (n=19), those from the 1st, 2nd, and 3rd group are characterised by a high typological and morphological variability, whereas those from the 4th group show a more standardised morphology (Fig. 3.13 d, e) and their thickness, width as well as length is perfectly comparable to backed truncated bladelets which do not show any fracture resumed. To cover previous breakage both inverse (n=25) and direct (n=18) retouches were applied, depending on the angle formed between the ventral face and the fracture surface.

Table 3.24 - Truncation localization according to SU groups.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Double	4	20.00	4	50.00	4	25.00	28	66.67
Proximal	5	25.00	2	25.00	3	18.75	9	21.43
Distal	10	50.00	2	25.00	9	56.25	5	11.90
N.D.	1	5.00	-	-	-	-	0	-
Total	20	100	8	100	16	100	42	100

Table 3.25 - Truncation extent, position and angle.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	5	n	%	n	%	n	%
Marginal direct abrupt	7	29.17	7	58.33	9	45.00	13	18.57
Marginal direct semi-abrupt	9	37.50	2	16.67	4	20.00	21	30.00
Marginal inverse semi-abrupt	3	12.50	3	25.00	2	10.00	10	14.29
Marginal inverse abrupt	3	12.50	-	-	2	10.00	1	1.43
Inverse flat	1	4.17	-	-	1	5.00	10	14.29
Deep direct abrupt	1	4.17	-		1	5.00	12	17.14
Deep direct semi-abrupt	-	-	-	-	1	5.00	1	1.43
Deep inverse semi-abrupt	-	-	-	-	-	-	2	2.86
Total	24	100	12	100	20	100	70	100

Table 3.26 - Comparison between backed truncated bladelets showing a fracture resumed and those without any fractures visible.

	1st gr.		2nd gr.		3rd gr.		4th gr.	
	n	%	n	%	n	%	n	%
Backed truncated bladelets with any resumed fracture	10	50.00	4	50.00	10	62.50	32	76.19
Backed truncated bladelets with a resumed fracture	10	50.00	4	50.00	6	37.50	10	23.81
Total backed truncated bladelets	20	100	8	100	16	100	42	100

3.2.4.2.3. Complementary retouches

Complementary retouches are rare all along the sequence. Only 10 pieces present a functional edge partially modified by a marginal, direct and abrupt or semi-abrupt retouch. The higher percentage of backed truncated bladelets presenting lateral complementary retouches belong to the 1st and 2nd group.

3.2.4.3 Morpho-types

In the first three groups backed truncated bladelets seem to be an occasional morphology and often the result of recycling process as suggesting by:

- a high frequency of resumed fractures
- a high typological and morphological variability
- an elevated percentage of single truncations applied after the backing process which do not strongly modify blank length.

Such an item might also be the result of a circumstantial practice to adapt the length to the limited space into which the armature must be inserted in case of the replacement of a broken backed bladelets on the shaft.

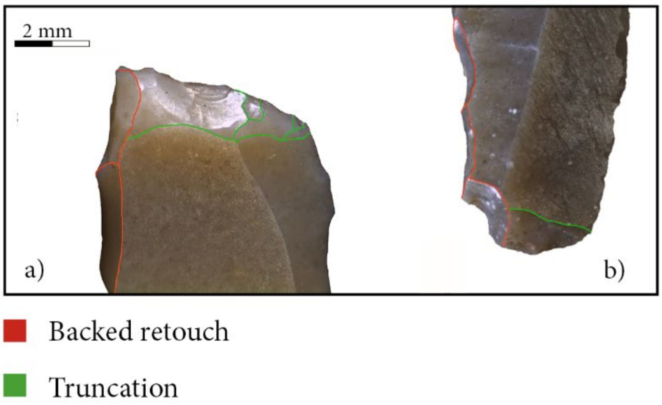


Figure 3.10 - Truncations applied before the backs.

On the other hand, backed truncated bladelets from layers 6 to 4 became more common and normalised both from a dimensional (in particular thickness and width, length remains extremely variable; Fig. 3.11) and morphological (rectilinear profile and double truncation) viewpoint. Among the latter, two main morpho-types can be observed: the former is a backed truncated bladelet characterised by a double direct truncation (Fig. 3.12 a), whereas the second one has at least one extremity (generally the proximal) shaped by an inverse and flat/semi-abrupt truncation (Fig. 3.12 b; Fig. 3.13 c, e).

Furthermore, looking at the 4th group the strong dimensional and morpho-typological similarities between backed truncated bladelets without any fractures resumed and those in which a fracture is covered by a truncation brought out two possible interpretations: the first one consists of recycling only pieces fractured during manufacture or after the use as projectile implement which meets specific morphological requirements. The second one, more fascinating, provides the use of an intentional fracturing technique to control blanks length. As a matter of fact, some of these items present fractures partially resumed by inverse truncation with a morphology similar to those experimentally produced by a single foothold bending fracturing technique (see Chapter 3.2.3 Part 1). Others (n=4) have an extremely characteristic fracture resumed by an inverse and flat retouch (e.g. Fig. 3.12 e). It is a fracture that starts from the functional edge and develops towards the backed retouch. Such a fracture can be reached holding the armatures with its transverse axis inclined (around 45°) with respect to the anvil surface, its functional edge facing up and then by pushing with a compressor (organic or lithic) towards the backed retouch.

3.2.5 Geometrics

One of the main variations attested by A. Guerreschi (Bartolomei et al 1982) along the late Epigravettian sequence of Riparo Tagliente was the appearance of geometrics starting from layer 10. However, their presence in Riparo Tagliente has been partially reconsidered. Among the 18 geometrics selected by A. Guerreschi, only 10 (from layers 11, 10, 8 and 6), despite their considerable size (length between 18 mm and 26 mm; width between 7 mm and 10 mm; thickness between 2 mm and 4 mm), show a morphology suitable with crescents (Fig. 3.14). Three of them are even characterised by a *piquant-trièdre* partially resumed. They are produced on wide elongated blanks through a curved back and a rectilinear functional edge. Strong similarities can be detected with somo crescents spreading during the Late Epigravettian in the Balkans (Montet-White and Kozlowski, 1983).

3.2.6. Pieces under construction

As for pieces abandoned during construction (n=59), 26 seem to be abandoned due to an unintentional breakage during the manufacturing process, while 33 show an unfinished morphology. The latter show three different morphologies:

- artefacts with a distal extremity already delineated while the other portion was not concluded (Fig. 3.15 a)
- artefacs with both extremities modified while the mesial portion was left unretouched (Fig. 15 b)
- artefacts with a total unfinished back (Fig. 15 c)

Thus, the backing process seems to follow at least three main modalities:

- the backed retouch can firstly occur by shaping one extremity (with an apex in case of backed points) and then by retouching progressively along the longitudinal axis of the blank by one single sequence of direct retouch (Fig. 3.15 a)
- by two independent sequences, the first one from one extremity encompassing the distal half, the second one from the other one (Fig. 15 b)
- by several unidirectional sequences (e.g. from the distal to the proximal portion) or bidirectional (e.g. from the distal to proximal and vice versa) (Fig. 15 c)

A fourth modality observable on finished armatures provides one of the three above mentioned options followed by a short sequence of inverse retouches located on restricted areas of the mesial or proximal portion. This latter was applied exclusively on thicker blanks (≥ 3 mm).

Thanks to the 1st experimental activity (Chapter 3.2.1. Part 1) we noticed that the first retou-

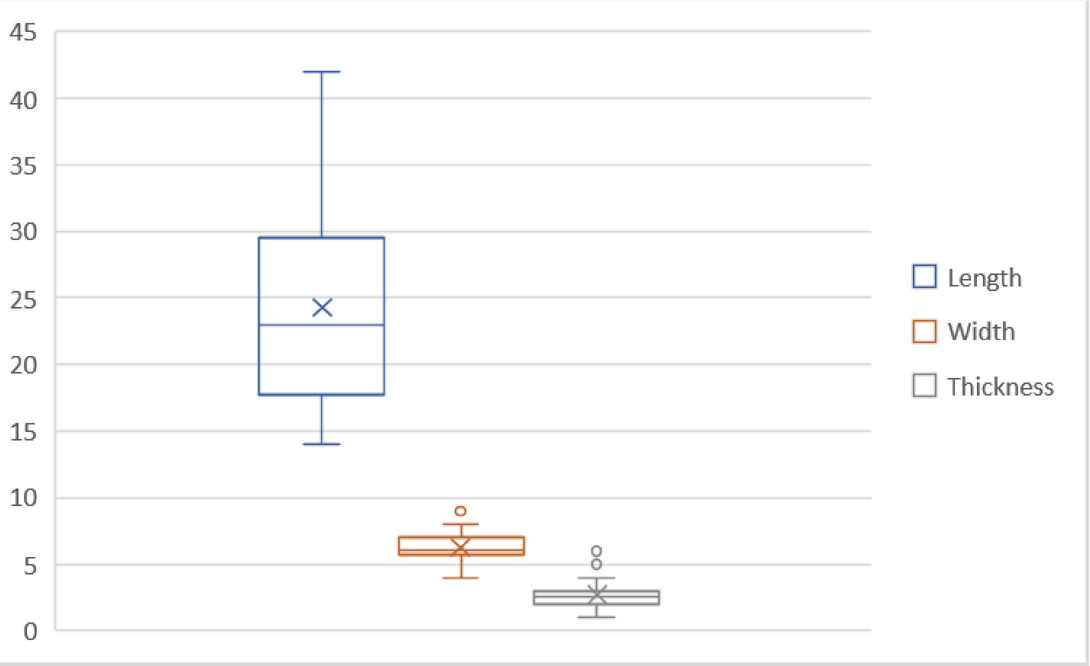


Figure 3.11 - Size (mm) of backed truncated bladelets from the 4th group

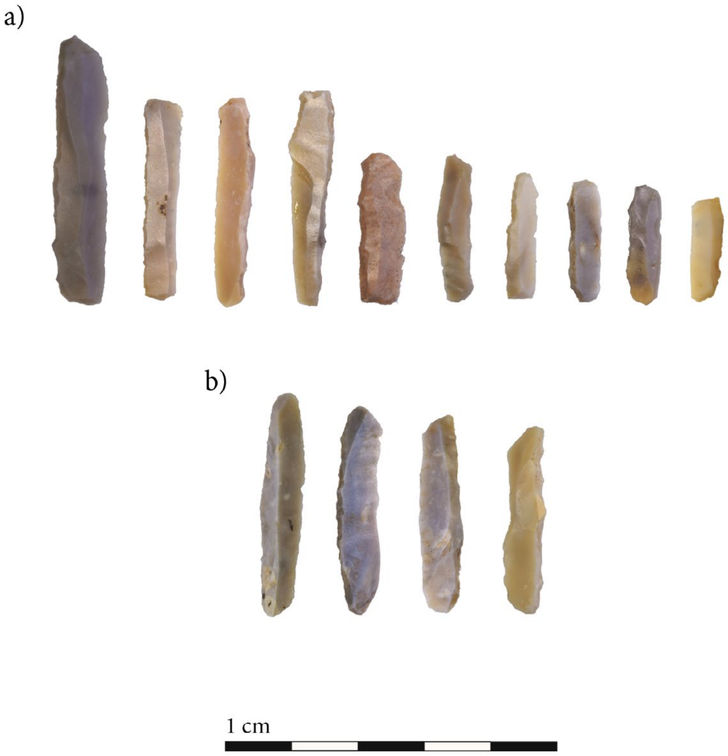


Figure 3.12 - backed truncated bladelets from layer 6 to 4. a: backed truncated bladelets produced by a double direct truncation. b: backed truncated bladelets produced by at least one inverse flat or semi-abrupt truncation.

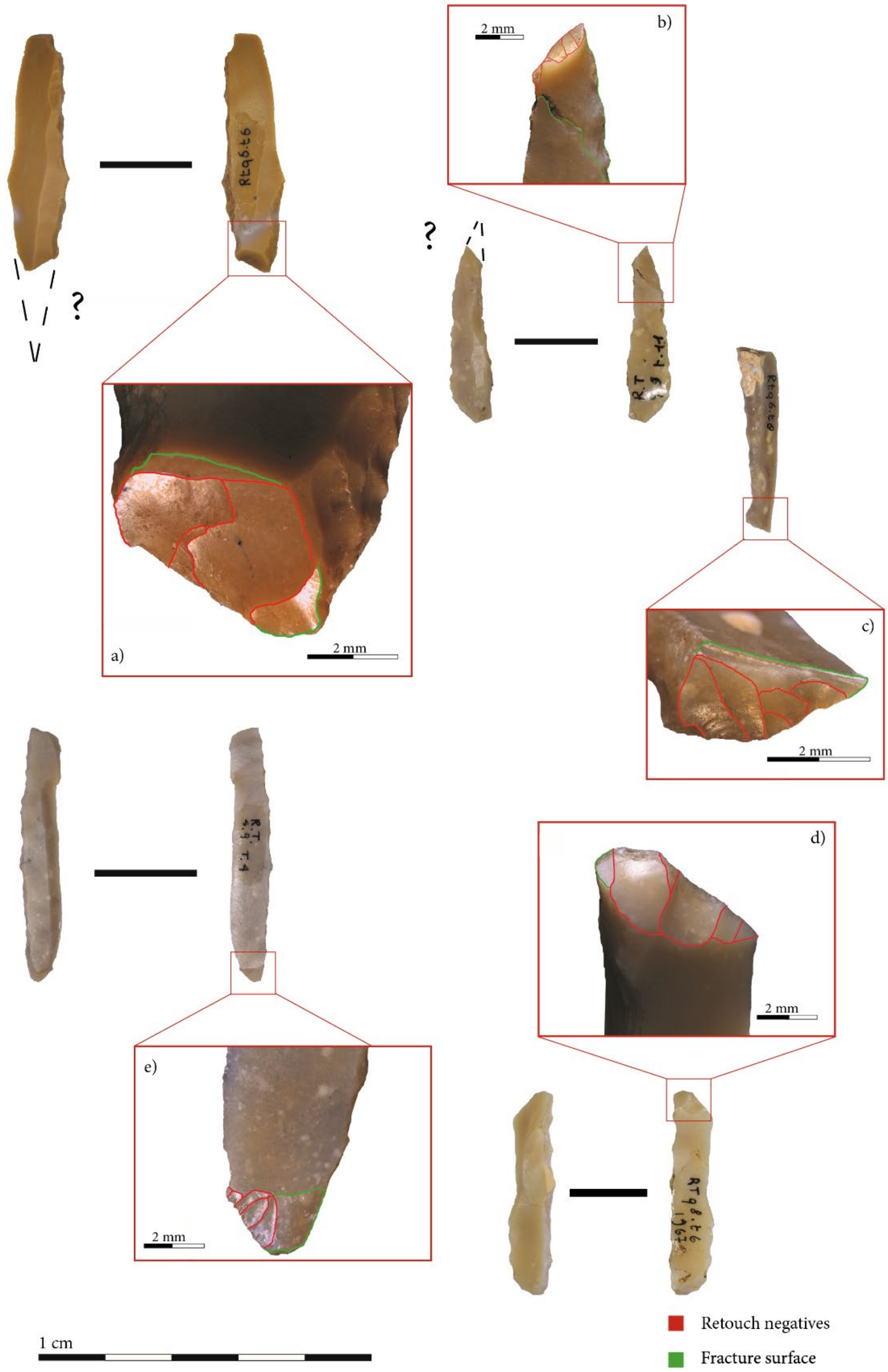


Figure 3.13 - a-b: backed point transformed into a backed truncated bladelet after a major breakage; c-e: backed truncated bladelets with a fracture resumed.

ching modality tends to produce a specific unintentional breakage which is a notch associated with a transversal fracture. The latter could be both a snap terminating bending fracture or a cone fracture. This production incident, called snap in notch (De Wilde and De Bie, 2011), is well attested at Riparo Tagliente (Fig. 3.16). 17 are proximal snap in notch, while only 4 are distal. This discrepancy between proximal and distal snap in notch underline the preference to start the backing process from the distal portion of the blank, rather than the proximal one.

It is interesting to note that different retouch sequences were applied according to width blanks. Pieces in construction attesting a single retouch sequence have an original width range between 5 and 15 mm (mean value 7.6 mm), while pieces produced by more than one sequences show a width (partially reduced by the backing process) between 9 and 15 mm (mean value 11.5 mm).

Krukowski microburins are highly attested counting a total of 83.

Figure 3.14 – Geometrics from the trench of Riparo Tagliente (recent phase).

3.2.7. Backing techniques

Retouch techniques used to shape armatures were examinted by a combined methodology including a qualitative (both analysis at low and high magnifications) and quantitative approaches. The low-power approach was applied on the entire assemblage presented in Table 3.2, whereas the high-power and the quantitative approach on a selected sample of 55 and 45 artefacts respectively.

3.2.7.1. Low-power approach

The morpho-scopic analysis allowed identifying three main backing techniques (Fig. 3.17):

- soft stone percussion on an organic anvil
- pressure applied by a stone retoucher
- pressure applied by an organic tool

In the most ancient layers (1st and 2nd group), a pressure technique (mostly applied by stone retoucher rather than organic) was dominant (70-65 %) compared to soft stone percussion on anvil (30-35%), while in the recent phase (3rd and 4th group), a different trend is attested: pressure by soft stone gradually decrease (40-35%) whereas soft stone percussion on anvil tends to increase (60-65%). Pressure with an organic tool remains stable all along the sequence without exceeding 12%.

By considering blank thickness, it is possible to appreciate its strong correlation with the adopted technique. Pressure by soft stone was predominantly applied to retouch thin blanks (average thickness 2.1 mm), whereas soft stone percussion on anvil was mostly used for thick ones (average thickness 3.2 mm). By correlating these values to the significant increase in blank thickness in all categories of armatures from the 1st to the 4th group it is possible to explain, at least partially, the variation of the backing techniques along the Epigravettian sequence. On the contrary, pressure by an organic tool was applied indiscriminately with any type of blank confirming the high flexibility of this backing technique.

The use of more than one technique on the same artefact is also documented. For example, thicker portions of backed points (mesial and basal) were reduced by soft stone percussion on anvil, while the more fragile apex was retouched using pressure by soft stone (Fig. 3.18). In this specific situation pressure by soft stone has a practical benefit with respect to the pressure with an organic retoucher: it allows to easily switch from one technique to the other without the need to change the retoucher and thus speeding up even further the process. When the back is over the main dorsal ridge in triangular cross-section blank or over the 2nd dorsal ridge in trapezoidal cross section-blank, inverse retouches are detached by a pressure technique.

The choice of which backing technique adopt depends also on blanks width and thus on the number of retouch sequences emploied as suggested by armatures abandoned during construction. A single sequence of removals normally used to reduce narrow blanks was preferentially applied by a pressure technique, whereas wider blanks are shaped by several unidirectional or bidirectional sequences by soft stone percussion on anvil.

Complementary retouches are applied by a pressure technique. Due to the small scale of these retouches, discern the retoucher raw material is often complicated. However, some pieces (n=13) present undoubted features diagnostic of an organic compressor.

3.2.7.2. High-power approach

An high magnification analysis was applied on a sample of 55 armatures coming from the entire stratigraphic sequence. Each artefact was cleaned with neutral soap, water and an ultrasonic cleaner for 15 minutes. This approach allowed confirming the three backing techniques previously identified by a lower-power approach. Backing micro-traces were detected on less than half of the sample. They are located on the ventral face near the retouch edge. 11 artefacts yielded micro-traces diagnostic of a lithic retoucher (Fig. 3.19 n. 1-5 and Fig. 3.20 n. 1-3) in association with a back presenting morpho-scopic features diagnostic of both percussion (e.g. Fig. 3.19 d) and pressure (e.g. Fig. 3.20 c). Furthermore, 6 armatures show linear polishes

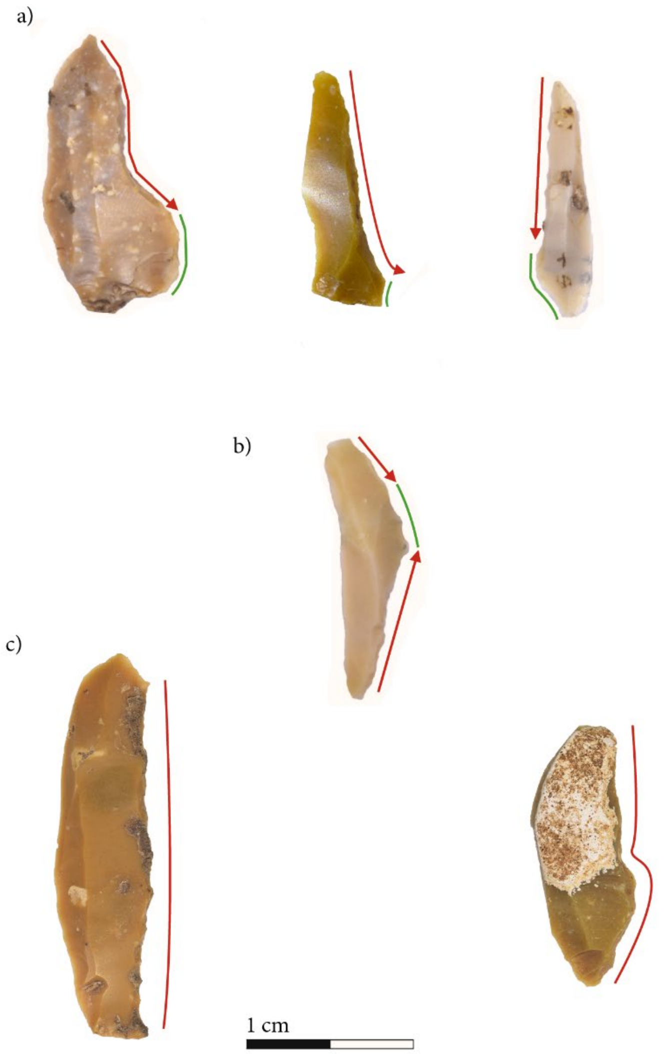


Figure 3.15 – Pieces in construction. a: backed armatures with one portion already delineated and the opposite one not concluded; b: Backed armature with both distal and proximal portion modified, while the mesial portion was left unretouched; c: backed armatures with an unfinished total back. Red line=retouched edge: green line: unretouched edge.

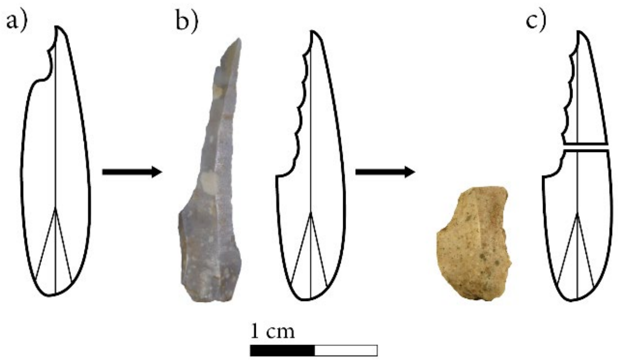


Figure 3.16 - The formation process of a notch associated with a snap terminating bending or cone fracture.

equivalent to those experimentally obtained with an antler compressor (Fig. 3.21). One polish may be referred to the use of a bone compressor (Fig. 3.20 e-f). It is interesting to note that more than half of backing micro-traces have been detected on armatures abandoned during construction after a major breakage or showing an unfinished morphology.

At a general level the interpretation of backing micro traces remain delicate because of the existent of other processes that may produce similar traces, such as hafting, transport, prehension and post-depositional alteration (Rots, 2016; Roux et al., 2020). If MLIT's are distinguishable from backing micro-traces due to an opposite orientation (longitudinal vs. transverse with respect to the back), other processes that might affect archaeological backed armatures need to be tested. However, in our opinion when micro-traces are linked to specific mechanical features strictly related to retouching, such as incipient cones (e.g. Fig. 3.19 a, g, h; Fig. 3.20 b) or fractures initiation (e.g. Fig. 3.21 e), they can be ascribed with a good degree of safety to the manufacturing process.

Table 3.27 - Backing micro-traces.

Retoucher raw material	n	%
Lithic	11	20.00
Antler	6	10.91
Bone?	1	1.82
Generic backing micro-traces	6	10.91
Undeterminable micro-traces	8	14.55
Pieces without micro-traces	23	41.82
Total armatures analysed	55	100

3.2.7.3. Quantitative approach

The sample analysed through a quantitative approach counts a total of 45 artefacts divided between the three retouch techniques attested by previous analysis, namely soft stone percussion on an anvil (n=15), pressure by soft stone (n=15) and pressure by an organic tool (n=15). To each artefact a single complete retouch scar was measured (Fig. 3.22). The parameters recorded are those statistically significant to distinguish backing techniques: width of the initiation and termination of the scar, angles of diffusion and depth of the transverse concavity. The first three parameters were recorded using a motorised digital stereomicroscope (ZEISS AxioCam Zoom v16; ZEISS Zen Core v.), whereas the transverse concavity through the MountainsLab v.7 (Digital Surf) software.

After this first step, metric values have been grouped according to the backing technique assumed through the low power approach and then proceeded using a Principal Component Analysis. The PCA confirmed the existence of three different scar morphologies corresponding to the three backing techniques previously assigned (Fig. 3.23). Only a few negatives belonging to artefacts interpreted as produced by pressure by soft stone fall within the cluster of pressure by organic tool and vice versa. These artefacts may be wrongly attributed.

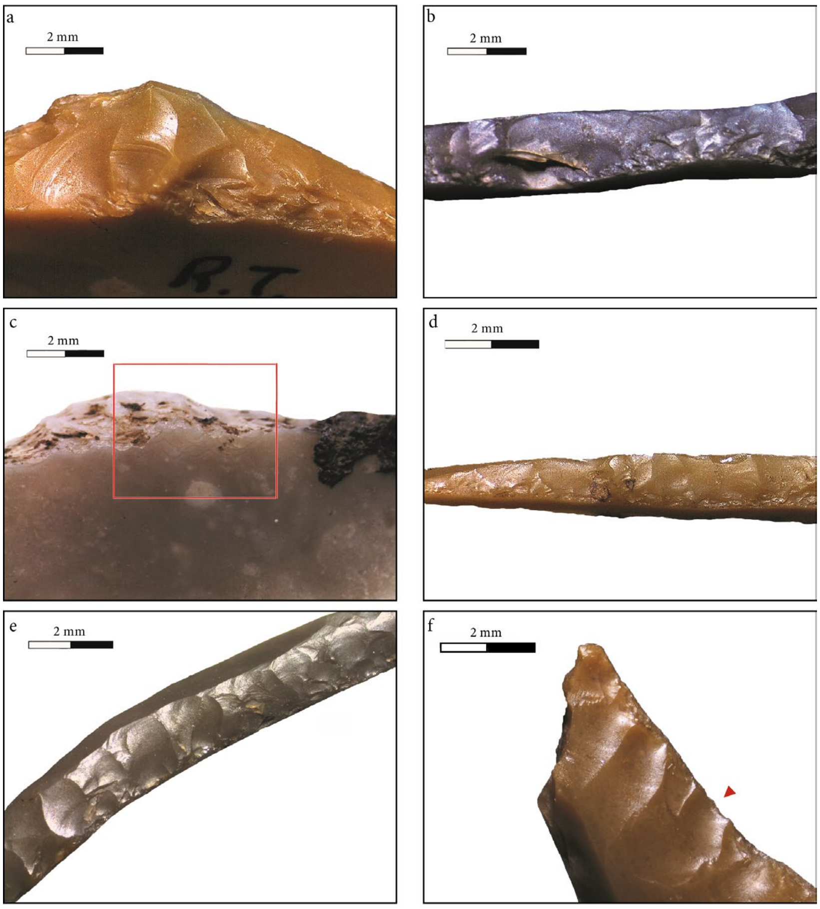


Figure 3.17 – Low power approach. a: hammered portion with multiple-step terminations and deep bulb negatives produced by soft stone percussion on anvil; b: Scar with an orthogonal development produced by soft stone percussion on anvil; c: Incipient cones far from the retouched edge produced by soft stone percussion anvil; d-e: regular, symmetrical and aligned removals associated to small unintentional removals along the edge produced by pressure by soft stone; f: negative with a large initiation characteristic of pressure by organic tool.

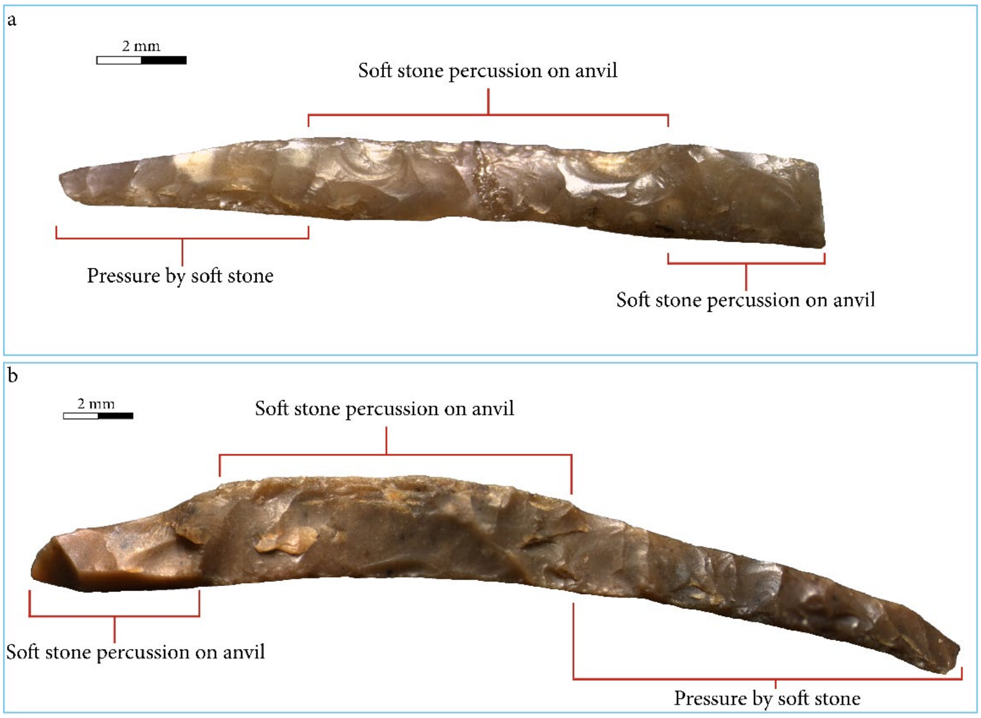


Figure 3.18 – a-b: Backed points produced by mixed technique.

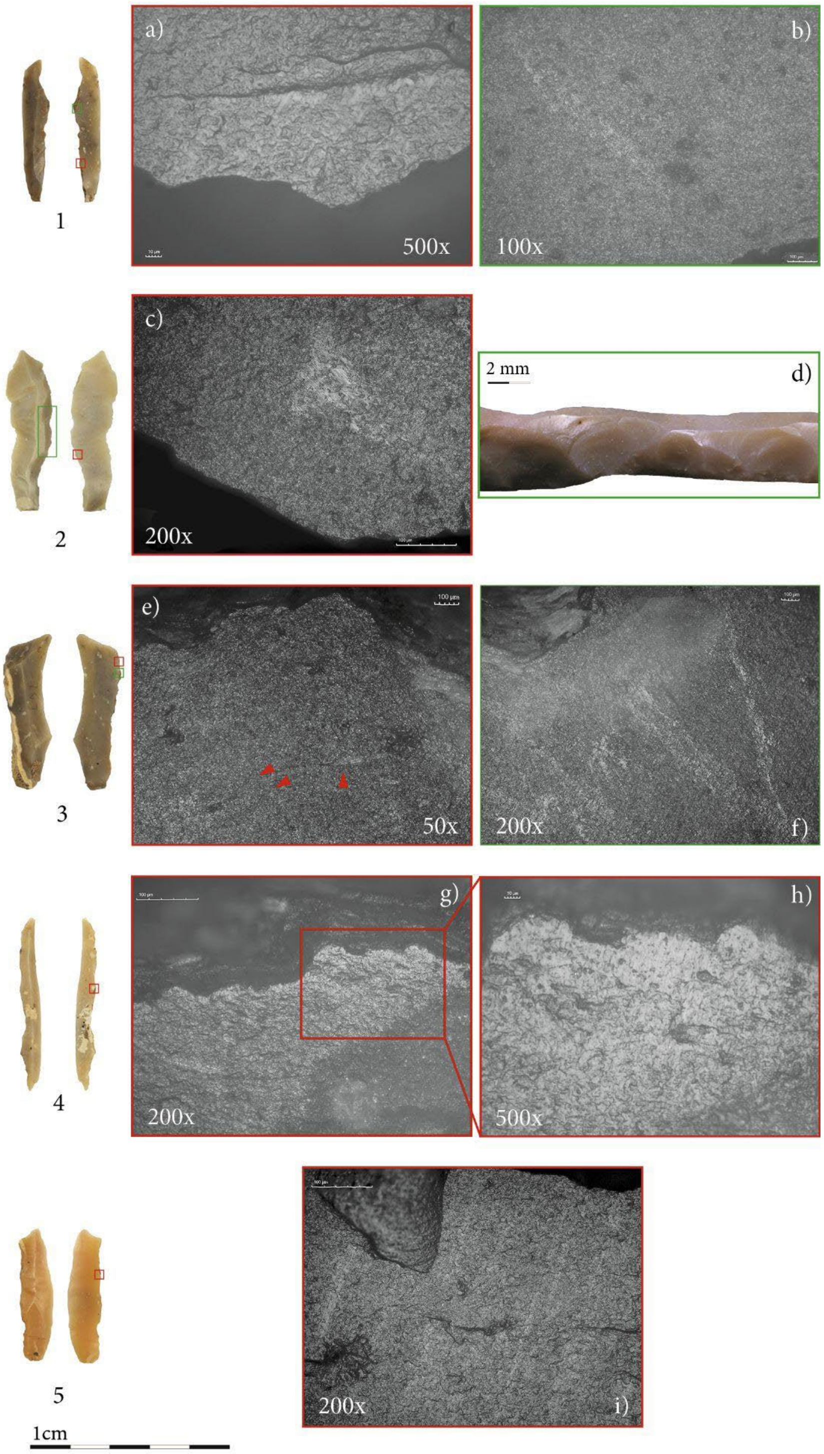


Figure 3.19 – Archaeological backing micro-traces. a, b, c, f, g, h, i: baking micro-traces comparable with those experimentally produceda with a lithic retoucher associated with backs showing features diagnostic of soft stone percussion on anvil (d). e: deep incipient cones diagnostic of soft stone percussion on anvil.

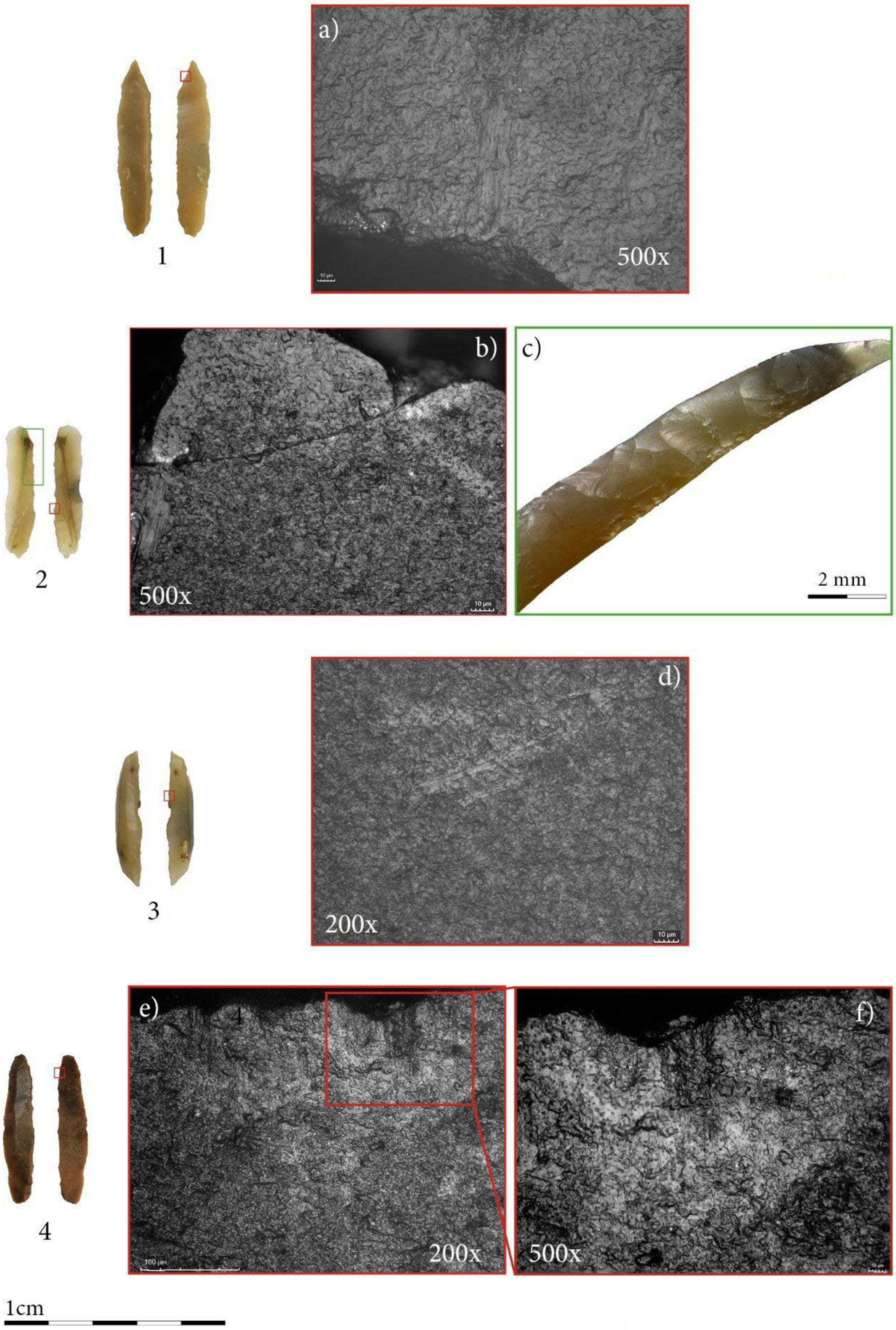


Figure 3.20 – Archaeological backing micro-traces. a, b, d: archaeological backing micro-traces comparable with those experimentally produced with a lithic retoucher associated with backs showing features diagnostic of a pressure technique (c); e-f: micro-trace produced by a bone compressor? (See Fig 3.33 d Chapter 3 Part 1).

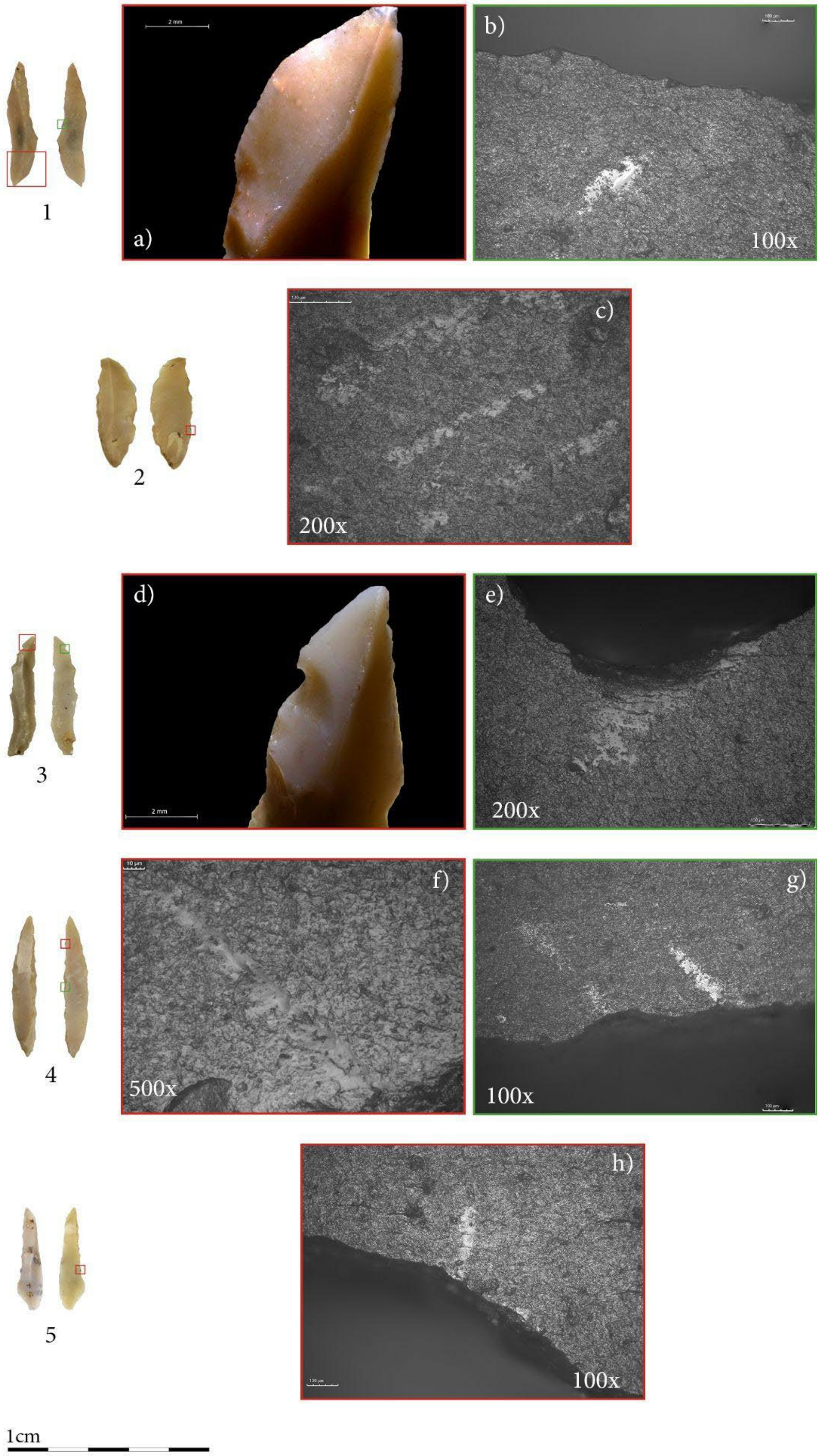


Figure 3.21 – Archaeological backing micro-traces. b, c, e, f, g, and h: backing micro-traces comparable with those experimentally produced with an antler compressor. a, d: equivalent of a Krukowski microburin fracture.

Plotting together metric values of archaeological and experimental material (we excluded the abrasion which is a technique not recorded at Riparo Tagliente) an interesting result was displayed: clusters of each archaeological retouch technique seem to match with the equivalent experimental one, confirming the existence among the armatures assemblage of Riparo Tagliente of the three backing techniques previously identified: soft stone percussion on anvil, pressure by soft stone and pressure by an organic tool.

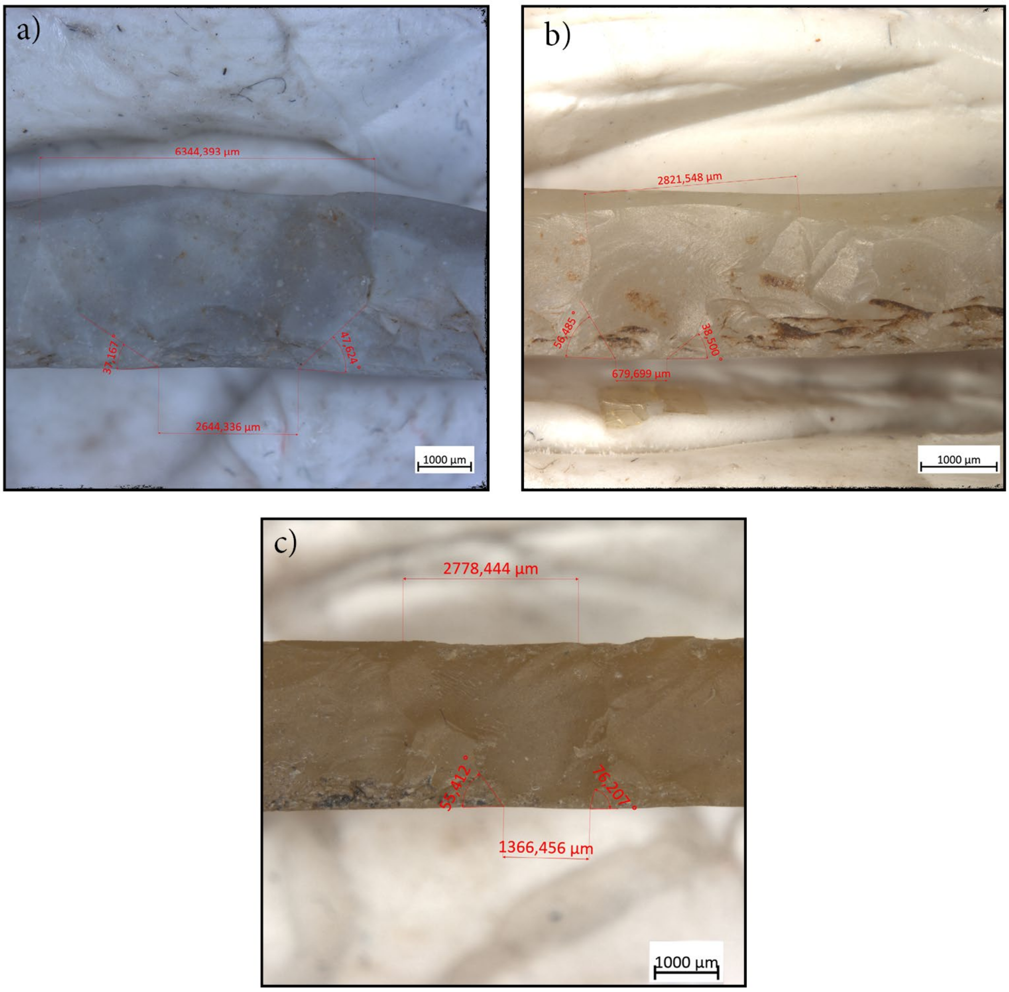


Figure 3.22 - Example of three retouch scars measured through a motorised digital stereomicroscope (ZEISS AxioCam Zoom v16; ZEISS Zen Core v.). a: Soft stone percussion on anvil; b: Pressure by soft stone; c: Pressure by an organic tool.

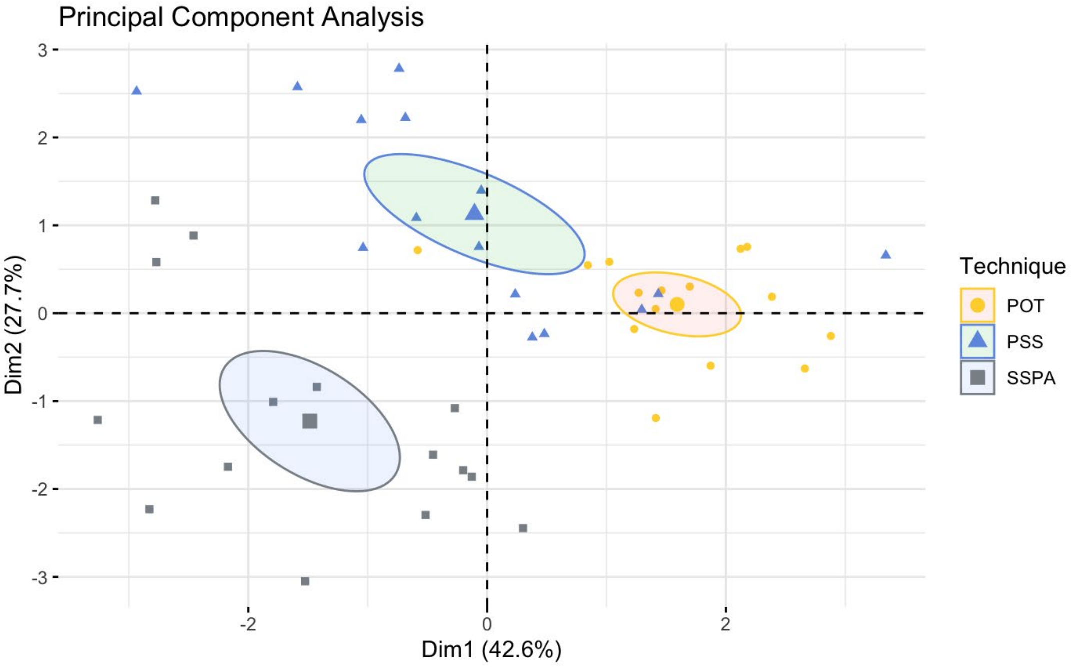


Figure 3.23 - Scatter plot of the PCA of the archaeological back negatives measured.

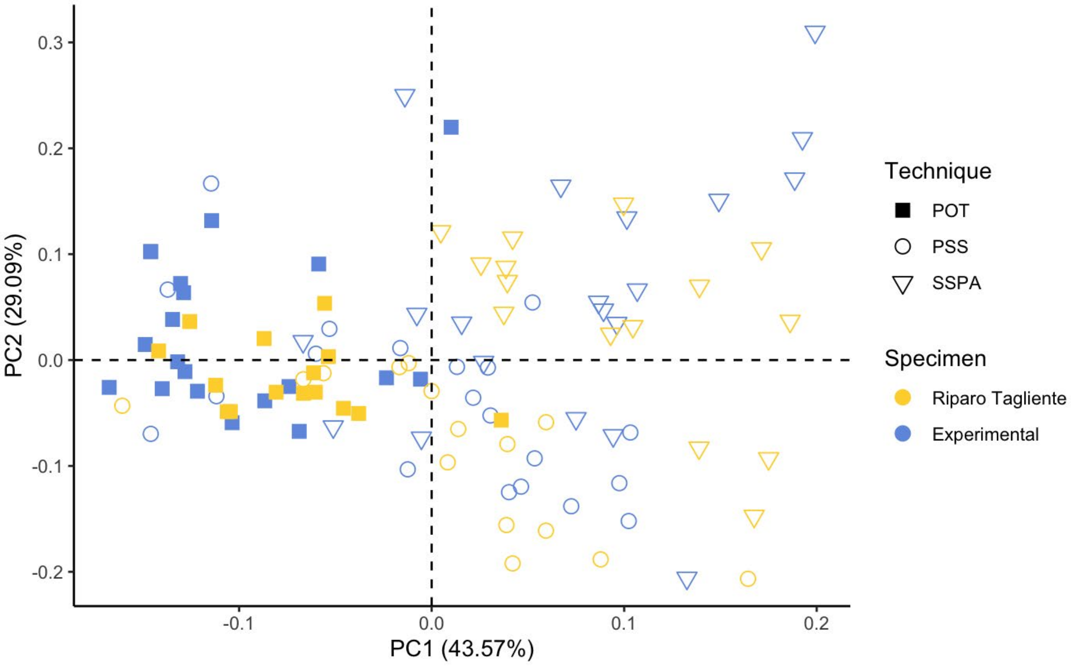


Figure 3.24 - Scatter plot of the PCA of the archeological and experimental back negatives measured.

3.2.8. Diagnostic impact fractures

A preliminary macroscopic use-wear analysis aimed at identifying fractures that can be considered diagnostics of a projectile function (DIF) was carried out. In Table 3.28 the totality of them are reported. As regard backed points and backed truncated points, the coexistence of different morphologies (elongated vs. wide) and size (type A and type B) could reflect a high variability of hafting methods and arrows as supposed by a prior study (Duches, 2011). More specifically, this could be related to a latero-distal hafting for elongated backed points and an axial hafting for wide backed points. Unfortunately, due the lack of an experimental programme and a high-power approach current data from Riparo Tagliente cannot confirm this hypothesis yet. Some of the fractures cited in Table 3.28 are shown in Figure 3.25 a-d.

Only three backed truncated bladelets conserved diagnostic fractures (Tab. 3.28; Fig. 3.25 e). They are two transverse bending fractures, respectively with a step and feather termination (see b3 type from Yaroshevich et al., 2010) and one burination developing directly from the truncation probably occurs due to the recoil with other armatures inside the shaft (see Duches 2011, p 333). One of them shows scars along the cutting edge (Fig. 3.25 e). These elements come from SSUU 15, 8 and 4, attesting the use of backed truncated bladelets as lateral implement all along the Late Epigravettian sequence.

Two backed bladelets present edge scars morphologically comparable to those attested during previous experimental studies (Duches, 2011).

Table 3.28 - Diagnostic impact fractures variability according to each type of armature. The percentage is with respect to the total number of fractures of each type of the analysed sample.

Backed points and backed truncated points	n
Bending (feather, step or hinge) fracture with a *languette* ≥ 3mm	1
Feather terminating bending fracture with a *languette* ≥ 3 mm	4
Step terminating bending fracture with a *languette* ≥ 3 mm	2
Transverse step terminating bending fracture with languette ≥ 3 mm	2
Burination ≥3 mm	9
Spin-off 3 ≥ mm	2
Burin-like spin-off ≥3 mm	10
Edge scars	8
Total fractures	**38 (15.38%)**
Backed truncated bladelets	**n**
Transverse feather terminating bending fracture	1
Transverse step terminating bending fracture	1
Burination of 5 mm	1
Total fractures	**3 (17.65%)**

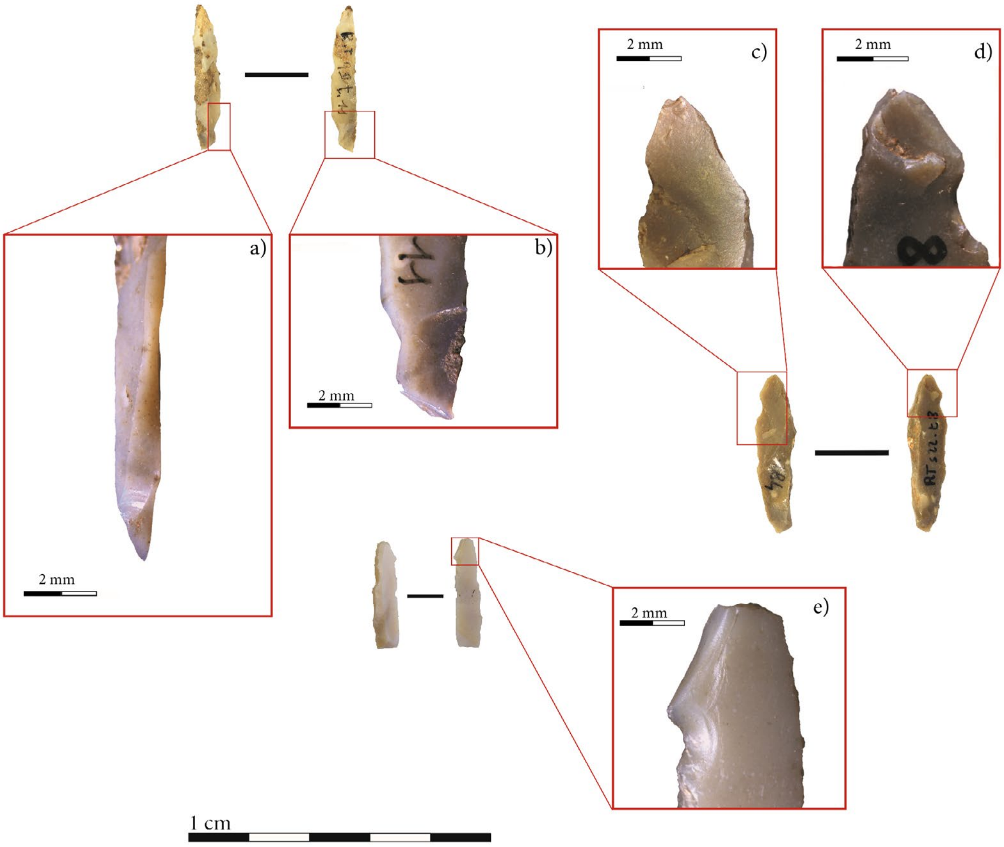


Figure 3.25 – Backed points (a-d) and backed truncated bladelets (e) with fractures diagnostic of projectile function. a: burin-like spin-off; b-d: step terminating bending fractures; c: edge scar; e: lateral step terminating bending fracture and edge scars.

Chapter 4 - Riparo Biarzo

4.1. Site introduction

Riparo Biarzo is one of the main sites located in North-Eastern Italy covering the time span between the end of the Pleistocene and the beginning of the Holocene. It is a valley bottom rock-shelter positioned on the hydrographic left bank of the Natisone river at 160 m a.s.l., in the municipality of San Pietro al Natisone (UD, Italy). The rock-shelter was formed in the Pleistocene fluvial conglomerates, composed of carbonate pebbles, transported in the valley bottom and subsequently cut by the Natisone river (Bressan et al., 1982). (Fig. 4.1. a).

The site was discovered in 1980 by the Friulian Speleological and Hydrological Association. Lately, A. Guerreschi (University of Ferrara) and F. Bressan (Natural History Museum of Udine) undertook the stratigraphic excavation (1982-1984) of around 4 m^2 for a depth of 1,5 m. They brought to light a stratigraphic sequence of five main levels dated from the Late Epigravettian (layer 5), through the Mesolithic, both Sauveterrian (layer 4 and 3B) and Castelnovian (layer 3A), until the Neolithic, Copper and Bronze Age (layer 1-2) (Fig. 4.1. b). Unfortunately, only a small part of the deposit was investigated due to the collapse of the vault in the inner portion of the sheltered area. The stratigraphic sequence for the lower units (namely Late Epigravettian and Sauveterrian occupation) is not disturbed, although an erosion phase damaged the north-eastern side of the top of layer 5. By contrast, in the upper layers there is evidence of mixing processes.

Except for layer 4 which is attributed to the Sauveterrian through the comparison with the lithic industry of layer AC of Riparo Romagnano (TN, Italy), several radiocarbon dates were conducted on charcoal and bone samples from ancient layers (Tab. 4.1). Layer 5 is dated to 13185-12759 cal BP. The latter was excavated as a unique level during the first year (1982). Only in the two following excavation campaigns, it was divided into three artificial sub-levels: 5a, 5b, 5c. Despite a large amount of carbonised sediment and burnt faunal and lithic remains any evidence of fireplaces or other structures were attested.

Several studies have been conducted aimed at reconstructing the paleoenvironment (Bartolomei, 1996; Castelletti et al., 1996; Cattani, 1996; Giovanelli, 1996) and the modalities of animal exploitation (Rowley-Conwy 1996; Bertolini et al. 2016; Romandini and Bertolini 2010). Several personal ornaments (one perforated red deer atrophic canine and 59 perforated shells both marine and freshwater) were found in the site (Giovanelli 1996; Cristiani 2012; Bertolini et al. 2016). The lithic industry from the Late Epigravettian level (SU 5) has been the object of several studies based on different approaches: typological (Guerreschi, 1996), functional (Ziggiotti, 2007) and techno-economical (Fasser et al., 2020). Otherwise lithic artefacts from the Mesolithic (SSUU 4, 3B and 3A) have been studied only from a typological viewpoint (Guerreschi, 1996).

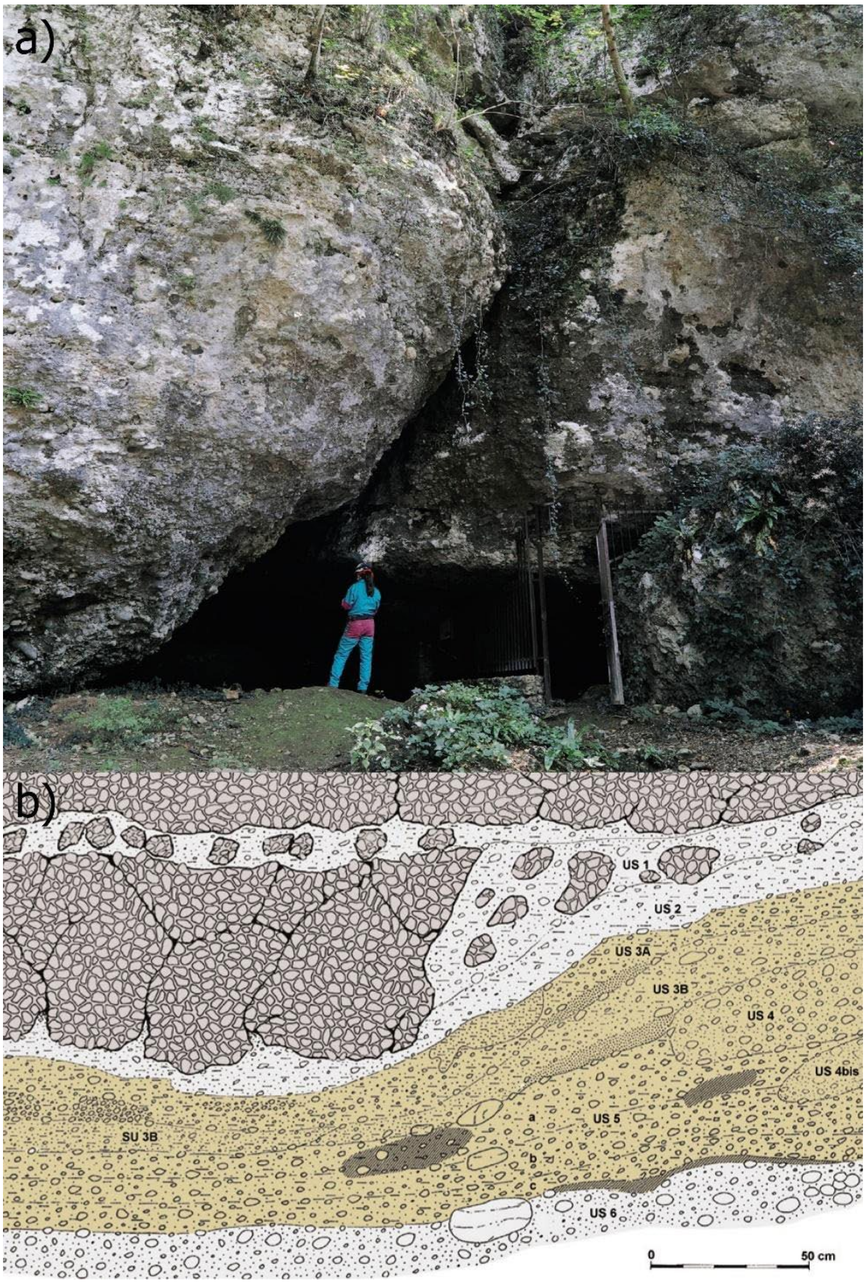


Figure 4.1 – a: Riparo Biarzo; b: the stratigraphic sequence (From Guerreschi et al., 2020).

Table 4.1 - Radiocarbon dates.

SU	**BP**	**Cal BP (2 sigma 95.4% probability)**	**Lab. code**	**Type of sample**	**References**	**Facies**
1	-	-	-	-	-	Copper Age/Bronze Age
2	-	-	-	-	-	
3A	5600 ± 300	7159-5852	-	Charcoal	Guerreschi et al. 1996	Early Neolithic / Castelnovian
3A	7950 ± 30	8986-8646	Beta - 396322	Bone (*Sus scrofa*)	Vai et al. 2015	
3A	8280 ± 30	9333-9193 9419-9343 9188-9135	Beta - 404755	Bone (*Sus scrofa*)	Vai et al. 2015	
3A	8600 ± 30	9633-9527	Beta - 396319	Bone (*Sus scrofa*)	Vai et al. 2015	
3B	8750 ± 30	9894-9598	Beta - 396321	Bone (*Sus scrofa*)	Vai et al. 2015	Sauveterrian
3B	9170 ± 40	10429-10240	Beta - 396320	Bone (*Sus scrofa*))	Vai et al. 2015	
4	-	-	-	-	-	
5	11100 ± 125	13185-12759	R-1850	Charcoal	Guerreschi et al. 1996	Late Epigravettian

Table 4.2 – Dimension of full debitage microbladelets from layer 5. Only complete artifacts were selected.

	Len. (mm)	Wi. (mm)	Th. (mm)
Min	10	4	1
1st quartile	18	8	2
Median	21	10	3
Medium	22,2	10,72	2,9
3rd quartile	26	13	4
Max	34	26	8
Total pieces measured	79	79	79

4.2. The armatures assemblage from layer 5

Armatures from layer 5 are composed of 339 artefacts, divided between backed points, backed truncated bladelets, backed bladelets, bi-truncations (trapezoids), generic backed fragments (41 proximal fragments, 29 distal and 49 mesial) and Krukowski microburins. Geometrics, Sauveterrian points and ordinary microburins were also attested. (Tab. 4.2). The raw materials selected to produce projectile implements are mostly attributable to local formations, in particular the Fonzaso and Maiolica ones, followed by Scaglia Variegata, Scaglia Rossa and Soverzene (Fasser et al., 2020).

Table 4.2 - Composition of the archaeological assemblage from layer 5.

Type of armature	n
Backed points	61
Backed truncated bladelets	93
Backed bladelets	9
Bi-truncations	2
Backed fragments	119
Geometrics	14
Sauveterrian points	9
Ordinary microburins	12
Krukowski microburins	20
Total	339

4.2.1. Backed points

Backed points assemblage presents a high fracture index. It comprises a small percentage of complete (18.03%) and almost complete (24.59%) backed points. Fragments are 57.38%: 20 are apical fragments, while 15 are basal. The latter were isolated from generic backed fragments thanks to their morphological similarities with the basal portion of complete backed points. According to Laplace's typology (1964), backed points from Riparo Biarzo are referable to total backed points (PD4). Two double backed points (PDD4) and eight backed truncated points (DT7/DT8) were identified (Tab. 4.3).

Table 4.3 - Composition of backed points assemblage according to Laplace's typology (1964). PD1 = marginal backed point; PD2 = partially retouched backed point; PD4 = total backed point; PPD4 = backed point with double tip; PDD4 = double backed point; DT7/DT8 = Backed point with a transversal or oblique truncation. TP = oblique truncated point (GEEM, 1972).

	n	%
PD1	3	4.92
PD2	3	4.92
PD4	45	73.77
PDD4	2	3.28
DT7/DT8	8	13.12
Total	61	100

4.2.1.1. Blank selection

Concerning the technical role in the *chaîne opératoire* of blanks selected to manufacture backed points, only in 21,31% the use of full debitage laminar/lamellar blanks was detected. Frequently, it was not possible to go further a generic elongated blank (67,21%). Cortical naturally backed blanks, naturally backed blanks, burin spalls and generic flakes achieved a percentage lower than 2%. Butts are occasionally preserved (40%), indicating a reduction process that did not systematically remove the proximal portion of the blank. Profiles are mostly straight, rarely slightly curved. Blanks have more frequently a trapezoidal cross-section. At a general level, blanks selected to produce backed points are fairly irregular in both their edge delineation and thickness along the longitudinal axis of the bank.

The high fractures index concerning the entire lithic assemblage (both retouch and unretouched artefacts) make the reconstruction of blank dimensional categories more complicated and uncertain. Anyway, since the technological analysis (Fasser et al., 2020) of the lithic assemblages attested one main reduction scheme aiming at producing microbladelets (L<35 mm) and the length of complete backed points rarely overtake 30 mm (length of microbladelets minus the LRI calculated during experimentation of Epigravettian-like backed points) and 3 mm of thicknesses (less than the 3rd quartile of thickness of full debitage microbladelets, see Table 4.2), is possible to hypotheses a higher exploitation of microbladelets compared to bladelets (Tab. 4.4). In bladelets category were included backed points thicker than 3 mm and longer than 30 mm. Elongated flakes were occasionally exploited.

Table 4.4 - Blank dimensional categories selected for backed points production.

	n	%
Microbladelets	42	68.85
Bladelets	15	24.59
Elongated Flakes	4	6.56
Total	61	100

In Table 4.5 backed points dimension is presented (Fig. 4.2). Interquartile range of length varies from 16 mm to 23.7, whereas width and thickness respectively from 5 mm to 7 mm and from 2 mm to 4 mm.

Table 4.5 - Backed points dimensional classes of length, width and thickness.

	Len.	Wid.	Th.
Min. value	10	2	1
1st quartile	16	5	2
Median	20.5	5	3
Medium value	20.3	6	2.9
3rd quartile	23.7	7	4
Max. value	36	16	6
SD	6.578	2.305	1.242
Total	24	61	61

4.2.1.2. Retouch methods

4.2.1.2.1. Backed retouch

Backs are mostly produced on the right side of the blank with a slightly curved or curved delineation (60.66%). Rectilinear backs are poorly attested (21.31%). The cutting edge tends to be slightly convex (67.21%), less frequent rectilinear (19,67%). On triangular and unidentified cross-section blanks, the backed retouch generally reaches totally the main dorsal ridge (48.72%). A back located adjacent to the main dorsal ridge or before have percentages respectively of 17.95% and 20.51% (Tab. 4.6). Backed points manufactured from blanks with trapezoidal cross-section show a back located almost systematically over the 1st ridge (Tab. 4.6). In both cases the purpose is to reach the maximum transverse thickness of the blank.

In triangular cross-section blanks, except for backed points with a back totally over the ridge, the apical portion was mainly shaped out crossing the main dorsal ridge (i.e. secant point). A tip produced by the convergence between the back, main dorsal ridge and functional edge is rare. On the contrary, in trapezoidal cross-section blanks the apex is produced crossing the 2nd dorsal ridge or at the convergence between backed retouch and 2nd dorsal ridge (Tab. 4.7).

Combining data from Table 4.6 and Table 4.7, four main back shaping modalities are attested (Fig. 4.3): the first one involves a backed point with a back located entirely over the main dorsal ridge (a); the second one a back located before the main dorsal ridge and a secant tip (b). The third and the fourth envisage a back located over the 1st ridge and a tip formed crossing the 2nd dorsal ridge (c) or at the convergence between retouched edge, 2nd dorsal ridge and functional edge (d)

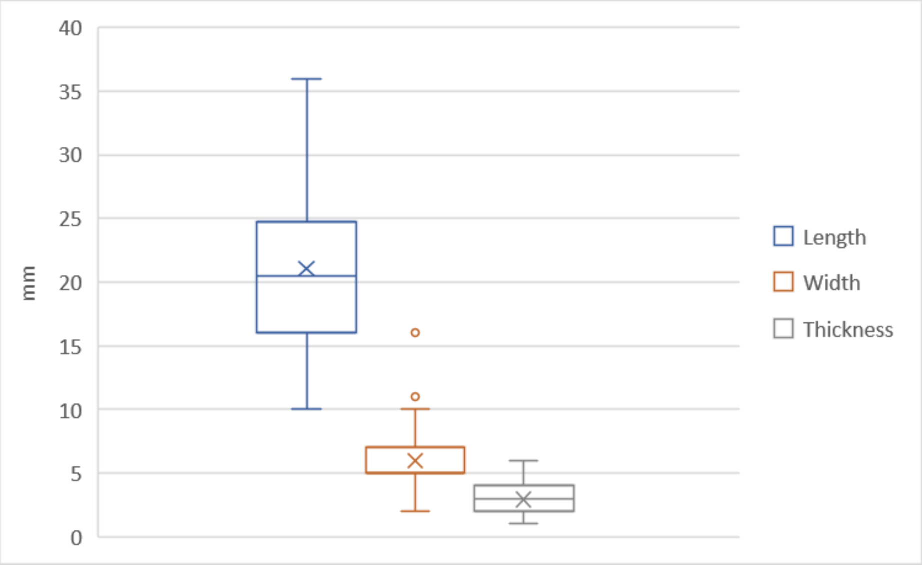


Figure 4.2 – Backed points size.

In order to create the back, a deep and abrupt retouch is generally applied, both direct (59.02%) and crossed (26,23%). Marginal, direct and abrupt (9.84%) or semi-abrupt (1.64%) retouches are slightly attested (Tab. 4.8). The use of a crossed retouch is strictly related to a back characterised by a thickness ≥ 3 mm and inverse detachments are generally located on the mesial or basal portion almost exclusively when the back is positioned over the point of maximum transverse thickness. In this case inverse retouches, besides being useful to remove micro-reflections and to regularise back delineation, are helpful to thin the thickest parts of the blank likely aimed to assisting the artefact hafting (Fig. 4.4 a).

Backed points orientation follows the morphological axis of the blank, namely the apex is located on the distal portion and the base on the proximal one (81.40%). Proximal points achieve a percentage of 16.26%.

Table 4.6 - Relation between back and main dorsal ridge according to cross-section blank.

Triangular/unidentified	n	%
Over the main ridge	19	48.72
Before the ridge	8	20.51
Adjacent to the main ridge	7	17.95
Oblique	2	5.13
N.D.	3	7.69
Total	39	100
Trapezoidal	n	%
Over the 1st ridge	16	72.73
Before the 1st ridge	1	4.55
Adjacent to the 1st ridge	3	13.64
Adjacent to the 2nd ridge	1	4.55
Oblique	1	4.55
Total	22	100

Table 4.7 - Relation between back and main dorsal ridge in the apical portion in backed points according to cross-section blank.

Triangular/unidentified	n	%
Over the ridge	9	23.08
Secant	10	25.64
Convergent	5	12.82
Break	13	33.33
N.D.	2	5.13
Total	39	100
Trapezoidal		
Secant to 2nd ridge	7	31.82
Convergent 2nd ridge	4	18,18
Break	9	40.91
N.D.	2	9.09
Total	22	100

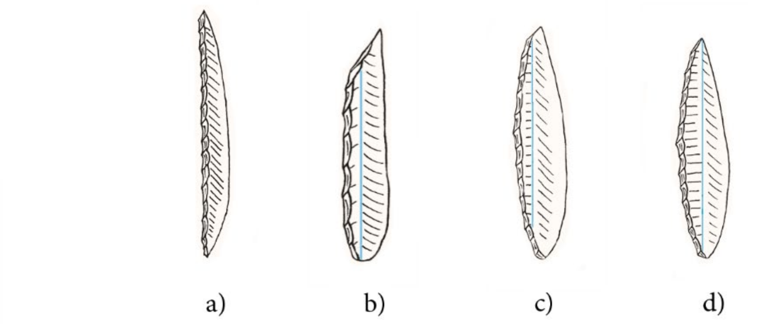


Figure 4.3 - Different modalities of delineating a backed point: a) the back is located over the main dorsal ridge along the entire longitudinal axis; b) the back follows the main dorsal ridge and it crosses this latter to shape a secant tip over it; c) the back follows the 1st dorsal ridge and it crosses this latter to shape a secant tip over it. d) the back is located before the 2nd dorsal ridge and the apex is shaped through the convergence between the backed retouch and the 2nd dorsal ridge.

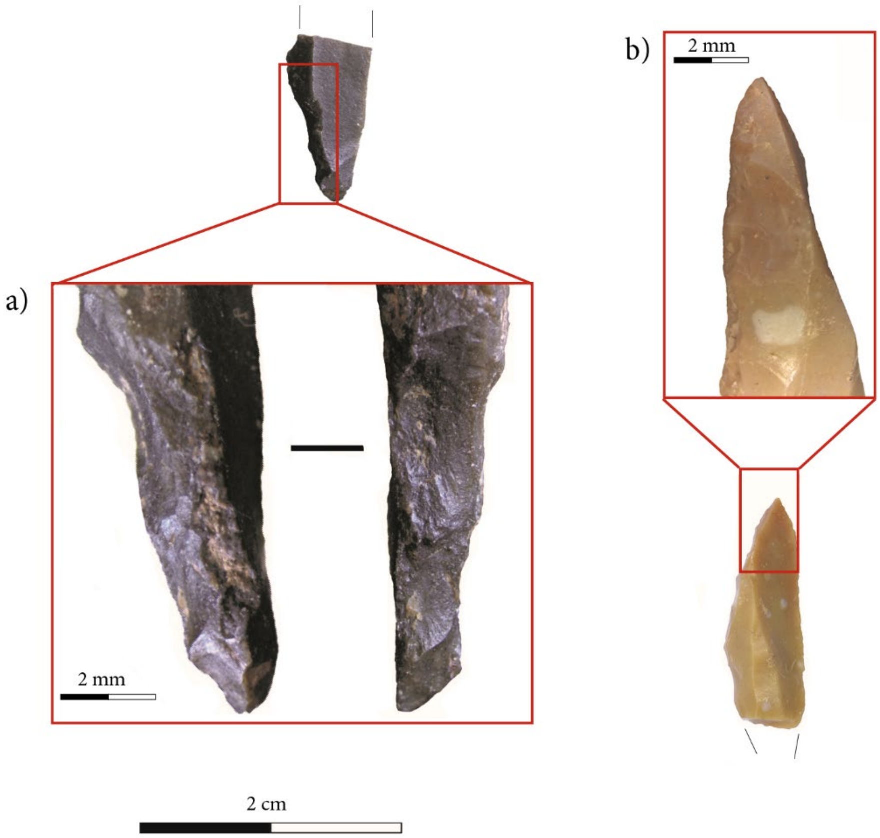


Figure 4.4 – a: inverse retouched used to thin the basal portion of a backed point; b: a *piquant-trièdre* fracture partially covered by the backed retouch.

. Table 4.8 - Backed retouch extent, position and angle.

	n	%
Deep direct abrupt	36	59.02
Deep direct semi-abrupt	2	3.28
Marginal direct abrupt	6	9.84
Deep crossed abrupt	16	26.23
Marginal direct semi-abrupt	1	1.64
Total	61	100

4.2.1.2.2. Complementary retouches and truncations

Complementary retouches are used for modifying the delineation of the cutting edge on less than half of the assemblage (36.07%). They were functional to point the apex (40.54%) and/or to shape out the base (48.65%) in order to facilitate the artefact hafting, less frequently to regularise the mesial portion of the cutting edge (Tab. 4.9).

Table 4.9 - Complementary retouch localization.

	n	%
Apical	15	40.54
Basal	18	48.65
Mesial	4	10.81
Total	37	100

Complementary retouches tend to be either direct semi-abrupt (35.14%) or inverse flat (24.32%). Inverse and flat retouches were applied from the cutting edge (very rarely from the back) aimed at thinning the basal portion. Direct and abrupt retouches, both marginal and deep, were rarely observed (Tab. 4.10). Only 11,48% of backed points were produced by applying more than one complementary retouch.

Seven backed points show a basal truncation transverse proximal retouch characterised by a rectilinear or convex delineation. One shows an oblique orientation forming an obtuse angle with respect to the back.

Table 4.10 - Complementary retouch and truncation extent, position and angle.

	n	%
Marginal direct semi-abrupt	13	35.14
Inverse flat	9	24.32
Marginal direct abrupt	7	18,92
Deep direct abrupt	4	10.81
Direct flat	2	5.41
Marginal inverse semi-abrupt	2	5.41
Total	37	100

4.2.1.3. Morpho-types

By considering several technological parameters, the backed points assemblage can be divided into two main morpho-type (elongated backed points and wide backed points) and two secondary types (double backed points and oblique truncated points). Their frequency index is presented in Table 4.11. The high fracture index of backed points did not allow an exhaustive description of each morpho-type category and it made the subdivision into morpho-type more difficult and uncertain. As a matter of fact, ten pieces were not put into any of the following categories.

- **Elongated backed points, Type A** (Fig. 4.5 a): they are thin and narrow backed points manufactured on microbladelets. The width-length ratio is equal or higher than 1:5. This category counts only ten complete and almost complete pieces. length range between 10 and 27 mm (interquartile range:14.5-20 mm); width between 3 and 8 mm (interquartile range: 4.25-5 mm); thickness between 1 and 3 mm (interquartile 2-2.75 mm). Backed retouch is rectilinear or slightly convex as well as the opposed edge. Apex is generally located in the distal portion, occasionally on the proximal one. The back reduction is carried out by deep direct abrupt retouches and it generally reaches the point of maximum transversal thickness. Frequently complementary retouches are applied to delineate the apex while information regarding base is lacking due to the artefacts integrity. One artefact shows a transversal basal truncation (Fig. 4.5 a, the first one on the left).
- **Elongated backed points, Type B** (Fig. 4.5 b): they are backed points manufactured from bladelets that show a width-length ratio equal or higher than 1:5. The only complete artefact has a length of 32 mm. A second one, almost complete, measures 29 mm. However, the width and thickness of some fragments suggest an even higher length. Width recorded a range between 6 and 9 mm (interquartile range: 6-8.75 mm) and thickness between 3 and 6 mm (interquartile 4-4 mm). Backed retouch is often irregular (i.e. slightly sinuous), sometimes rectilinear, while opposed edge is slightly convex. One element presents a slightly convex backed retouch and a rectilinear opposed edge. The apex is mainly positioned in the distal portion. Backs are shaped out by deep crossed retouches (seldom direct) and it achieves partially (adjacent) or totally (over)

the main dorsal ridge in triangular cross-section blank or totally the 1st ridge in case of trapezoidal cross-section blank. Secondary retouches can be applied to shape out the tip and the base. One artefact shows a basal truncation with an oblique orientation (Fig. 4.5 b, the first one on the left).

- **Wide backed points** (Fig. 4.5 c): they are manufactured on microbladelets (n=8), bladelets (n=7), and elongated flakes (n=4). The width-length ratio is lower than 1:5. Length varies between 16 and 36 mm (interquartile range: 20-24 mm), width between 4 and 11 mm (interquartile range: 5-7,5 mm), thickness between 1 and 6 mm (interquartile 3-4 mm). Backed retouch can be slightly convex as well as the opposed edge designing a symmetric shape. Same artefacts are characterised by a convex back and a rectilinear functional edge. These latter have an apex located asymmetrically with respect to the blank morphological axis. The apex is located on the distal portion, sometimes it is proximal. The backing process is conducted by direct abrupt retouches or less frequently crossed. It follows one of the main dorsal ridges crossing it to to shape a secant tip. Frequently (more than 50%) secondary retouches are applied to figure out the tip and as well as the base. When the base portion is preserved it shows a back that removes the proximal extremity of the blank reaching the functional edge through a sort of convex truncation in continuity with the back (Fig. 4.4 b).
- **Double backed points** (Fig. 4.5 d): Only two pieces were included in this group. Both are apical fragments characterised by a double backed retouch. They differ from typical Sauveterrian points for their bigger size.
- **Oblique truncated points** (Fig. 4.5 e): It is an unusual element for the Italian Late Epigravettian. Both specimens are produced on the proximal portion of a microbladelets through a distal oblique truncation characterised by an angle approximately between 45° and 60°. From a typological viewpoint, they can be related to truncated points of the Epiahrensburgian well known during the Younger Dryas in the German-Dutch plain (G.E.E.M., 1972; Vermeersch, 2008) or to some microlithics sporadically attested in the Balkans during the Late Epigravettian (Montet-White and Kozlowski, 1983).

Table 4.11 - Morpho-types attested at Riparo Biarzo and relative frequency.

	n	%
Elongated backed points, Type A	22	36.07
Elongated backed points, Type B	7	11.48
Wide backed points	19	31.15
Double backed points	2	3.28
Oblique truncated points	2	3.28
N.D.	9	14.75
Total	61	100

4.2.1.4. Resumed backed points

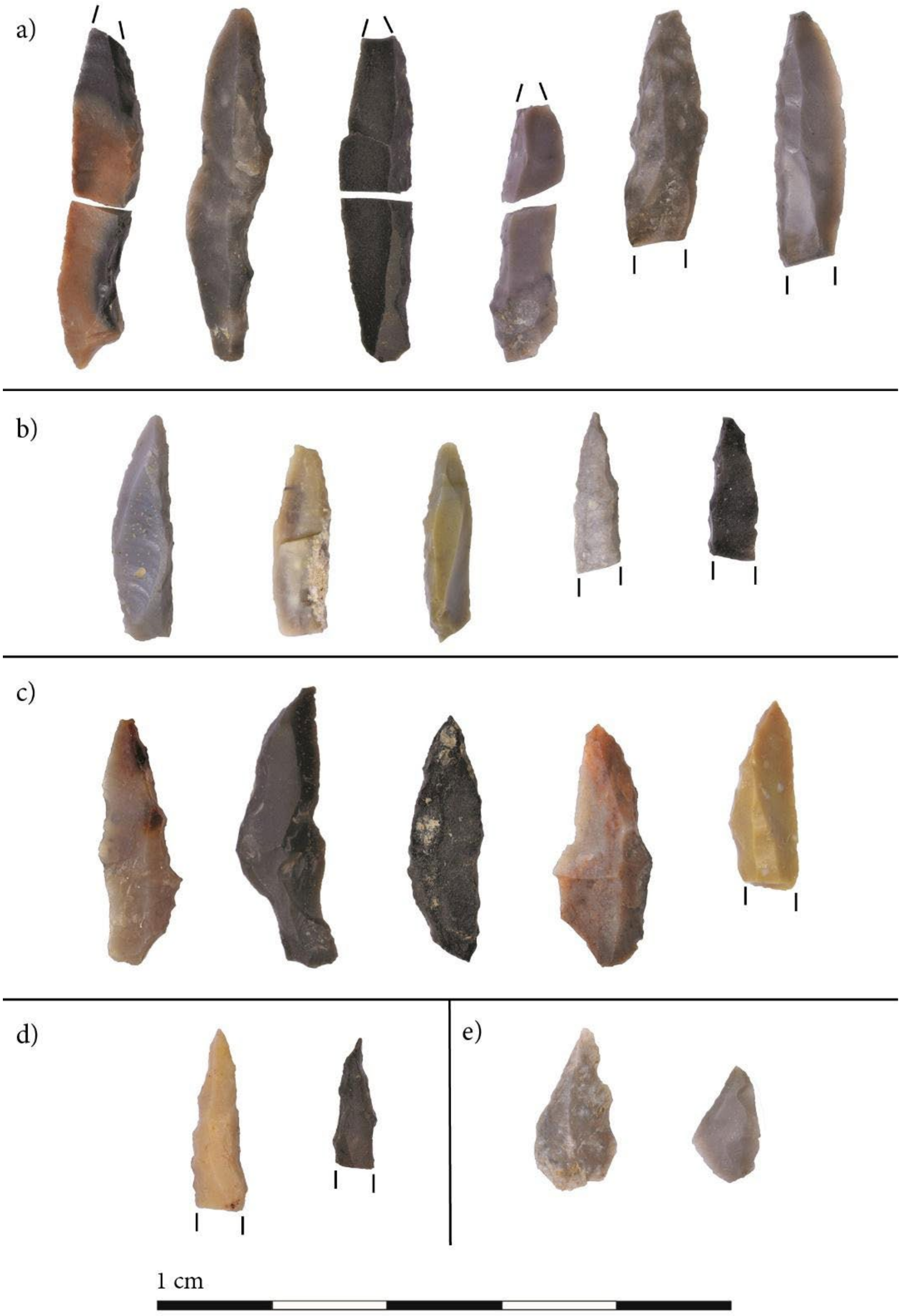


Figure 4.5 – Backed points morpho-types. a: Elongated backed points, Type A; b: Elongated backed points, Type B; c: Wide backed points; d: Double backed points; e: Oblique truncated points.

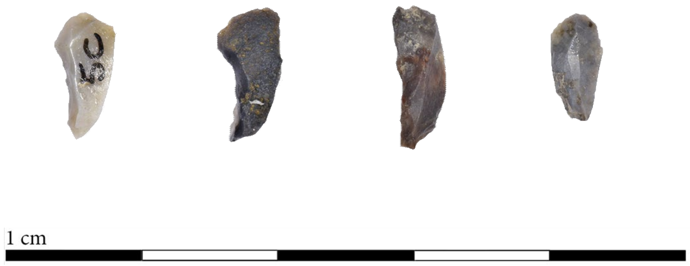


Figure 4.6 – Distal Krukowski microburins.

Figure 4.7 – Experimental curved-backed point and its distal Krukowski microburin.

Resumed pieces are a total of eight. Six show a distal *piquant-trièdre* (i.e. the counter-part of a Krukowski microburin fracture) resumed by a marginal direct retouch in order to shape a distal tip (Fig. 4.4 b). They are wide backed points with a curved or slightly curved back and a secant tip. During the 1st experiment we noticed that shaping a secant tip through a *piquant-trièdre* obtained can be extremely useful and it produced a specific production waste: a distal Krukowski microburin with a partially backed retouch, namely a large notch (Fig. 4.7). In Riparo Biarzo Krukowski microburins are consistent with this production waste (Fig. 4.6), suggesting a sort of intentionality behind Krukowski microburins.

The other two resumed backed points present a basal fracture covered by a direct abrupt truncation.

4.2.2. Backed truncated bladelets

Backed truncated bladelets are the most represented class at Riparo Biarzo (Fig. 4.8). 36,56% are complete (n=34), whereas 63,44% are fractured (n=59). From a typological viewpoint (Laplace 1964) complete pieces can be referred to DT1, DT2, trapezoidal DT2 (cf. *segmenti trapezoidali*), DT3, DT4 and DT5. As shown in Table 4.12 the most represented type is trapezoidal DT2 which is characterised by double obtuse truncation (Fig. 4.8 f). Among fragments, fDT1 and fDT4, namely fractured pieces respectively characterised by a rectilinear and obtuse truncation, reached the higher percentage. fDT3 type is poorly attested.

Table 4.12 - Composition of backed truncated bladelets assemblage according to Laplace's typology (1964). DT1 = single transversal truncation; DT2 = double symmetric transversal truncation; DT2 trap. = double symmetric oblique truncation DT3 = single acute truncation; DT4 = asymmetric double truncation; DT5 = asymmetric double truncation; fDT1 = fractured pieces with transversa truncation; fDT3 = fractured pieces with acute single truncation; fDT4 = fractured pieces with obtuse single truncation.

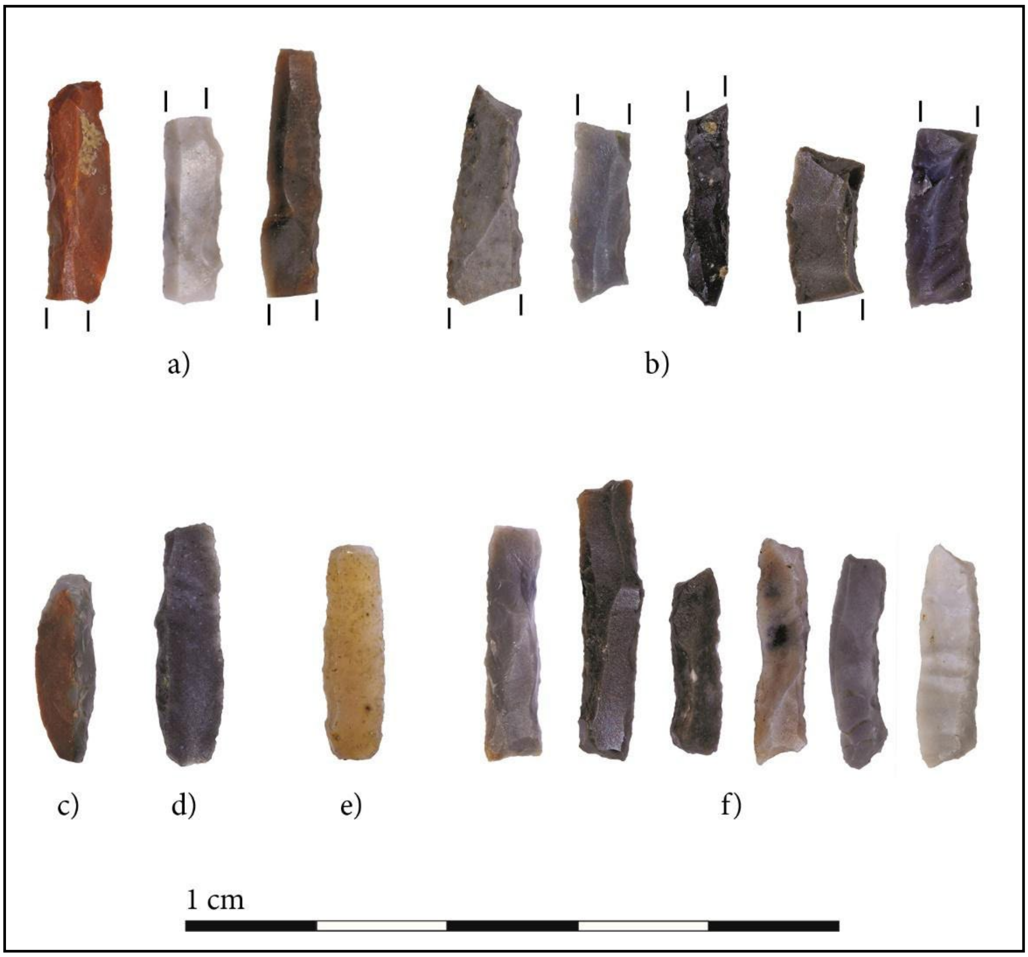


Figure 4.8 – Backed truncated bladelets from layer 5 of Riparo Biarzo. a: fractured backed truncated bladelets with a single transverse truncation (fDT1); b: fractured backed truncated bladelets with a single obtuse truncation (fDT4); c: backed truncated bladelet with a single transverse truncation (DT1); d: backed truncated bladelet with a single obtuse truncation (DT4); e: backed truncated bladelet with a double transverse truncation; f: backed truncated bladelets with a double obtuse truncation.

	n	%
DT1	4	4.30
DT2	3	3.23
DT2 trap	22	23.65
DT3	1	1.08
DT4	2	2.15
DT5	2	2.15
fDT1	23	24.73
fDT3	3	3.23
fDT4	33	35.48
Total	93	100

4.2.2.1. Blank selection

Blanks selected to manufacture backed truncated bladelest are full debitage laminar/lamellar blanks with a triangular or trapezoidal cross-section, a profile almost systematically rectilinear and a calibrate thickness around 2-3 mm. The values of thickness of backed truncated bladelets fits perfectly with the variability of full debitage products illustrated in Table 4.2, suggesting the major selection of microbladelets. To be more cautious, items characterised by a thickness of 3 mm were marked as microbladelets/bladelets. One artefact may be produced from a flake (Tab. 4.13). By considering pieces abandoned during construction and the invasiveness of the backed retouch (as seen from the ventral face), width of selected blanks seems to range between 5 mm and 10 mm.

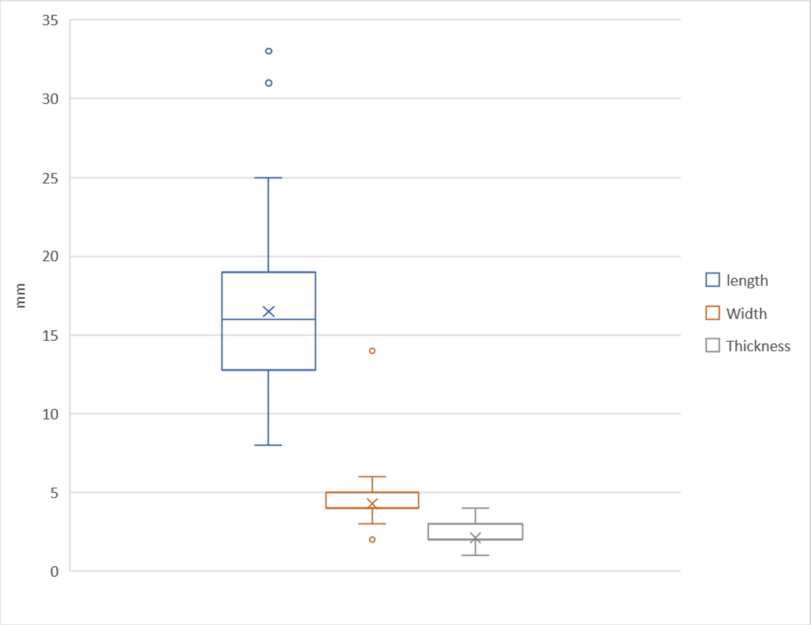


Figure 4.9 – Backed truncated bladelets size.

As for backed truncation bladelets size, Figure 4.9 shows the willingness to produce short gears (rarely longer than 20 mm) with a standardised width and thickness. Their interquartile range varies respectively from 4 to 5 mm and from 2 to 3 mm (Tab. 4.14).

Table 4.13 - Blank dimensional categories selected for backed truncated bladelets production.

	n	%
Microbladelets	69	74.19
Microbladelets/Bladelets	23	24.74
Flakes	1	1.08
Total	93	100

Table 4.14 - Backed truncated bladelets dimensional classes of length, width and thickness.

	Len.	Wid.	Th.
Min. value	8	2	1
1st quartile	13	4	2
Median	16	4	2
Medium value	16.5	4.3	2.1
3rd quartile	19	5	3
Max. value	33	14	4
SD	5.742	1.392	0.778
Total	34	93	93

4.2.2.2. Retouch methods

4.2.2.2.1. Backed retouch

Backed truncated bladelets are mostly characterised by a rectilinear back delineation as well as the cutting edge. There is no specific back lateralization being equally located on the right and on the left side. The only parameter that guides back position seems to be the regularity of the edges. Backs are located on the less regular side.

The back reduction is mostly provided by a deep, direct and abrupt retouch (63.44%), followed by deep crossed abrupt (20,43%) and marginal direct abrupt (8.60%) (Tab. 4.15). Backed deepness is relate to the achievement of a specific range of width (4-5 mm) resulting in a back located over the main dorsal ridge (50.75%) or adjacent to (22.39%) in triangular/indeterminable cross-section blanks and over the 1st ridge (69.23%) or adjacent to the 2nd ridge in trapezoidal ones (23.08%) (Tab. 4.16). The backing process reduces at least half of the original blank width. Marginal backs located before the ridge are rare.

Crossed backed retouches are connected to pieces with a thickness of at least 3 mm and inverse detachments are positioned systematically on the thicker portions of the blank (mesial and proximal) (Fig. 4.10 a), sometimes even along the entire longitudinal profile. As could be observed for backed points, inverse retouches are applied only when the back is over the point of maximum transverse thickness. In this situation inverse retouches allowed adjusting the blank thickness. Backed truncated bladelets thinner than 3 mm with a calibrated thickness do not present inverse retouches (Fig. 4.10 b).

Table 4.15 - Backed retouch extent, position and angle.

	n	%
Deep direct abrupt	59	63.44
Deep direct semi-abrupt	3	3.23
Marginal direct abrupt	8	8.60
Deep crossed abrupt	19	20.43
Marginal direct semi-abrupt	4	4.30
Total	93	100

Table 4.16 - Relation between back and main dorsal ridge according to cross-section blank.

Triangular/unidentified	n	%
Over the main ridge	34	50.75
Before the ridge	14	20.90
Adjacent to the main ridge	15	22.39
N.D.	4	5.97
Total	67	100
Trapezoidal	n	%
Over the 1st ridge	18	69.23
Before the 1st ridge	-	-
Adjacent to the 1st ridge	1	3.85
Adjacent to the 1nd ridge	6	23.08
Total	26	100

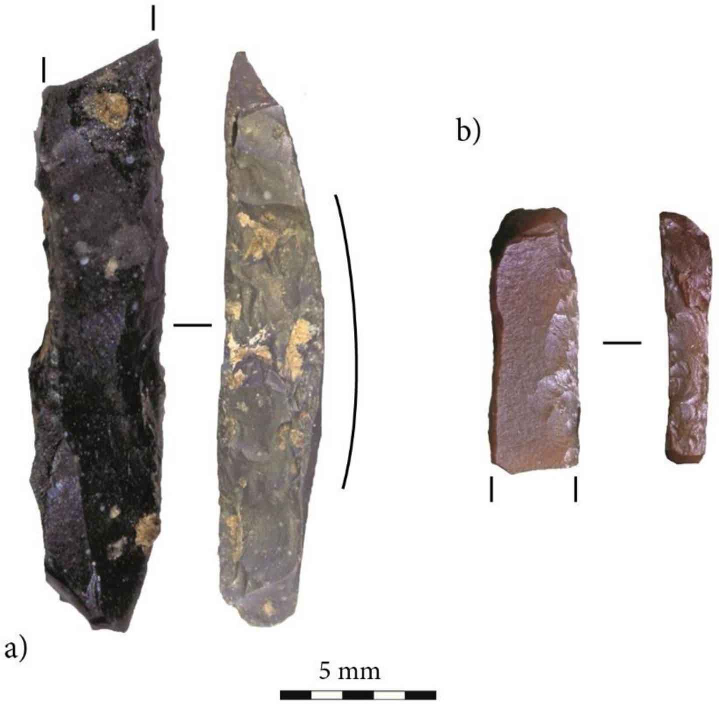


Figure 4.10 – Backed truncated bladelets. a: the black line indicates the localization of inverse backed retouches on the thicker portion of the blank (> 3 mm). A thin back reduced only by direct retouch.

4.2.2.2.2. Truncations

Complete backed truncated bladelets from Riparo Biarzo are almost systematically characterised by double symmetric truncation. It can be oblique forming an obtuse angle with respect to the back or more rarely transverse. Only a few complete pieces are characterised by an asymmetric double truncation or a single one. Among fractured pieces oblique and transverse truncations reached a similar percentage (Tab. 4.17). The retouch is generally direct and abrupt, hardly ever inverse. In some pieces the truncation is formed by a single direct detachment (n=4).

Truncations seem to have different functionality according to type of retouch (deep or marginal) and location (distal or proximal). Deep and direct truncations are mostly employed on proximal portions (65.96%; Tab. 4.18) to remove butts and prominent bulbs, to remove extremities with an excessive concave profile or too thick and to control item length. By contrast, marginal and direct truncations are mainly applied to merely adjust the delineation of the distal portion. Proximal, marginal and direct truncations that remove exclusively the butt are related to extremely thin artefacts (1 mm) in which the bulb convexity is lacking. This discrepancy between proximal-deep and distal-marginal truncations suggests the preference to shaped backed truncated bladelets close to the mesial-distal portion of the blanks, although the difference between the initial support length and the finished product should not be too high, varying probably between 10 and 15 mm.

Nine items have a truncation that covers a previous fracture. These fractures occurred during the manufacturing process and it seems possible to exclude a recycling process of fractured backed points into backed truncated bladelets due to a clear difference in size between these two types of items.

Table 4.17 **-** Truncation delineation and orientation.

Double symmetric truncations	n	%
Double >90° rectilinear	22	23.66
Double trans. rectilinear	3	3.23
Double asymmetric truncations		
Trans. rectilinear and <90° rectilinear	1	1.08
Trans. rectilinear and >90° rectilinear	1	1.08
Single truncation (complete pieces)		
Trans. convex	1	1.08
>90° rectilinear	2	2.15
Trans. rectilinear	3	3.23
<90° rectilinear	1	1.08
Single truncation (fractured pieces)		
Trans. convex	1	1.08
Trans. concave	1	1.08
>90° convex	4	4.30
>90° rectilinear	29	31.18
Trans. rectilinear	21	22.58
<90° rectilinear	3	3.23
Total	93	100

Table 4.18 - Deepness of truncation according to proximal or distal extremity.

	Marginal direct truncation		Deep direct truncation	
	n	%	n	%
Distal	37	71.15	11	23.40
Proximal	13	25.00	31	65.96
N.D.	2	3.85	5	10.64
Total	52	100	47	100

4.2.2.2.3. Complementary retouches

Complementary retouches are present on more than half of the assemblage (56.99%). In 50% of cases they are located all along the functional edge. In the other half they are applied only on one portion of the edge, in particular in the proximal one (Tab. 4.19), likely due to the greater width of this latter compared to the distal extremity. As shown in Table 4.20, marginal, direct and semi-abrupt retouches reached a percentage of 59.26% and direct and flat of 27.78%. This latter can be extremely invasive (Fig. 4.10 b). To apply semi-abrupt or flat retouches instead of abrupt ones allows modifying the functional edge delineation, which must be rectilinear, maintaining an acute angle and therefore avoiding any loss (or just a little) in cutting.

Table 4.19 - Complementary retouch localization.

	n	%
Distal	5	9.26
Proximal	15	27.78
Mesial	7	12.96
Along the entire edge	27	55.10
Total	49	100

Table 4.20 - Complementary retouch extent, position and angle.

	n	%
Marginal direct semi-abrupt	32	59.26
Inverse flat	4	7.41
Marginal direct abrupt	3	5.56
Direct flat	15	27.41
Total	54	100

4.2.2.3 Intentional fracturing to produce backed truncated bladelets?

The similar length between complete and broken backed truncated bladelets led A. Guerreschi (1996) to assume an intentional segmentation of blanks to manufacture this type of gear. Actually, looking at Figure 4.11 a degree of overlap between complete and fractured backed truncated bladelets exists, in particular between backed bi-truncated bladelets characterised by a symmetric double truncation (DT2) and fragments with a single obtuse truncation.

Additional factors argued in favour of an intentional fracturing process:

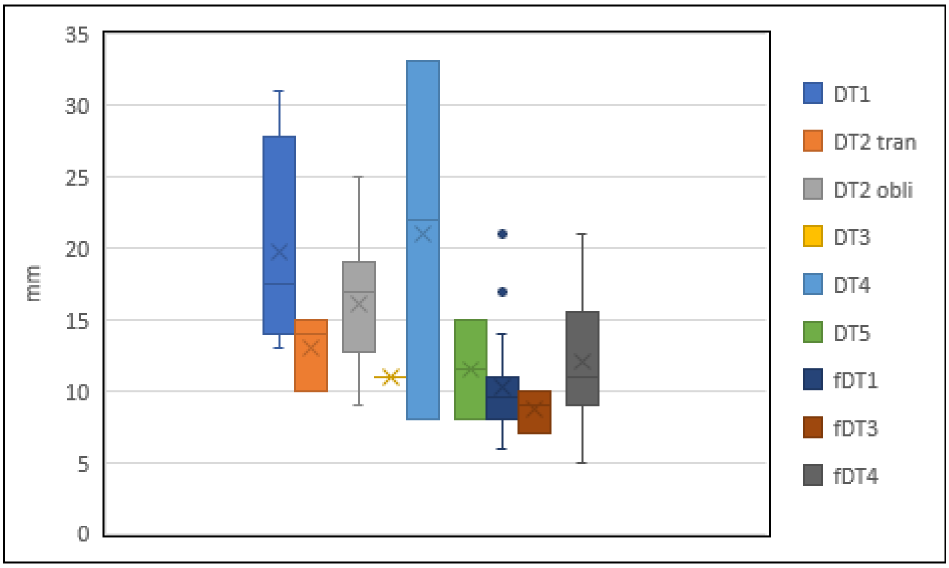


Figure 4.11 – comparison between lengths of complete and fractured backed truncated bladelets according to different types (f=fractured).

- more than half of fractured backed truncated bladelets have breakages orientation symmetric compared to truncations, i.e. an obtuse truncation corresponds to an obtuse fracture and a transverse truncation corresponds to a transverse fracture (Tab. 4.2.1; Fig. 4.8 a, b)
- observing the entire assemblage of distal and proximal backed fragments (n=62), fractures have transverse orientation (41.94%) or they form an acute angle with respect to the back (35.48%), matching with fractures belong to backed truncated bladelets (Tab. 4.21).
- among mesial fragments, some pieces show two symmetric fractures (44.68%).

This combination of features is consistent with a manufacture mode that would provide firstly a backed retouch and then one or two truncations formed by one or two fractures. In this case distal and proximal backed fragments would be considered as a production waste. To verify this hypothesis a comparison between the archaeological and experimental materials obtained during the 3rd experiments (Chapter 3.2.3 Part 1) was carried out.

Table 4.21 - Fracture orientation compared to the back according to backed truncated bladelets fractured and generic fragments.

Fracture orientation	fDT1		fDT4		Proximal and distal fragments	
	n	%	n	%	n	%
>90°	3	13.04	18	54.55	9	14.52
<90°	1	4.35	4	12.12	22	35.48
Transverse	16	69.57	8	24.24	26	41.94
DIF	3	13.04	2	6.06	3	4.84
N.D.	-	-	1	3.03	2	3.23
Total	23	100	33	100	62	100

4.2.2.3.1. Comparison between archaeological and experimental fracture

4.2.2.3.1.1. Fractured backed truncated bladelets

Considering archaeological backed truncated bladelets with a fracture orientated symmetrically with respect to the truncation, only four pieces show a clear cone initiation fractures. Moreover, two of them are certainly attributable to the backing process, excluding the use of a percussion technique to intentionally break blanks. On the contrary, analysing those with a bending fracture, around half of the assemblage (n=21; 12 are fDT4 and 9 are fDT1) presents features comparable to those experimentally obtained with the “bending on a single foothold” fracturing technique:

- feather and hinge terminating bending fracture with S profile and oblique inclination
- snap terminating bending fracture with slightly S profile and oblique inclination
- snap terminating bending fracture with slightly S profile and vertical inclination

The other half (n=18) presents snap terminating bending fractures with a rectilinear profile which is not recorded by either of the two effective fracturing techniques experimented.

4.2.2.3.1.2. Distal, proximal and mesial backed fragments

Proximal and distal backed fragments with a transverse or acute fracture orientation (n=48) show a similar trend: almost half has a bending fracture consistent with those experimentally produced with the “bending on a single foothold” technique (n=19), whereas the rest (n=19) has a snap terminating bending fracture with a rectilinear profile. Ten present a cone fracture, but five are certainly related to the backing process.

Concerning mesial backed fragments with fractures orientated symmetrically (n=15), only three elements have both fractures potentially attributable to an intentional bending fracture.

To sum up, the comparison between archaeological and experimental assemblage did not allow to confirm the hypothesis of the use of a fracturing technique to shape backed truncated bladelets. Only 50% of fractures are comparable with those obtained with the two effective fracturing techniques : “bending on a single foothold” and “percussion on a edge”. In our opinion, this is a too low number considering that these types of fractures can easily result from other processes, such as retouching (see result of the 1st experiment), trampling and hunting activity (O'Farrell 1996; Chesnaux 2014; Roux et al. 2020). Moreover, three additionally factors support the thesis against an unintentional fracturing:

- full debitage laminar/lamellar blanks selected to produce backed truncated bladelets (L<35 mm) do not need an excessive length reduction to achieve the sought-after dimension.
- two backed truncated bladelets characterised by fracture orientation symmetric to that one of the truncation have been refitted.
- the site of Riparo Dalmeri (TN), which is contemporary of Riparo Biarzo, yielded several items longer than 20 mm (Duches et al., 2018). At Riparo Biarzo this length class was missing before finding the aforementioned refit pieces.

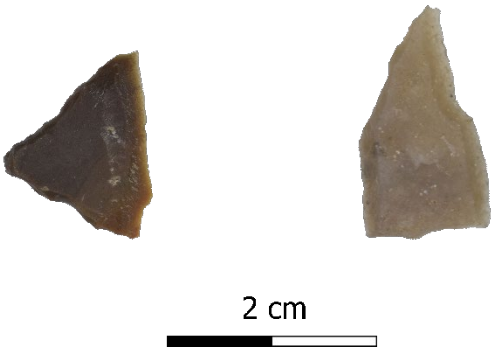


Figure 4.12 – Bi-truncations from layer 5.

Thus the high fracture index of backed truncated bladelets is probably the result of post-depositional processes that normally occurs on artefacts with a higher length values

4.2.2.2.4 Morpho-types

The backed truncated assemblages form Riparo Biarzo manly belong to an unique morpho-type: a fairly standardised backed bi-truncated bladelets produced on thin and rectilinear microbledelets with a double obtuse or less frequently transverse direct truncation, a rectilinear back and a functional edge often adjust by direct and flat or semi-abrupt complementary retouches (Fig. 4.8 e, f).

4.2.3 Backed bladelets and bi-truncations

Backed bladelets and bi-truncations are a secondary target for Late Epigravettian groups of Riparo Biarzo. The former counts a total of nine. Four present a well-defined morphology with a length ranging between 15 and 18 mm, a width between 4 and 5 mm and a thickness between 1 and 2 mm. Backs are produced by a deep, direct and abrupt retouch with a rectilinear delineation. By contrast, five seem to be artefacts abandoned during different stages of the production. This latter will be discussed later in the text. Bi-truncations are a total of two. One is characterised by a proximal transverse truncation and a distal oblique truncation, whereas the second one has a double oblique truncation (Fig. 4.12).

4.2.4 Sauveterrian elements?

Nine Sauvetterian points and fourteen geometrics (6 crescents, 7 scalene triangles and 4 isosceles triangles) were identified in layer 5. Although geometrics were attested in other sites dated to the Late Epigravettian (Bassetti et al., 2009; Cusinato et al., 2004; Peresani et al., 2011), their similarity with those recorded in Sauveterrian layers 4 and 3B may indicate a provenance from these overhead levels. The same goes from Sauveterrian points which is a morphology extremely diagnostic of the Sauveterrian, in particular those produced transversally on flake.

Mixing processes between the Sauveterrian and the Late Epigravettian layers calls into question also the belonging to layer 5 of ordinary microburins (n=12). As a matter of fact, except for 2 pieces, they come from the sub-level 5A which is in direct contact with the Sauveterrian occupation (level 4 and 3B; Fig. 4.1 b). Furthermore, their morphology is diagnostic of a fracture occurred intentionally by a pressure/bending by organic tool (for detailed see results of the 2nd experiment), which is a retouch technique poorly documented in Riparo Biarzo (see Chapter 4.2.6.).

4.2.5. Pieces under construction

Seven complete armatures were interpreted as pieces abandoned during construction: a backed truncated bladelet (Fig. 4.13 a), a backed point (Fig. 4.13 b) and five generic backed armatures. If the majority of them does not show clear morphological issues that explain its abandonment before finishing the manufacture process, the unfinished backed truncated bladelet presents an excessive thickness (4 mm) compared to finished ones. Artefacts discarded after an unintentional breakage are 47 (Tab. 4.22). They include Krukowski microburins (Fig. 4.13 d-e) and their equivalents, proximal snap in notches (Fig. 4.13 c), snap in fan-shaped negative (Fig. 4. 13 f) and other diagnostic backing fractures (Tab. 4.22).

Table 4.22 - Diagnostic backing fractures (DBF). The percentage is with respect to the total number of fractured pieces.

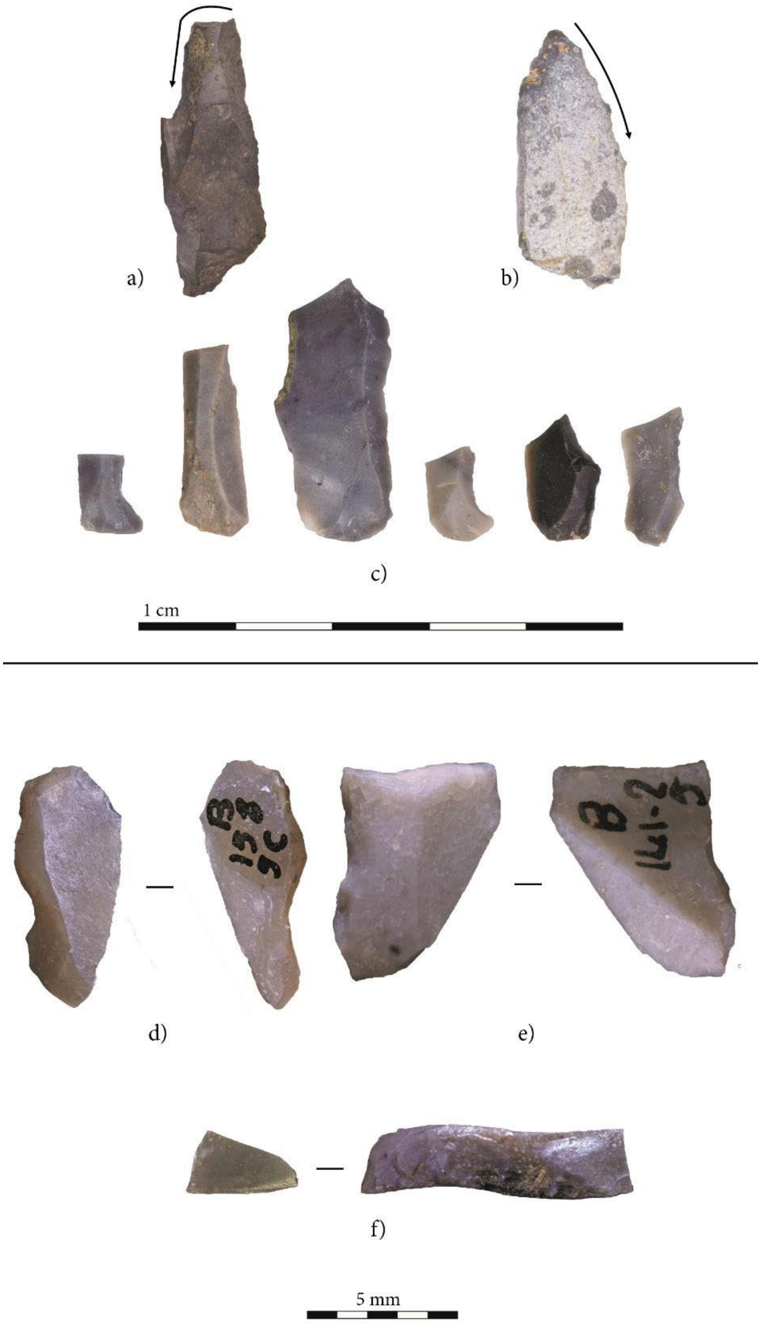


Figure 4.13 – Pieces abandoned during construction. a: backed truncated bladelet; b: backed point; c: proximal snap in notches diagnostic of a single retouch sequence applied from the distal portion towards the proximal one; d-e: backed truncated bladelets fractured during the backing process with a distal truncation already shaped; f: snap in fun-shaped negative diagnostic of soft stone percussion on anvil. Arrows indicate the direction of the retouch sequence.

Type of fracture	**n**
Backed points fragments	
Snap terminating bending fracture	2
Cone fracture	4
Krukowski microburin	4
Generic backed fragments	
Snap terminating bending fracture	2
Snap in fan-shaped negative	1
Snap in notch	6
Feather terminating bending fracture	2
Cone fracture	5
Cone fracture plus *piquant trièdre*	1
Cone fracture plus spin-off	1
Krukowski microburin	15
Backed truncated fragments	
Snap terminating bending fracture	1
Cone fracture	1
Cone fracture plus *piquant trièdre*	1
Krukowski microburin with truncation	1
Total	47 (18,73%)

By observing these unfinished elements two main retouch sequences were attested:

- the first one starts by shaping the distal extremity - an apex in backed points and a distal truncation in backed truncated bladelets - and then it continues by retouching progressively along the longitudinal axis of the blank by one single sequence of direct retouch. Less often the backing process starts from the proximal portion moving toward the distal one
- the second one occurs by several unidirectional sequences (e.g. from the distal to the proximal portion) or bidirectional (e.g. from the distal to proximal and vice versa)

Blanks thicker than 3 mm often attest the use of an additional retouch sequence: several inverse retouches located on the mesial or proximal portion. Looking at the relationship between direct and inverse retouches, the latter are usually the last applied. Occasionally armatures fractured during manufacturing show complementary retouches (both basal and apical).

4.2.6. Backing techniques

4.2.6.1. Low power approach

The morpho-scopic analysis allowed the identification of two main backing techniques: soft stone percussion on an anvil and a generic pressure technique. Looking at the entire assemblage the former is more frequently applied (65%). It is clearly dominant in backed points, whereas in backed truncated bladelets is slightly lower.

Figure 4.14 – Backs produced by soft stone percussion on anvil. Irregular sequence of removals characterised by a denticulated longitudinal profile, rounded edges with hammered portions, scars with a fan-shaped outline and deep bulb negatives. The arrow indicates the direction of overlapping of negatives from the apex towards the base

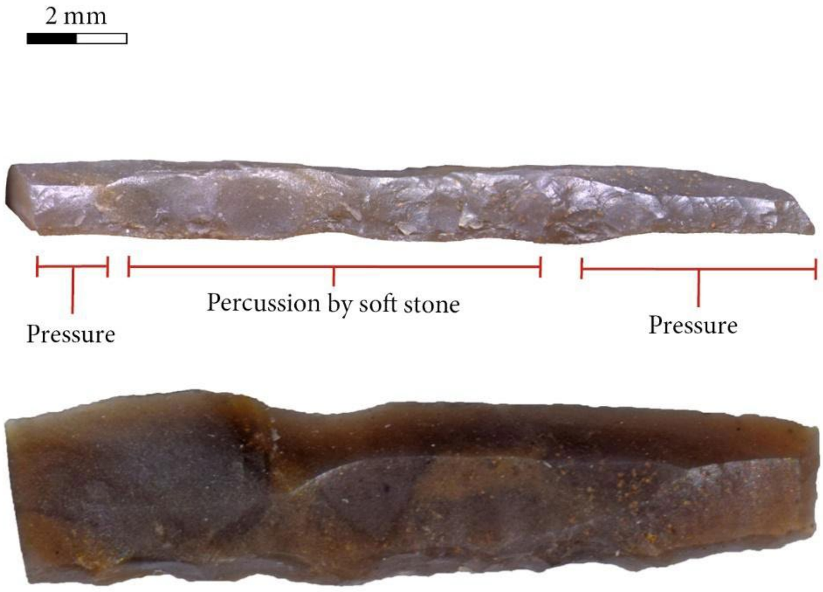


Figure 4.15 - Backed truncated bladelet produced by mixed technique.

If backs produced by soft stone percussion on anvil are easy to identify showing clear features related to this technique (Fig. 4.14), pressure by soft stone and pressure by an organic tool are not always simple to distinguish. In Riparo Biarzo backs characterised by regular, symmetrical and aligned removals are generally associated to slightly rounded edges, small and short unintentional removals along the edge, negatives with punctiform initiations and no evidence of sharp residual indentations visible from the ventral face (Fig. 4.16 a-b). These features are normally related to a pressure technique applied by a soft stone retoucher. Only few items, characterised by a marginal retouch, show features diagnostic of pressure by organic tool, i.e. large impact point (Fig. 4.16 c) and residual indentations (Fig. 4.16 d). However, due to the partial superposition of diagnostic criteria between these two pressure techniques, especially on thin blanks (1-2 mm), the use of a high-power approach is recommended before trying to define the compressor raw material (lithic vs organic). Features related to the recoil effect are lacking, suggesting the use of an organic anvil in case of percussion.

A strong connection between blanks dimensions (width and thickness) and the adopted technique was recorded. The pressure was predominantly applied to retouch narrow and thin (average thickness 1.5 mm) blanks while soft stone percussion on anvil was mostly used for large and thick (average thickness 2.6 mm) ones. Moreover, a different backing technique was applied according to the deepness of retouch: marginal retouches are systematically produced by pressure, while deep retouches are more often applied by soft stone percussion on anvil.

Sometimes, backed points show a mesial and proximal portion retouched by soft stone percussion on anvil, while the apex has a more regular sequence characteristic of a pressure technique. In backed truncated bladelets a simultaneous used of two backing techniques is generally related to the discrepancy of the thickness along the longitudinal axis (Fig. 4.15).

Concerning complementary retouches, a pressure technique (pressure by soft stone or pressure by organic tool) is systematically applied in order to achieve a semi-abrupt or even flat retouch angle.

4.2.7 Diagnostic impact fractures

Diagnostic impact fractures recorded in Riparo Biarzo are reported in Table 4.23 divided between the different types of projectile implements. Damages identified on backed points are localised both in correspondence of their tip and base. Although the lack of an experimental programme does not allow to go into detail, these fractures are suitable with a distal hafting modality (Yaroshevich, 2010; Duches, 2011). In backed truncated bladelets and backed fragments, macro impact traces related to hunting activity are step terminating bending fractures with languette ≥ 3 mm, transverse step terminating bending fractures, burin-like spin-off and spin-off ≥ 3 mm and burinations of at least 3 mm. Edge scars were recorded on four backed

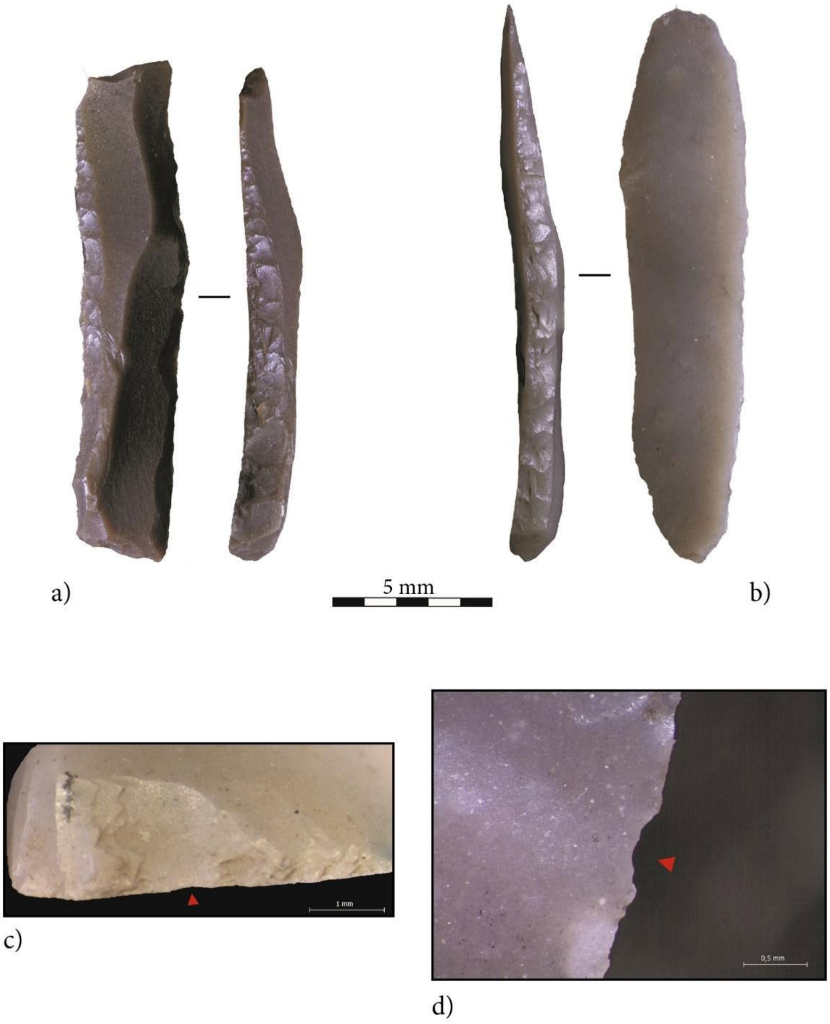


Figure 4.16 – Backs produced by pressure by soft stone (a-b) and pressure by organic tool (c-d). a-b: regular, symmetrical and aligned removals connected to a slightly rounded edge, small and short unintentional removals along the edge, negatives with punctiform initiation and no evidence of sharp residual indentations visible from the ventral face; c: large impact point; d: residual indentations.

truncated bladelets and two backed fragments, but not in association with DIF. In Figure 4.17 several examples are reported.

As supposed by a prior study (Duches, 2011), Late Epigravettian backed truncated bladelets can be hafted in multiple rows with a sub-parallel (Fig. 4.17 n. 10) or oblique (*barbelue*; Fig. 4.17 n. 11) position with respect to the shaft. According to the Author, if multiple backed truncated bladelets are hafted forming a continuous slashing edge, they are subject to compression forces causing fractures characterised by a secondary detachment along a surface (i.e. spin-off) or along a lateral edge (i.e. burin-like spin-off; Fig. 4.17 a-c), burinations fractures initiating directly from the truncation and transverse bending fractures. On the contrary, a low number of fractures related to compression and a higher number of edge scars can suggest an oblique insert. Based on R. Duches (2011) experimental results, diagnostic impact fractures identified in Riparo Biarzo are more suitable with the parallel hafting method. However, two pieces show a burination initiating from the angle formed between the truncation and functional edge (Fig. 4.17 d) that according to L. Chesnaux (2014) occurs more frequently with an oblique position. A high-power approach aimed at identified MLIT's is required for a better comprehension of the projectile head design.

Table 4.23 - Diagnostic impact fractures variability according to each type of armature. The percentage is with respect to the total number of fractured pieces in each type.

Fracture type	**n**
Backed points	
Bending (feather, step or hinge) fracture with a languette ≥ 3 mm	1
Feather terminating bending fracture with a languette ≥ 3 mm + spin-off	1
Transverse feather terminating bending fracture	2
Step terminating bending fracture with a languette ≥ 3 mm + spin-off	1
Transverse step terminating bending fracture	1
Burin-like spin-off ≥3 mm	3
Burination of 4 mm	1
Total	**10 (14.29%)**
Generic backed fragments	
Feather terminating bending fracture with languette ≥ 3 mm	1
Step terminating bending fracture with languette ≥ 3 mm	2
Burin-like spin-off 3mm	1
Scars edge	2
Total	**4 (5,04%)**
Backed truncated fragments	
Step terminating bending fracture with languette ≥ 3 mm	1
Transversal step terminating bending fracture	1
Burination ≥ 3 mm	2
Scars edge	4
Total	**4 (9,38%)**

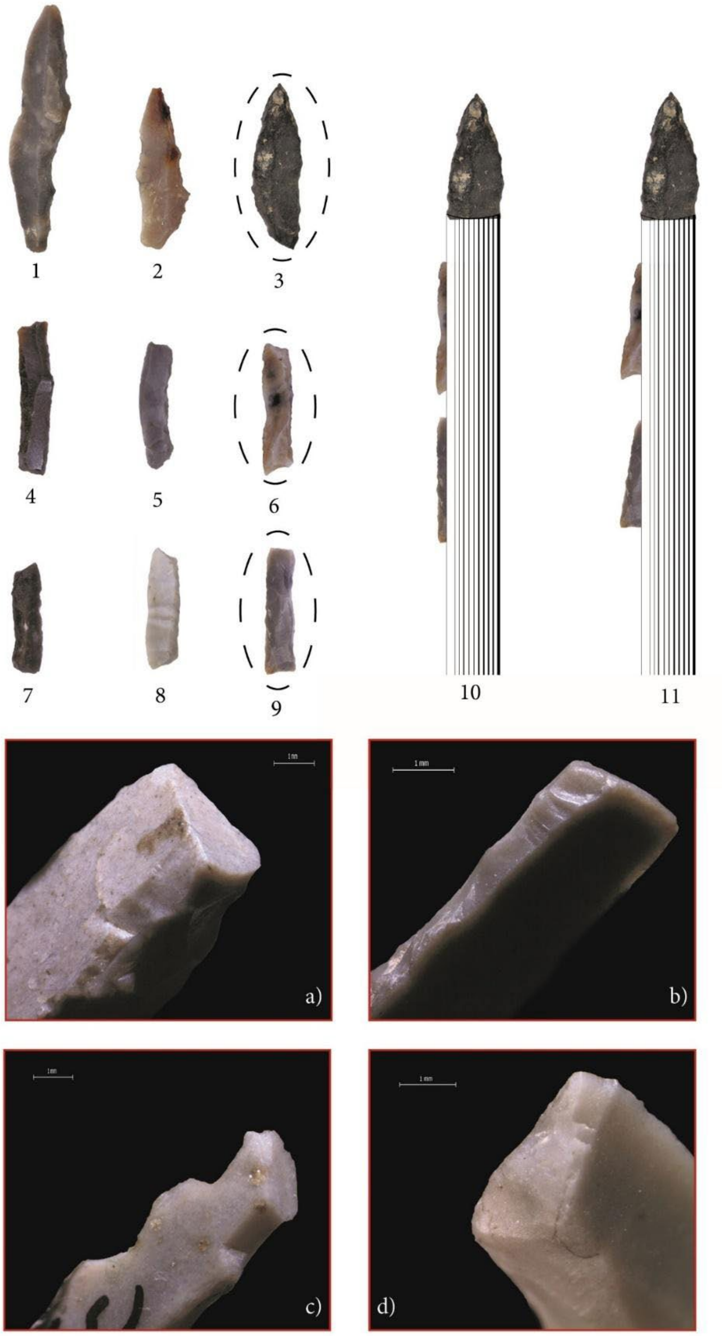


Figure 4.17 – Hafting modalities and diagnostic impact fractures in backed truncated bladelets. 1-3: Backed points; 4-9: Backed truncated bladelets; 10: backed truncated bladelets hafted in multiple rows with a sub-parallel position with respect to the shaft; 11: backed truncated bladelets hafted in multiple rows with an oblique position with respect to the shaft. a-c: burin-like spin-off fractures; d: burination starting at the convergence between the truncation and functional

Chapter 5 - Riparo Soman

5.1. Site introduction

Riparo Soman is a rock-shelter excavated into the Jurassic formation of Calcari Grigi di Noriglio on the hydrographic left bank of the Adige River (Fig. 5.1 a). It is located in the valley bottom at a distance of 1 km from the Chiusa di Ceraiono (VR, Italy). The site has been identified in the early 1980s following the fortuitous discovery of a Bronze Age burial in the western zone of the rock-shelter. Since 1984 several archaeological campaigns have been carried out directed by A. Broglio and M. Lanzinger from the University of Ferrara. Unfortunately, the deposit was preserved exclusively in the inner zone, while the external area was previously removed by roadworks.

Two main sectors have been investigated: sector 1 (northern sector), which cover a surface of around 7 m^2 and sector 2 (southern sector) of around 27 m^2 (Fig. 5.1 b). The investigated area was divided into square metres and successively sub-divided into squares of 33x33 cm. The sediment was sieved using a sieve with a mesh of 1.5 mm. A third sector, where the Bronze Age burial was found, was partially excavated.

A. Broglio and M. Lanzinger brought to light a stratigraphic sequence characterised by two main deposits. The ancient one is connected to the river activity and completely sterile. The second one was mainly composed of coarse breccia (detached from the rock-shelter vault due to thermoelastic phenomenon) that gradually decreased going up the sequence, giving way to a more abundant silt-sandy matrix. This composition suggests a formation under the control of a rather cold climate (Battaglia et al., 1994). Its upper part attests an intense human occupation containing numerous artefacts spanning between the Late Epigravettian, the Mesolithic, both Sauveterrian and Castelnovian, the Early Neolithic and the Bronze age (Battaglia et al., 1994; Broglio and Lanzinger, 1986).

As far as the Late Epigravettian is concerned, Authors (Broglio and Lanzinger, 1986) identified two main phases (Fig. 5.1 b): the first one is dated to the central part of the interstadial Bølling-Allerød (layer 22 and 23 from sector 1; layer 115, 116, 122, 123, 124, 125, 150, 151, 159, 160, 161 and 162 from sector 2), the second one to the younger Dryas (layers 12, 13, 14, 15, 16, 17, 20 and 21 from sector 1; layer 110, 117, 118, 121, 130, 132, 157, 158 from sector 2) (Tab. 5.1). At the moment it is not clear the attribution of some undated layers to one phase rather than other one and the excavation documentation is partially lost. Figure 5.1 b illustrates the stratigraphic sequences and the planimetries of both sectors.

From a generic viewpoint the Late Epigravettian occupation is clearer and more intense in sector 2. The upper layers yielded a combustion structure (SUs 132, 133) characterised by stones arrangement, a radial distribution of faunal remains and evidence of floor preparation through the introduction of sandy sediment taken from the adjacent alluvial deposit. The analysis of charcoal remains from the aforementioned hearth-pit reveals the exploitation of *Larix/Pice*a and *Pinus sylvestris/montana* (Battaglia et al., 1994).

In both sectors the Sauveterrian occupation is in direct contact with the Late Epigravettian levels due to an erosion phase related to practises of soil management of Mesolithic groups.

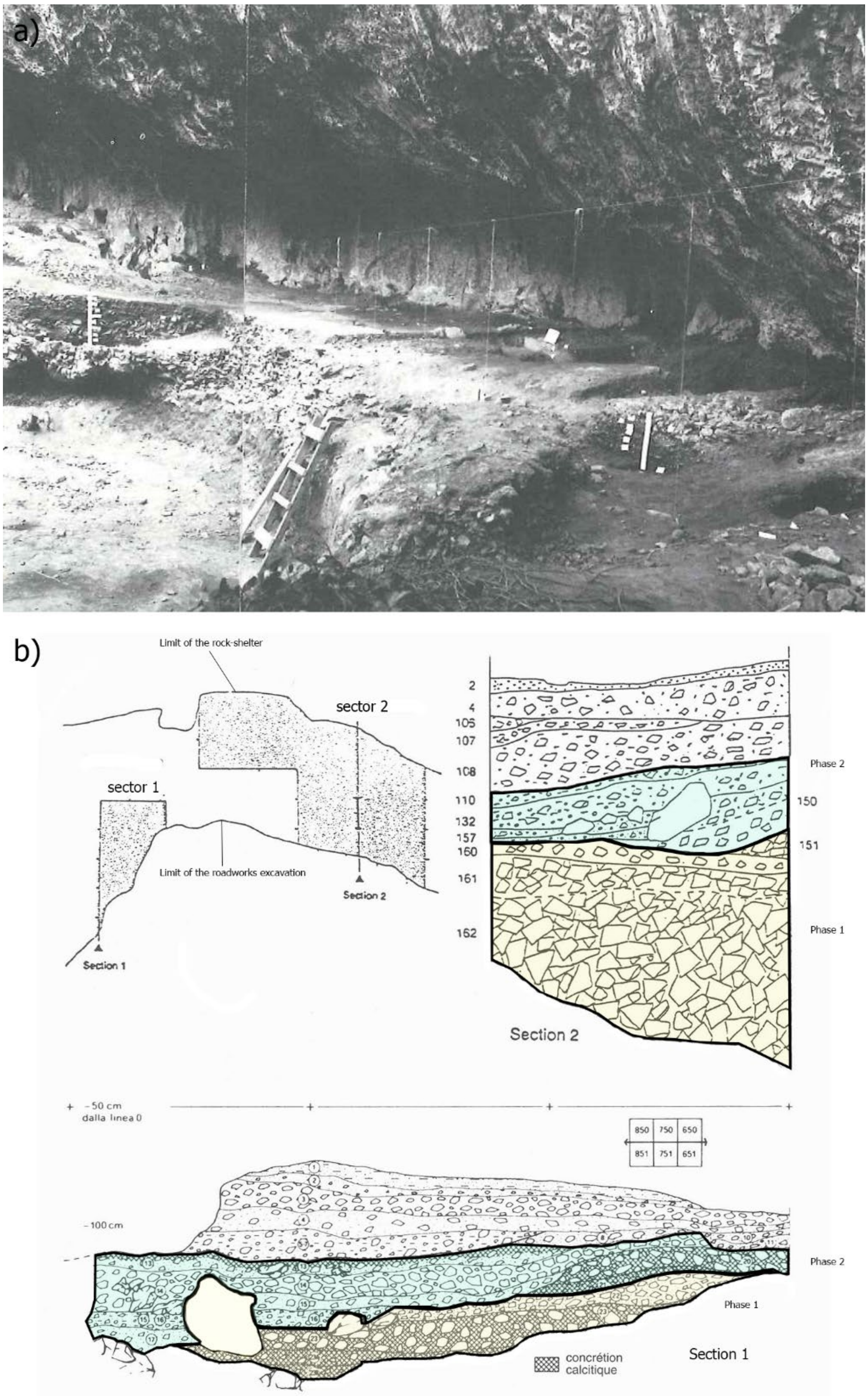


Figure 5.1 – Riparo Soman. a: The rock-shelter; b: planimetries and sections (from Broglio and Lanzinger, 1986; Battaglia et al., 1994 modified).

Table 5.1 - Radiocarbon date of Late Epigravettian layers.

Layer	Laboratory identifier	BP	Cal BP (2 sigma 95.4% probability)	Chronozone	Sector	Phase
14-13	Gd-6163	10370±110	12514-11828	Younger Dryas	1	II
?	Gd-4511	10450±150	-	Younger Dryas	?	II
132	Gd-6159	10470±150	12731-11926	Younger Dryas	2	II
157	Gd-4511	10510±180	12766-11813	Younger Dryas	2	II
161	Gd-6158	11880±170	14146-13404	Interstadial B-A	2	I

The archaeozoological analysis of the Late Epigravettian and Mesolithic layers was performed by Tagliacozzo and Cassou (1994). 1,400 faunal remains have been determined. Among them chamois, red deer and ibex are the most attested. Roe deer, aurochs, wild boar and elk played a minor role. Carnivorous are rare as well as birds and fishes. From a diachronic viewpoint some variation along the sequence were highlighted: wild boar and roe deer slightly decrease from the Late Epigravettian occupation phase I to the phase II, while strongly increase in Mesolithic levels. Chamois and ibex, well-documented in both Late Epigravettian phases, decrease in Mesolithics layers. Regarding the seasonality of site occupation, the age of hunted prey shows that the hunting activity occurred from the summer to the beginning of the autumn.

The lithic industry has been studied only through a merely typological approach (Battaglia et al., 1994; Broglio and Lanzinger, 1986). The debitage products and by-products have been never analysed and data concerning the raw material provisioning are not available, although a major exploitation of local flint (Maiolica and Sacaglia Rossa) is evident. The only diachronic variation highlighted is the disappearance of backed knives in phase II.

5.2. Composition of the studied sample

The entire Late Epigravettian armatures assemblage reached a total of 680 elements (more than half belongs to the occupation phase I; Tab. 5.2). In order to reconstruct production methods and techniques, the totality of complete armatures were analysed (n=156), plus 35 fracturated backed points and 47 pieces showing fractures diagnostic of the manufacturing process.

Because of the low numbers of complete and almost complete artefacts belonging to the II phase (n=47) compared to the I one (n=109), data are presented according to the entire assemblage. Only if relevant changes were recorded results were presented according to the two occupation phases.

Table 5.2 - The entire armatures assemblage belongs to the Late Epigravettian layers divided between the two occupation phases.

Type of armature	**I phase**		**II phase**		**Total**
	Total	**Analysed**	**Total**	**Analysed**	
Backed points	47	47	16	16	63
Double backed points	1	1	1	1	2
Backed truncated points	10	10	4	4	14
Backed bladelets	6	6	6	6	12
Backed truncated bladelets	37	37	11	11	48
Backed truncated fragments	113	-	40	-	153
Backed fragments	221	-	94	-	315
Geometrics	3	3	3	3	6
Ordinary microburins	6	6	3	3	9
Complete pieces under constr.	5	5	6	6	11
Backing fractures	26	26	21	21	47
Total	**475**	**141**	**205**	**71**	**680**

5.2.1. Backed points

From a typological viewpoint (Laplace, 1964) total backed points (PD4) are the most abundant type, followed by backed truncated points (DT7/8) (Tab. 5.3). Any typological difference between the two phases was documented. The assemblage integrity is represented by 33,33% of complete pieces, 21,79% of almost complete, whereas 44,87% are apical fragments. 58 backed points belong to phase I, 20 to phase II.

Table 5.3 - Composition of backed points assemblage according to Laplace's typology (1964). PD1 = marginal backed point; PD2 = partially retouched backed point; PD4 = total backed point; PDD1 = double marginal backed point; DT7/DT8 = Backed point with a transversal or oblique truncation. "f" means fractured pieces.

Type	n	%
PD1	7	8.97
PD2	2	2.56
PD4	20	25.64
DT7/8	14	18.95
fPD1	4	5.13
fPD4	30	38.46
fPDD1	1	1.28
Total	78	100

5.2.1.1. Blank selection

Full debitage lamino/lamellar products are the main selected blanks. Rarely laminar by-products were chosen (e.g. cortical blanks, on edge blanks and crested blanks). Cross-sections are equally triangular and trapezoidal. Butts are almost systematically removed by the backing process, basal complementary retouches or truncations. Negatives of the previous removals indicate the use of blanks extracted by a unidirectional debitage sequence.

Unlike other Late Epigravettian sites here analysed in which data concerning debitage products was available, the reconstruction of blanks dimensional category was based exclusively on backed points dimensions. As illustrated in Table 5.4, microbladelets (29,49%) and bladelets (21,79%) reached a similar percentage, whereas blades were not exploited. The high percentage of indeterminable pieces (42,31%) derived from the numerous apical fragments included in the analysed sample. Microbladelets are characterised by a relatively plain cross-section suggesting a provenance from a debitage surface with a slight transverse convexity. Their profile is rectilinear and the width, assumed through comparison between finished backed points and back depth, seems to vary approximately between 7 and 15 mm. Conversely, bladelets have a more elongated shape, a slightly curved profile and they were extracted by cores with narrower debitage surface. Their width appears to be between 9 and 16 mm.

Table 5.4 - Blank dimensional categories selected for backed points production.

	n	%
Microbladelets	23	29.49
Bladelets	17	21.79
Elongated flakes	1	1.28
Microbladelets/Bladelets	4	5.13
N.D.	33	42.31
Total	7	100

Length of complete backed points goes from 12 mm to 41 mm (interquartile range: 20 mm – 32 mm). Width and thickness are more standardised showing a Standard Deviation of 1.529 and 0.848, respectively. The former is normalised by the backed retouch (interquartile range: 5-7), the latter is controlled by the selection of blanks that rarely overpass 3 mm of thickness (3rd interquartile value) (Tab. 5.3; Fig. 5.2).

Table 5.3 - Backed points and backed truncated points dimensional classes of length, width and thickness.

	Len.	Wid.	Th.
Min. value	12	3	1
1st quartile	20	5	2
Median	26	6	2
Medium value	26.3	5.8	2,5
3rd quartile	32	7	3
Max. value	41	14	5
SD	7.465	1.529	0.848
Total	24	61	61

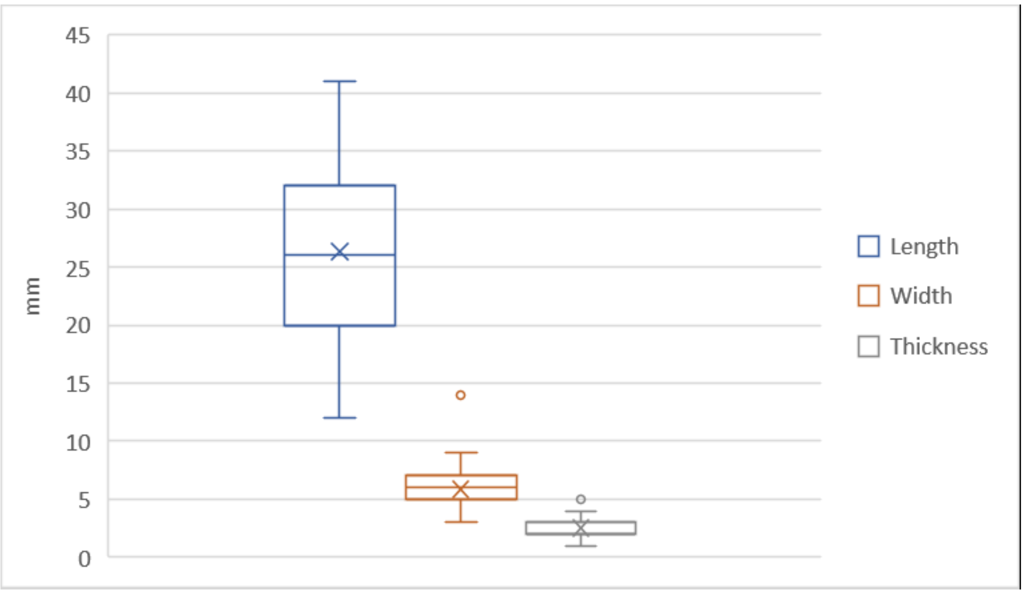


Figure 5.2 - Backed points size.

5.2.1.2. Retouch methods

5.2.1.2.1. Backed retouch

Backed points are characterised by a rectilinear or at least slightly convex back delineation, as well as the cutting edge. Any preference in back localization (right or left side of the blank) was attested. The backing process is carried out by a deep, direct and abrupt retouch (53,85%), followed by deep, crossed and abrupt one (28,21%) (Tab. 5.4). The latter are applied on blanks with a thickness of at least 2 mm and in which the back reaches one of the main dorsal ridges. The aim is to remove protuberances formed during the direct retouch and sometimes normalise the blank thickness in the mesial and/or basal portion (Fig. 5.3). In some cases it was used to thin the apex (n=7).

Marginal retouches were applied on microbladelets characterised by a width of around 5-7 mm (Tab. 5.4). Some artefacts (n=6) present a backed retouch restricted to the apical portion, while the basal one is left unretouched. This technical solution is related, again, to the selection of narrow microbladelets. The relation between the backed retouch and the main dorsal ridge is highly variable, especially with triangular/unidentified cross-section blank (Tab. 5.5). However, the back reduction generally stops before or in correspondence with the half of the original blank width.

The apex is mainly located in the distal portion (79,49%) and in case of triangular cross-section blanks it is formed by the convergence between the back, the main dorsal ridge and the cutting edge, except for backed points in which the backed retouch is located completely over it (Tab. 5.6). Secant tips are occasionally attested. Backed points produced on trapezoidal cross-section blanks have an apex created by the convergence between the back, the 2nd dorsal ridge and the cutting edge (Tab. 5.6). In Figure 5.4 are illustrated the main modalities for delineating a backed point according to blank dorsal ridges.

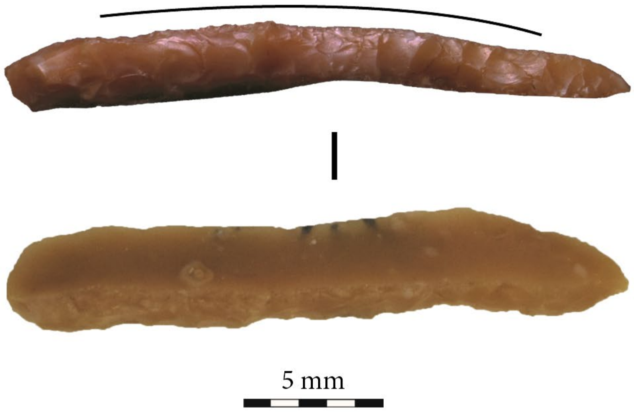


Figure 5.3 - Backed point produced by applying an inverse retouch in the mesial portion aimed at regularising the blank thickness. The back is located over the main dorsal ridge. The black line indicates the position of inverse detachments.

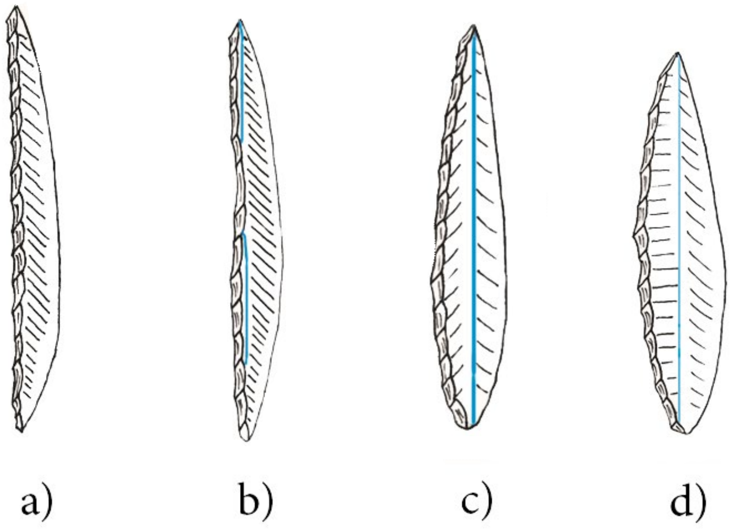


Figure 5.4 - Different modalities of delineating a backed point according to cross-section blank. a: the back is located over the main dorsal ridge along the entire longitudinal axis; b: the back is located adjacent to the main dorsal ridge; c: the back stops before reaching the main dorsal ridge and it converges with this latter in the apical portion; d: the back is positioned over the 1st dorsal ridge and converge with the 2nd dorsal ridge to form the tip.

Table 5.4 - Backed retouch extent, position and angle.

	n	%
Deep direct abrupt	42	53.85
Deep crossed abrupt	22	28.21
Marginal direct abrupt	11	14.10
Marginal crossed abrupt	1	1.28
Marginal direct semi-abrupt	2	2.56
Total	108	100

Table 5.5 - Relation between back and main dorsal ridge in the mesial and basal portion according to cross-section blank.

Triangular/unidentified	n	%
Before the ridge	19	35.19
Adjacent to the main ridge	14	25.93
Over the main ridge	19	35.19
N.D.	2	3.70
Total	54	100
Trapezoidal	n	%
Before the 1st ridge	1	4.17
Adjacent to the 1 st ridge	2	8.33
Over the 1 st ridge	20	83.33
Adjacent to the 2nd ridge	1	4.17
Total	24	100

Table 5.6 - Relation between back and main dorsal ridge in the apical portion in backed points according to cross-section blank.

Triangular/unidentified	n	%
Over the ridge	22	40.74
Secant	6	11.11
Convergent	20	37.04
N.D.	6	11.11
Total	54	100
Trapezoidal		
Secant to 2nd ridge	3	12.50
Convergent 2nd ridge	14	58,33
Break	1	4.17
N.D.	6	25.50
Total	24	100

5.2.1.2.2. Complementary retouches and basal truncations

76% of backed points show an additional retouch phase besides the backing process aimed at pointing the apex (61,64%) or at modifying the base (32,88%) (Tab. 5.7). Among them sixteen pieces present a complementary retouch on more than one area (apical vs. mesial vs. basal) and fourteen have a basal transverse or oblique truncation. Two artefacts show a cutting edge entirely modified by a marginal retouch (Tab. 5.7).

Table 5.7 - Complementary retouch localization.

	n	%
Apical	45	61.64
Basal	24	32.88
Mesial	4	1.37
Entire edge	2	2.74
Total retouched areas	73	100

Complementary retouches have an extent, position and angle extremely variable (Tab. 5.8): the most attested type is the marginal, direct and semi-abrupt (30.56%) or inverse and flat (19.44%). These latter were employed both to thin the apex and the base eliminating the bulb (Fig. 5.5 a-b). Several backed points (n=11) show a bifacial or alternate complementary retouch applied to point the apex (Fig. 5 d).

Table 5.8 - Complementary retouch and truncation extent, position and angle.

	n	%
Marginal direct semi-abrupt	22	30.56
Marginal direct abrupt	11	15.28
Marginal inverse semi-abrupt	3	4.17
Deep direct abrupt	10	13.89
Deep direct semi-abrupt	1	1.39
Inverse flat	14	19.44
Direct flat	1	1.39
Bifacial flat	8	9.72
Alternate flat	3	4.17
Total	72	100

Truncations are deep and direct and almost systematically located in the proximal portion (13 out of 14) to remove the butt and the bulb of the blank. In two pieces they are functional to cover an indeterminable previous fracture. Its delineation varies from transverse rectilinear (n=8) to transverse slightly convex (n=2). Two backed truncated points show a basal rectilinear truncation with an oblique orientation that forms an obtuse angle with respect to the back (Fig. 5.5 c).

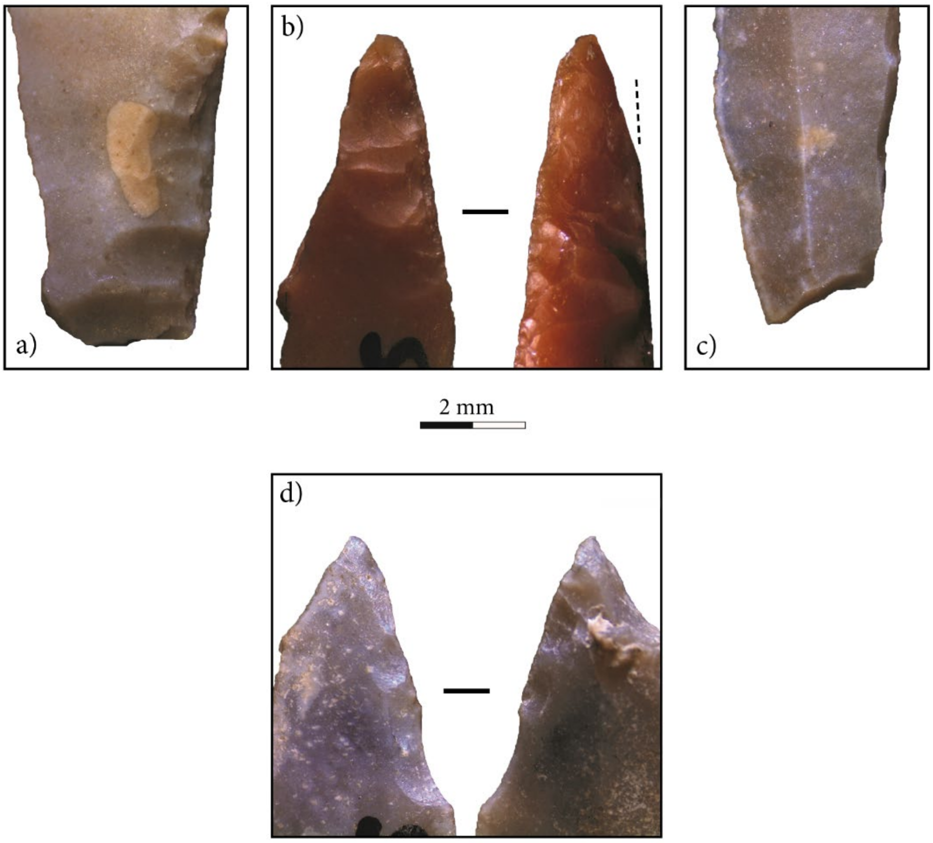


Figure 5.5 - Complementary retouches. a: basal inverse and fat retouch removing the butt and bulb of the original blank; b: apical inverse and flat retouch thinning the apex (the dotted line indicates how the apex profile would be without the complementary retouch; c: basal oblique truncation; d: bifacial apical complementary retouch.

5.2.1.2.3. Morpho-types

The backed points assemblage can be divided into four main morpho-types according to the original blank selected (microbladelets vs. bladelets) and the width-length ratio. A detailed description of each of them is presented below:

- **Elongated backed points, Type A** (Fig. 5.6 a): they are manufactured on thin and narrow microbladelets with a triangular or less frequently trapezoidal cross-section blank and a rectilinear profile. Length varies between 19 and 28 mm (interquartile range: 20-25 mm), width between 3 and 6 mm (interquartile range: 4-5 mm) and the thickness is systematically of 2 mm. The width-length ratio is equal or higher than 1:5. The back is located on the left side and it is produced by deep and direct retouch with a rectilinear delineation. The backing process reaches totally or partially the main dorsal ridge in case of triangular/indeterminable cross-section blanks or it stops over the 1st dorsal ridge with trapezoidal cross-section ones. Complementary retouches are always applied to point the apex, to modify the base or both. Three artefacts present a proximal basal truncation.
- **Elongated backed points, Type B** (Fig. 5.6 b): they are manufactured on fairly narrow bladelets with a triangular or trapezoidal cross-section and a slightly curved or twisted

profile. Length ranging from 29 to 41 mm (interquartile range: 31-35 mm), width from 5 to 7 mm (interquartile range: 5,5-6 mm) and thickness from 2 to 4 mm (interquartile range: 3-3,5 mm). The width-length ratio is equal or higher than 1:5. The back is rectilinear or slightly convex as well as the functional edge. The two edges design an asymmetric or symmetric shape with similar percentages. The deepness of the back is quite variable and carried out both by deep and direct or crossed retouches. The functional edge is almost systematically modified in the apical portion as much as in the basal one (82%). One artefact has a basal truncation.

- **Wide backed points, Type A** (Fig. 5.6 c): they are manufactured on larger microbladelets with a triangular or trapezoidal cross-section and a rectilinear profile. The length varies between 12 and 30 mm (interquartile range: 18.2-21 mm), width between 4 and 8 mm (interquartile range: 5-6 mm) and thickness between 1 and 3 mm (interquartile range: 2-2.7). The width-length ratio is lower than 1:5. The backing process is carried out by deep or marginal direct abrupt retouch, rarely deep and crossed. The back is slightly convex, hardly ever rectilinear, as well as the functional edge, shaping out a fairly symmetric backed point. The back depth, with respect to the main dorsal ridge of the blank, is highly flexible, positioning before, adjacent or over it with similar percentage. Conversely, it stops over the 1st dorsal ridge in case of trapezoidal cross-section blanks. An additional retouch phase besides the back reduction is recorded to adjust the apex or the base. Eight pieces have a truncated base.
- **Wide backed points, Type B** (Fig. 5.6 d): they count a total of only four pieces and therefore not enough to well characterise this morpho-type. They are manufactured on thick and irregular bladelets with a slightly curved profile. Length varies between 30 and 39 mm (interquartile range: 31.5-38 mm), width between 8 and 9 mm (interquartile range: 8-8.2 mm) and the thickness is of 4 mm for all artefacts. The width-length ratio is lower than 1:5. Backed retouch is convex or slightly convex as well as the cutting edge shaping out a backed point with a symmetric morphology. The back reduction is conducted by deep direct abrupt retouches, in one case it is crossed, and it stops before reaching the half of the original blank. One piece has a basal truncation, while a second one an apical complementary retouch.

Among these categories the most attested one is the wide backed point produced on microbladelets (39,53%). Elongated backed points on bladelets reached a percentage of 25,58% and on microbladelets of 20,93%. Wide backed points produced on bladelets are only 9,30% (Tab. 5.7). Although complete and almost complete backed points belonging to phase II are not particularly abundant (n=6) and therefore poorly significant, a disappearance of elongated backed points and wide backed points produced on bladelets (Type B) was attested. Backed truncated points are documented in both phases.

Figure 5.6 – Backed points morpho-types. a: Elongated backed points, Type A; b: Elongated backed points, Type B; c: Wide backed points, Type A; Wide backed points, Type B. The curved black line indicates a basal truncation.

Table 5.7 - Morpho-types attested at Riparo Soman and relative frequency. Apical fragments and backed points abandoned during construction (n=37) were excluded.

	n	%
Elongated backed points, Type A	7	17.07
With basal truncation	3	
Elongated backed points, Type B	11	26.83
With basal truncation	1	
Wide backed points, Type A	19	46.34
With basal truncation	8	
Wide backed points, Type B	4	9.76
With basal truncation	1	
Total	41	100

5.2.2. Backed truncated bladelets

Baked truncated bladelet is the most frequent type within complete armatures. As illustrated in Table 5.8 DT2 is the most attested type. Any backed truncated fragment was analysed due to the difficulty to discern a basal fragment of a backed truncated point from a backed truncated bladelet fractured. Our sample includes 95,83% of complete backed truncated bladelets and only 4,17% of almost complete ones.

Table 5.8 - Composition of backed truncated bladelets assemblage according to Laplace's typology (1964). DT1 = single transversal truncation; DT2 = double transversal symmetric truncation; DT2 trapezoidal = double oblique symmetric truncations DT3 = single acute truncation; DT4 = asymmetric double truncation; DT5 = asymmetric double truncation.

	n	%
DT1	7	14.58
DT2	4	8.33
DT2 trapezoidal	20	22.92
DT3	2	4.17
DT4	4	8.33
DT5	11	41.67
Total	48	100

5.2.2.1. Blank selection

For the production of this category of gear, microbladelets (87,50%) and rarely bladelets (4,17%) were selected (Tab. 5.9). Obviously, the exact frequency of each blanks category is more difficult to estimate compared to backed points because of the intense modification of both the width (by the backed retouch) and length (by one or two truncations). Along with full debitage lamino/lamellar blanks a limited set of by-products were selected.

Table 5.9 - Blank dimensional categories selected for backed truncated bladelets production.

	n	%
Microbladelets	42	87.50
Bladelets	2	4.17
Microbladelets/bladelets	4	8.33
Total	48	100

Microbladelets exploited are fairly regular and narrow with a rectilinear profile and a triangular cross-section, less frequently trapezoidal. They are obtained by cores with a narrow debitage surface. Their butts and bulbs are hardly ever preserved. Thickness is well calibrated all along the morphological axis of the blank and it varies between 1 and 2 mm (Tab. 5.10). The original blanks width is impossible to surely reconstruct, but by analysing the artefacts size and the deepness of the backed retouch can be estimated between 6 mm and 10 mm. Blank selection is clearly less flexible compared to backed points and blanks selected have a more standardised width. From a general level, blanks are the same exploited for the production of Elongated backed points, type A. Negatives of the previous removals show the selection of blanks extracted by unidirectional sequences.

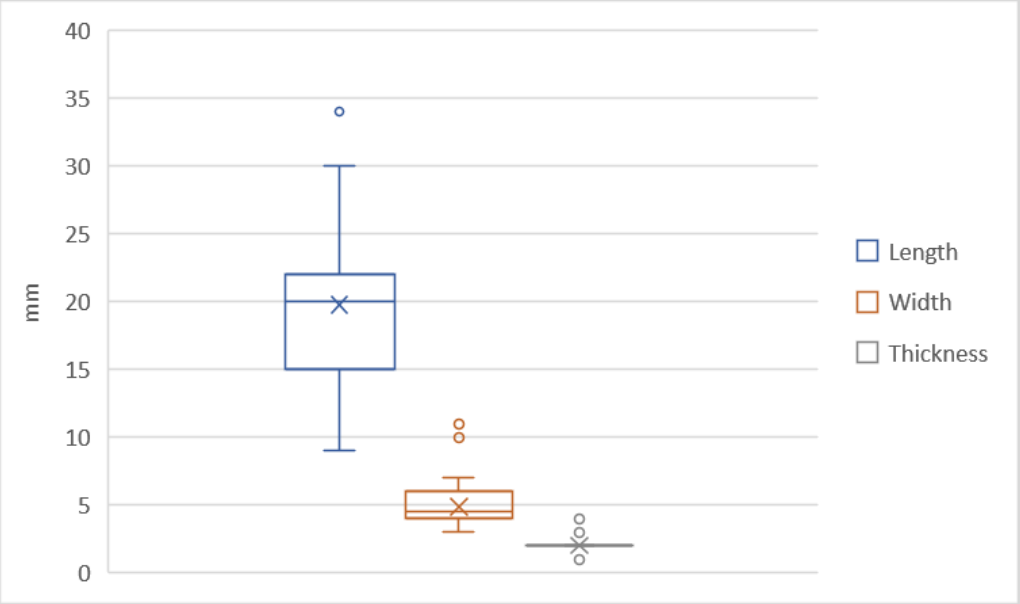


Figure 5.7 – Backed truncated bladelets size.

Table 5.10 - Backed truncated bladelets size.

	Len.	Wid.	Th.
Min. value	9	3	1
1st quartile	15	4	2
Median	20	4.5	2
Medium value	19.7	4.9	2,1
3rd quartile	22	6	2
Max. value	34	14	4
SD	5.164	1.666	0.658
Total	48	48	48

5.2.2.1. Retouch methods

5.2.2.1.1. Backed retouch

The backed delineation is systematically rectilinear just as the opposite edge. The backing process was aimed at achieving a width class mostly ranging between 4 and 6 mm (Tab. 5.10). It was applied almost exclusively by deep direct abrupt retouch (Tab. 5.11). Crossed retouches are poorly attested likely due to the selection of thin blanks that rarely need inverse retouches to regulate the blank thickness or the delineation of the back. If the original blank width already falls within the width values sought-after, the backed retouch can be marginal (n=9) or even partial (n=4).

Table 5.11 - Backed retouch extent, position and angle.

	n	%
Deep direct abrupt	32	66.67
Deep crossed abrupt	7	14.58
Marginal direct abrupt	7	14.58
Marginal crossed abrupt	2	4.17
Total	48	100

The relation between back and main dorsal ridge was assessed according to the blank cross-section. On triangular and unidentified cross-section blanks, the backed retouch reaches totally (31.43%) or partially (40.00%) the main dorsal ridge. Backs located before the main dorsal ridge are also well attested (31,43%). Conversely, backed truncated bladelets manufactured from blanks with trapezoidal cross-section, which are a total of 22 elements, show a back located over (61,54%) or adjacent (38,46%) to the 1st ridge (Tab. 5.12). Approximately 50% of the sample analysed had a reduction in width of at least half compared to the original blank, while the other 50% had a minor reduction.

Table 5.12 - Relation between back and main dorsal ridge according to cross-section blank.

Triangular/unidentified	n	%
Before the ridge	11	31.43
Adjacent to the main ridge	14	40.00
Over the main ridge	10	28.57
Total	35	100
Trapezoidal	n	%
Adjacent to the 1 st ridge	5	38.46
Over the 1st ridge	8	61.54
Total	13	100

5.2.2.1.2. Truncations

Truncations have the purpose to control artefacts length. As a matter of fact, the backed truncated assemblage shows a lower Standard Deviation with respect to backed points. The interquartile range of length comprises values between 15 and 22 mm (Tab. 5.10). Artefacts out of this range are rare. However, this dimensional standardisation, which became more evident by also considering width and thickness values (Tab. 5.10), do not always reflect a morphological one. Backed truncated bladelets can be produced by applying a double truncation (n=35), designing a symmetric or asymmetric morphology, as well as a single one located in the distal (n=8) or proximal (n=5) extremity (Tab. 5.13).

Table 5.13 - Truncation delineation and orientation.

Double symmetric truncations	n	%
Double oblique >90°	11	22.92
Double oblique <90°	2	4.17
Double transverse	4	8.34
Double N.D.	1	2.08
Double asymmetric truncations		
Transverse and oblique <90°	7	14.58
Transverse and oblique >90°	8	16.66
Oblique <90° and oblique >90°	1	2.08
N.D.	1	2.08
Single truncation		
>90° rectilinear	4	8.33
Transversal	5	10.41
<90° rectilinear	3	6.25
Total	48	100

The deepness of truncation seems to change according to the portion where it is applied

(Tab. 5.14). The proximal one is mainly modified by deep abrupt (approximately between 60°-80°) truncations aimed at completely removing the butt and the bulb (61,45%). The distal one is delineated by a marginal (54.76%) or deep (38.10%) truncations depending on the discrepancy between the length desired and that of the selected blank. Occasionally truncations are helpful to remove blank extremities characterised by an excessive concave profile.

Several artefacts (n=8) are shaped by an inverse flat retouch designed to thin the proximal or the distal extremity, or even both. Similarly to layer 6 to 4 of Riparo Tagliente this retouch often (5 out of 8) covers a previous fracture that starts from the functional edge and it develops towards the backed retouch parallel to the ventral face of the artefact (Fig. 5.8 b). This fracture may be produced intentionally for reducing blank length and to thin one or both extremities. It is not clear if this technical expedient has the purpose to delineate a hafted or active portion.

Other artefacts present a previous fracture partially covered by truncation. They are snap terminating bending fractures with a rectilinear profile and a vertical inclination that likely occurred during the shaping of the truncation as we could observe during experimentation. Only one piece shows a *piquant trièdre* partially resumed by a marginal retouch.

Table 5.14 - Deepness of truncation according to proximal or distal extremity.

	Proximal		Distal		N.D.	
	n	%	n	%	n	%
Deep abrupt truncation	24	61.45	16	38.10	2	100.00
Marginal abrupt truncation	8	20.51	8	54.76	-	-
Inverse flat retouch	7	17.95	3	7.14	-	-
Total	42	100	31	100	10	100

5.2.2.1.3. Complementary retouch

Around half of the assemblage has a functional edge modified by a complementary retouch. This additional retouch phase is used to outline a rectilinear delineation. The majority of them are marginal and direct with a semi-abrupt angle (Tab. 5.15) and they are applied all along the functional edge (Tab. 5.16; Fig. 5.8 a). Occasionally a brief sequence of marginal retouches was observed exclusively on the proximal or distal position. In case of selection of wider blanks, complementary retouch can become sporadically deeper and therefore effective to reduce artefacts width.

Table 5.15 - Complementary retouch extent, position and angle.

	n	%
Marginal direct semi-abrupt	13	56.52
Deep direct semi-abrupt	1	4.35
Marginal direct abrupt	4	17.39
Deep direct abrupt	3	13.04
Marginal inverse semi-abrupt	1	4.35
Inverse flat	1	4.35
Total	54	100

Table 5.16 - Complementary retouch localization.

	n	%
Distal	3	13.04
Proximal	8	34.78
Mesial	-	-
Along the entire edge	23	52.17
Total	23	100

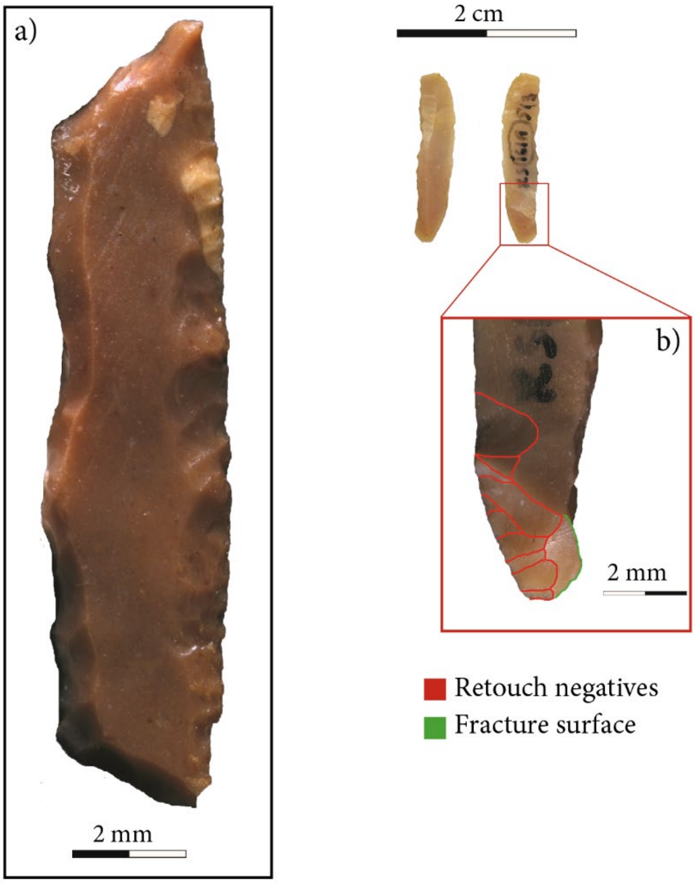


Figure 5.8 - backed truncated bladelets. a: trapezoidal backed bi-truncated bladelet with a complementary retouch all along the functional edge; b: elongated backed truncated bladelet with both extremities delineated by a fracture parallel to the ventral face covered by a flat and inverse retouch.

5.2.2.2. Morpho-types

Three different morpho-types have been identified following several technological parameters: morphology and typometry of the selected blank, artefact size, presence or absence of complementary retouches and number and type of truncations.

- **Type A** (Fig. 5.9 a): it is produced on regular microbledelets. The length ranges between 9 and 23 mm (interquartile range: 14-20 mm), width between 3 and 6 mm (interquartile range: 4-5 mm) and thickness between 1 and 3 mm (interquartile 2-2 mm). They are characterised by a trapezoidal shape design by a rectilinear back as well as the functional edge and both obtuse truncations. The proximal truncation occasionally has a transverse or slightly acute orientation, but among them 3 out of 4 are recycled pieces after a major breakage. The cutting edge is almost systematically modified by a marginal complementary retouch. The original blanks length is affected by a significant reduction process compared to other morpho-types. They are perfectly comparable with backed truncated bladelets of Riparo Biarzo.
- **Type B** (Fig. 5.9 b): they are produced on regular microbledelets. The length ranges between 15 and 25 mm (interquartile range: 19.5-22 mm), width between 3 and 5 mm (interquartile range: 3-5 mm) and thickness between 1 and 2 mm (interquartile 2-2 mm). They are characterised by a higher width-length ratio and a more flexible truncation morphology. This latter can be transverse, obtuse, as well as acute with both a rectilinear and slightly convex delineation. One or even both extremities can be rectified by inverse flat retouches. To this morpho-type belong both double and single backed truncated bladelets. The functional edge is more often unretouched (9 out of 14). Only one artefact shows a complementary retouch along the entire functional edge. The length of the original blank is affected by a lower reduction process with respect to the previous morpho-type.
- **Type C** (Fig. 5.9 c): they are produced on microbladelets and bladelets. The length ranges between 12 and 34 mm (interquartile range: 19.5-27 mm), width between 5 and 7 mm (interquartile range: 6-6 mm) and thickness between 1 and 4 mm (interquartile 2-3 mm). They are artefacts that present one of the three-dimensional parameters (length, width or thickness) over size with respect to the other morpho-types. Their shape tends to be irregular and after careful inspection some of them were interpreted as recycled pieces in which one of truncations cover a previous fracture. Others merely have an irregular delineation.

Table 5.17 shows the frequency of each morpho-type. All of them are present in both Late Epigravettian phases.

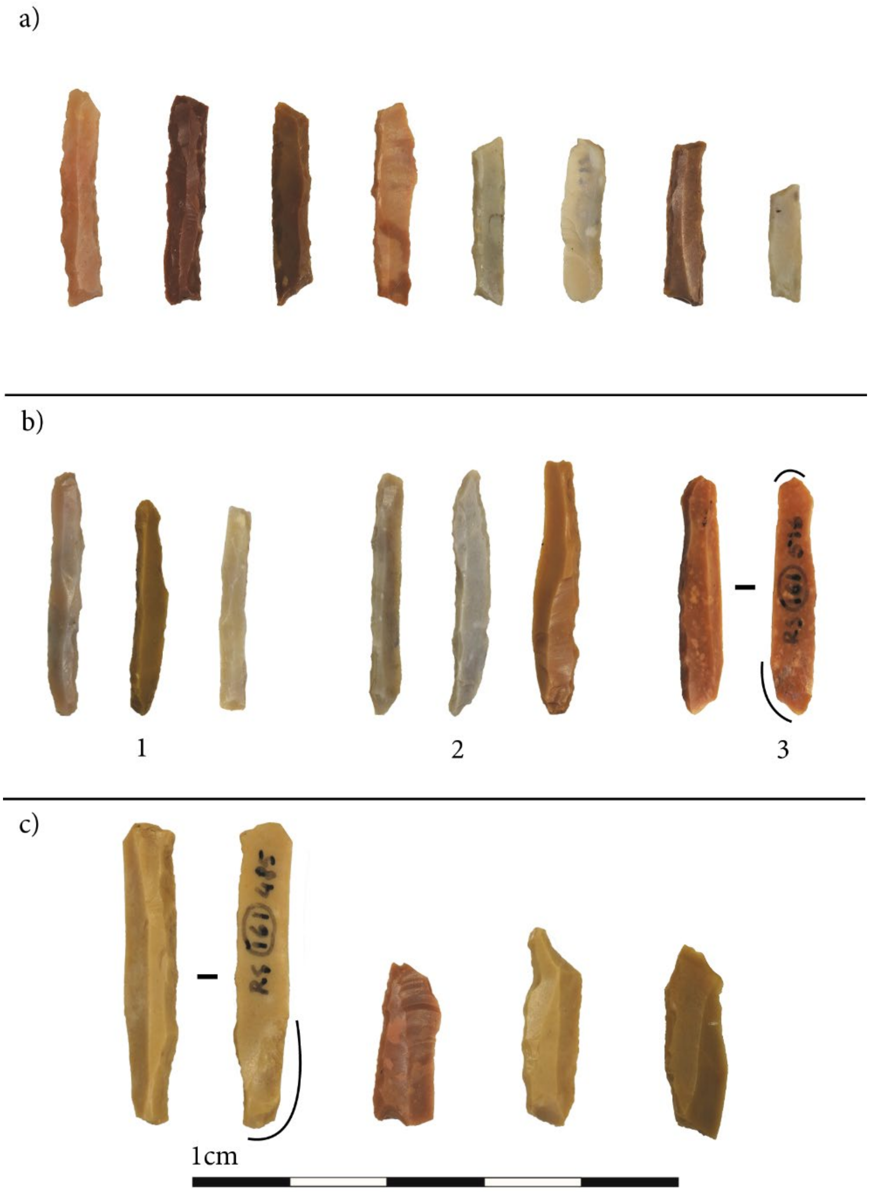


Figure 5.9 – Backed truncated bladelets morpho-types. a: Trapezoidal backed bi-truncated bladelets; b: Elongated backed truncated bladelets with a double truncation (1), a single truncation (2) or a double inverse and flat retouch (3); c: Wide backed truncated bladelets. The curved black line indicates inverse and flat retouches.

Table 5.17 - Backed truncated bladelets morpho-types attested at Riparo Soman and relative frequency.

	n	%
Trapezoidal backed bi-truncated bladelets	20	41.97
Elongated backed truncated bladelets	14	29.17
Wide backed truncated bladelets	12	25.00
Under construction	2	4.17
Total	48	100

5.2.3. Backed bladelets and bi-truncations

Backed bladelets are systematically manufactured on thin microbladelets (1-2 mm), their length varies from 15 mm to 32 and the width from 4 to 7 mm. Except for the lack of truncations they do not present differences with backed truncated bladelets. It is interesting to note that 7 out of 12 are produced on hinged blanks. The hinged extremity was probably considered as a "natural" truncation. The backed retouch is systematically rectilinear, as well as the cutting edge, and designed by deep (n=6) or marginal (n=6) direct abrupt retouch depending on the original blank size. The backing process generally reduces less than half the initial blank width. Occasionally short sequences of marginal and semi-abrupt retouches are applied on the cutting edge. Although the high degree of fragmentations of back items could lead to an underestimation, backed bladelets seem to be a rarely produced tool.

Few bitruncations are reported both by Battaglia et al. (1994) and Ferrari and Peresani (2003). However, the former counts a total of 5 bitruncations, three from the phase I and two from the phase II, whereas the latter marked a total of six bitruncations, one from the phase I and five from the phase II.

5.2.4. Sauveterrian elements?

The superimposition between the Sauvetterian and the Late Epigravettian occupation in both sectors cast doubt upon the stratigraphic position of six geometrics (two scalene triangles, two isosceles triangles and two crescents) and two double backed points find in the Late Epigravettian layers (both in phase I and II; Tab. 5.2). In confirmation of mixing problems there is a Late Epigravettian bi-truncation drawn among the Sauveterrian artefacts in Broglio and Lanzinger (1986). Also ordinary microburins (n=9) may be affected by the same post-depositional process. Late Epigravettian armatures rarely present a *piquant trièdre* (n=4) and it is more probably related to an accidental Krukowski microburin fracture (n=23).

5.2.5. Pieces under construction

The assemblage of pieces abandoned under construction is composed of 47 backs affected by a major breakage connected to the backing process (Tab. 5.18) and 11 items with an unfinished shape. All these artefacts were discarded at different steps of the *chaine opératoire* highlighting at least three different modalities of back reduction:

- the first one provides one single sequence of direct retouch starting from the distal portion, rarely from the proximal one. This modality is confirmed by a good amount of proximal snap in notches (n=8). Distal snap in notches are rarer (n=2) (Fig. 5.10 a). The fracture is systematically a bending snap which starts from the dorsal face towards the ventral one. Blanks modified by this modality have a width that varies between 7 and 15 mm (average: 9,4 mm) and a thickness between 2 and 4 mm

- the second one consists of several unidirectional (e.g. from the distal to the proximal portion) or bidirectional (e.g. from the distal to proximal and vice versa) sequences generally applied in case of wide blanks. This modality, even if was rarely employed, is attested by armatures characterised by a total, but unfinished backed retouch. One of them shows an inverse flat complementary retouch aimed at removing the butt and the bulb already applied before finishing the backing process (Fig. 5.10 b). Also in finished backed points basal, inverse and flat complementary retouches are applied before backing process.
- a third retouch sequence attested on armatures thicker than 2 mm provide, after one of the two above mentioned options, a sequence of inverse retouches located on restricted areas of the mesial, basal or apical portion. As attested in the other Late Epigravettian sites here analysed, inverse retouches are generally the last applied. The only exception is represented by two Krukowski microburins resulting from a direct retouch but associated with a crossed abrupt back retouch. Such evidence attests a backing process occurred by alternating direct and inverse retouches

The first step of blank retouching seems to be the delineation of the apex in case of backed points and of one of the distal truncations in case of backed truncated bladelets. These technical expedients are assumed by the presence of several fragments or unfinished pieces with an apex or a truncation already shaped (Fig. 5.10 c).

Interesting is the presence of one Krukowski microburin characterised by a diagnostic impact fracture partially resumed by truncation. This element may attest to a third (?) re-shaping phase after using.

Table 5.18 - Diagnostic backing fractures identified.

Type of fracture	**n**
Backed points fragments	
Apical K. microburins	3
Generic backed fragments	
K. microburins	16
Snap in notch	10
Snap terminating bending fractures	8
Cone fractures	2
N.D.	1
Backed truncated fragments	
K. microburins with truncation	4
Snap terminating bending fracture	2
Fracture generated by an overshot retouch flake	1
Total	47

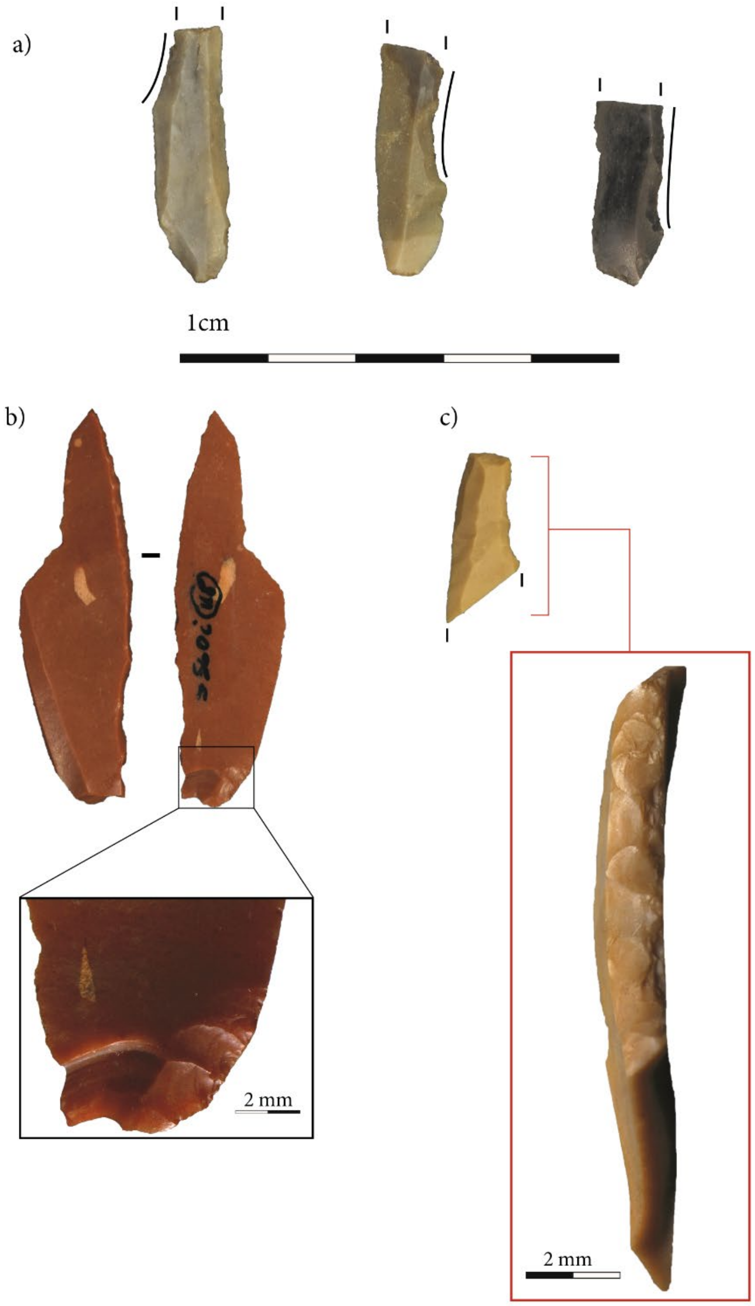


Figure 5.10 – artefacts abandoned during construction. a: proximal snap in notches; b: unfinished backed point with a flat and inverse complementary retouch already applied; c: a backed truncated bladelet fracturated during the backing process with a distal truncation already delineated. The back is shaped by pressure by soft stone.

5.2.6. Backing techniques

5.2.6.1. Low power approach

The morho-scopic analysis performed on 179 artefacts attested a greater use of a pressure technique (50%) compared to soft stone percussion on anvil (25%; Figure 5.11 a-c.). The former was more frequently applied by an organic retoucher (Fig. 5.11 d, f, g) rather than a stone one (Fig. 5.10 c), while the latter was applied with an organic anvil since any trace related to the recoil was recorded on armatures dorsal face.

As we could observed for the others Late Epigravettian sites analyse during this dissertation, the use of one or the other technique varies according to blank morphology and retouch depness: soft stone percussion on anvil was used to reduce thicker (average thickness: 3,3 mm) and wider blanks by a deep retouch, whereas a pressure technique was used to shape thinner (average thickness 2,1 mm) and narrow blanks by more marginal retouches. Dividing the sample between the two occupational phases an increase of pressure by organic tool is attested. Soft stone percussion on anvil slightly decreases. The selection of blanks with an irregulalar thickness and/or width along the morphological axis can easily provoke a switch of backing technique. For example in case of backed points pressure by soft stone was used to shape out the tip and soft stone percussion on anvil to modify the mesial and basal portions of the blank. A change of retoucher during the shaping phase (from stone to organic) was also recognized. These items present backs with clear features related to a lithic retoucher and inverse and flat complementary retouches certainly applied by an organic compressor. At a general level, complementary retouches and truncations are systematically applied by a pressure technique.

The variability of backing technique adopted is confirmed also by backing fractures: for instance among 23 Krukowski microburins, 7 were unintentionally broken by percussion, 7 by pressure, whereas 9 does not present any diagnostic feature of one of the two force application modes.

5.2.7. Diagnostic impact fractures

Although the low number of backed fragments included in the sample analysed did not allow a proper evaluation of diagnostic impact fractures, few considerations can be advanced. Backed points record a utilisation rate of 15.38% (12 out of 78). Impact damages include frontal step or feather terminating bending fractures (*languettes* ≥ 3 mm), burinations, spin-off and burin-like spin-off, both on the tip and the base. Edge scarrings were also attested (Tab. 5.19). These types of fractures are conformed to an apical hafting as perforating implements.

The low number of backed truncated bladelets (n=4) with diagnostic impact fractures is the consequence of the selected sample (complete and almost complete items). Impact damages identified are burinations developed directly from one of truncations (Tab. 5.19). As supposed by a prior study focused on Late Epigravettian armatures (Duches, 2011), this fracture occurs when more than one backed truncated bladelet is hafted in a lateral position with respect to the shaft due to compression forces generated by the impact of the projectile against a target. However, the high morphological variability of backed truncated bladelets may reflect a high flexibility in hafting methods (a row composed by multiple items vs. single lateral element; sub-parallel vs. oblique position with respect to the shaft). This aspect needs to be better investigated.

Table 5.19 - Diagnostic impact fractures variability according to each type of armature. The percentage is the ratio between the number of artefacts presenting DIF with respect to the total number of items analysed for each type.

Fracture type	**n**
Backed points	
Feather terminating bending fracture with a languette ≥ 3 mm	2
Step terminating bending fracture with a languette ≥ 3 mm	3
Burination ≥ 3 mm	4
Burin-like spin-off ≥3 mm	1
Spin-off ≥ 3 mm	2
Edge scars	4
Total	**10 (15.38%)**
Backed truncated fragments	
Burination ≥ 3 mm	4
Scars edge	1
Total	**4 (10,42%)**

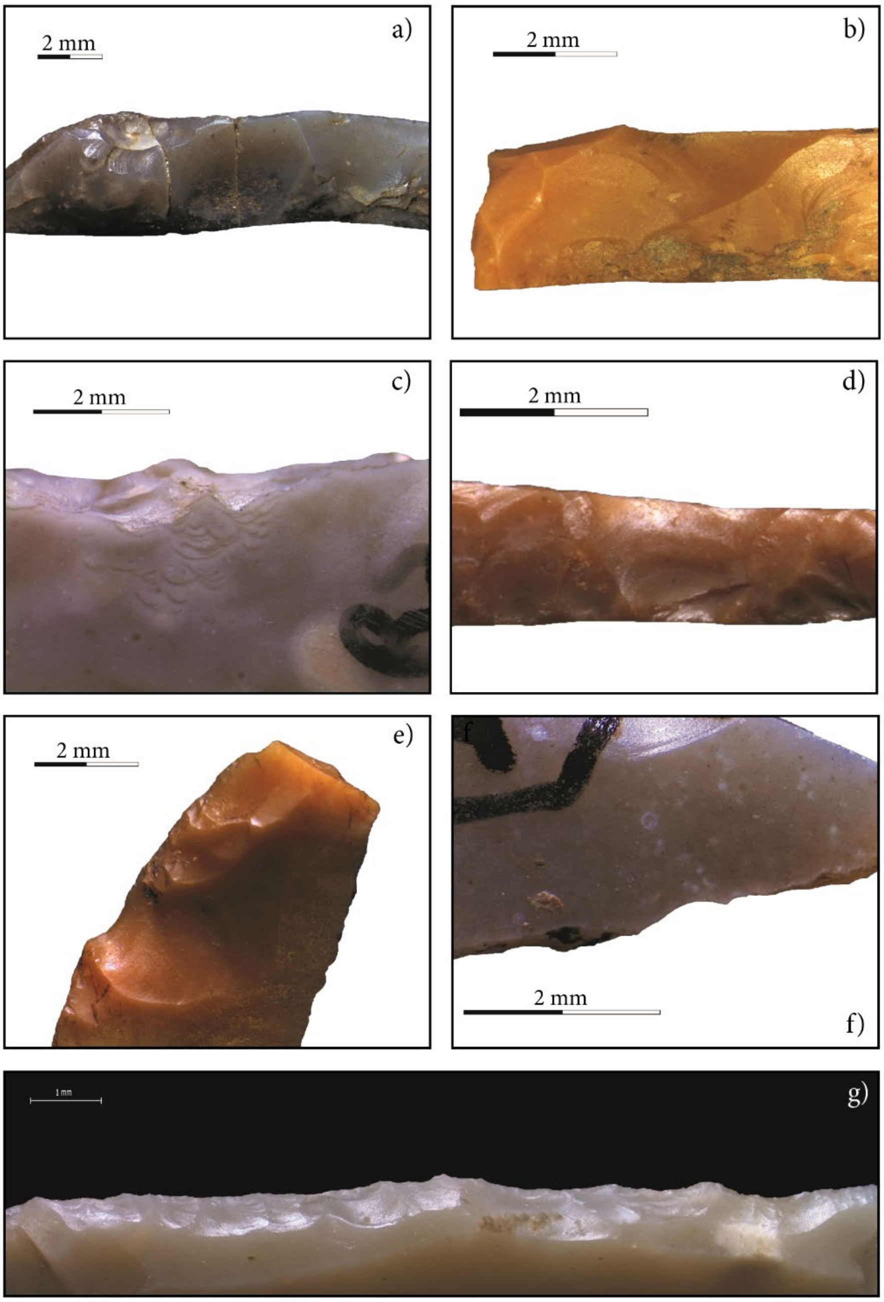


Figure 5.11 – Retouches applied by soft stone percussion on anvil (a-c) and pressure by organic tol (e-g). a-b: fan-shaped deep negatives with lateral diffusion; c: grouped incipient cones; d-e: negatives with a large initiation and a fresh edge; f: residual indentations as seen from the ventral face; g: residual indentations as seen from the dorsal face.

Chapter 6 - Mondeval de Sora

6.1 Site introduction

The site of Mondeval de Sora (San Vito di Cadore, BL) is located under the overhang of a large erratic mass located in the middle of the Mondeval basin at an elevation of 2,150 m a.s.l. The excavation was carried out by the University of Ferrara between 1986 and 2000 revealing traces of an intensive human occupation on the south-western (sector I) and north-eastern (sector III) side of the boulder (Fig. 6.1). Sector I covered a surface of about 60 m^2, whereas sector III of 30 m^2. Both yielded a stratigraphic sequence of approximately 50 cm thick, conserving layers dated between the Mesolithic (Sauveterrian and Castelnovian), the Bronze Age and the historical period (Fontana et al., 2012, 2009b).

In the Sector I Sauveterrian evidence includes several structures, such as a paved area made of local tufo slabs (SU14), an arrangement of blocks of dolomite stones (SU 33) and a sub-circular hearth (SU 32). Above them two main anthropic layers were recorded, respectively in the inner (SU 8) and external part of the shelter (SU 31). Stratigraphic Unit 8 represents a palimpsest of several frequentations phases and it was divided in two sub-levels (8I and 8II). It yielded a significant amount of faunal remains, lithic artefacts and charcoals. Two recent radiocarbon dates from this layer reveal a date of 10582-10407 and 10716-10556 cal BP respectively (Tab. 6.1).

Sector III consists of five main stratigraphic units (SSUU 10, 20, 21, 30 and 32) likely referable to three frequentation phases (Valletta et al., 2016). Two radiocarbon dates were obtained, respectively from layer 32 (GX-27748: 9,160 ± 90 BP, 10,563-10,193 cal BP) and 10 (GX-21797: 8,445 ± 50 BP, 9,537-9,320 cal BP).

Castelnovian layers are poorly preserved. The most significant evidence is a burial associated with extremely rich grave goods (around 60 items) identified in 1987 (Alciati et al., 1994; Fontana et al., 2020).

The archaeozoological analysis carried out on faunal remains from layer 8 attests a hunting activity focus on red deer (*Cervus elaphus*), ibex (*Capra ibex*), alpine chamois (*Rupicapra rupicapra*) and roe deer (*Capreolus capreolus*). A techno-economic analysis was performed on artefacts from layer 8 of sector I (Fontana, 1997; Fontana et al., 2009b) and on the entire sequence of sector III (Valletta et al., 2016). The raw material exploited comes from Scaglia Rossa, Maiolica and Scaglia Variegata formations outcropping in the Belluno Valley, in Alpago and Longarone areas. Local rocks such as Livinalongo and Marne del Puez were occasionally flaked as well as rock crystal belonging to the metamorphic formation of the inner Alps (Alti Tauri) (Fontana et al., 2009; Valletta et al., 2016).

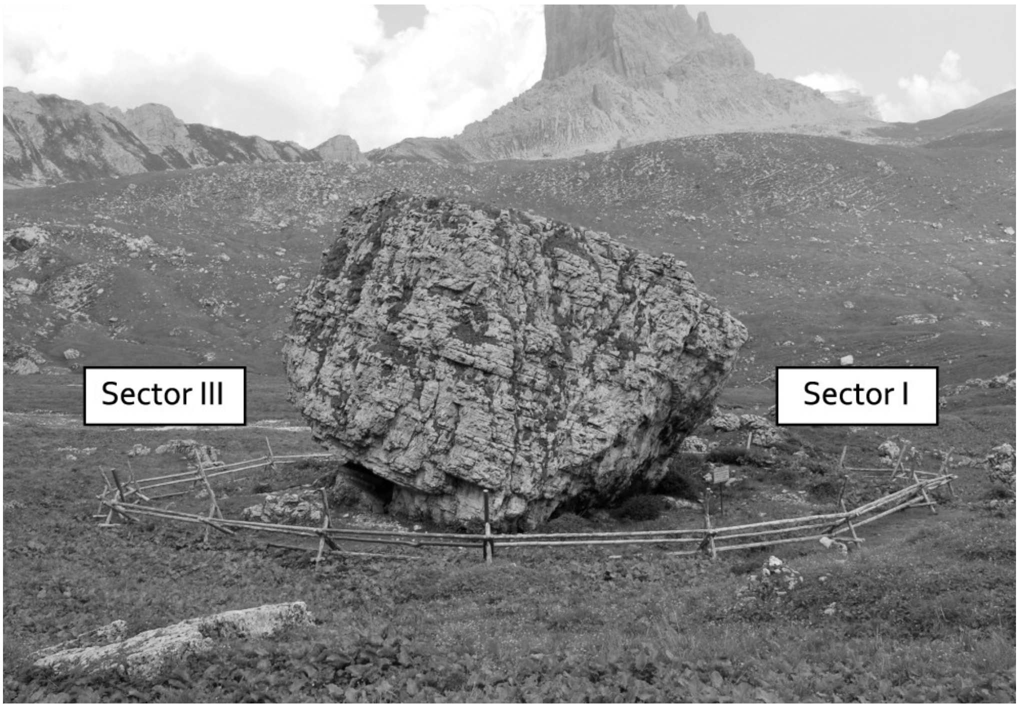


Figure 6.1 – The site of Mondeval de Sora (Fontana et al., 2020).

Table 6.1 - Radiocarbon dates from layer 8 sector I.

Layer	Sample type	Laboratory identifier	BP	Cal BP (2 sigma 95.4% probability)
8	Charcoal	GX-21788	9185±240	11111-9694
8I	Charcoal	Beta - 543677	9300±30	10583 - 10407
8II	Charcoal	Beta - 543678	9400±30	10716 - 10556

6.2 Composition of the studied sample

The armatures assemblage analysed includes backed points, geometrics, backed truncated bladelets and microburins belonging to layer 8 of Sector 1. (Tab. 6.2). It is a sample selected by the Author and it does not correspond to the totality of armatures from layer 8. 60% are complete, 21% almost complete and 19% are fragments. The preservation state is fairly good. Only 7% are patinated and 18% are burnt or thermally altered. The raw material mostly exploited is the Scaglia Rossa formation. Scaglia Variegata, Maiolica, Fonzaso and Livinallongo are less attested. Some of these artefacts were previously studied from a typological and functional viewpoint and results were published in Fontana et al. (2009).

Table 6.2 - Composition of the assemblage analysed from layer 8.

	n
Backed points	72
Geometrics	101
Backed truncated bladelets	35
Microburins	421
Total	629

6.2.1. Backed points

6.2.1.1 Blank selection

The major retouching process characterising backed points does not allowed to certainly determine the exact type of blank selected for each item and they were thus attributed to generic categories, i.e. “elongated blanks” and “generic flakes” (Tab. 6.3).

Table 6.3 - Blank categories selected for backed points production.

	n	%
Elongated blanks	42	58.33
Flakes	19	26.39
Elongated blanks/flakes	3	4.17
N.D.	8	11.11
Total	72	100

Elongated blanks are characterised by a straight profile and a trapezoidal cross-section. As seen during experimentation both these features allow a high blank stability during the retouch process which is an essential factor for the production of double backed point (cf. Sauveterrian points). Among elongated blanks, full debitage products were undoubtedly detected only in 14.67% of cases. Three artefacts were produced on natural backed blank.

In order to achieve a higher detail regarding the blanks length, full debitage lamino/lammer blanks and laminar flakes from layer 8 with a thickness comparable to those of backed points (1-2 mm) were plotted (Fig. 6.2). Only complete and almost complete pieces were taken into account. The majority of products with thickness values of 1-2 mm are microbladelets and laminar flakes shorter than 25 mm, suggesting a higher exploitation of these categories for the production of longitudinal backed points.

Observing dorsal ridges of backed points produced transversally on flakes few hypotheses can be proposed:

- the lack of parallel ridges excludes the use of flakes derive from a lamino-lamellar debitage surface (e.g. surface maintenance flakes), suggesting the exploitation of flakes generated from a dedicated *chaine opératoire.* As a matter of fact, an independent flakes production has been observed (Fontana, 1997).

- Some backed points have no ridges in the dorsal surface attesting, perhaps, the use of striking platform maintenance flakes (striking platforms are generally plains or on natural fracture surfaces; Fontana et al., 2009) or flakes extracted by a facial reduction of the ventral face of flake-cores.

Flakes selected rarely overcome 2 mm of thick.

Except for one artefact, backed points manufactured on flakes are orientated transversally with respect to the morphological axis of the blank, whereas those produced on elongated

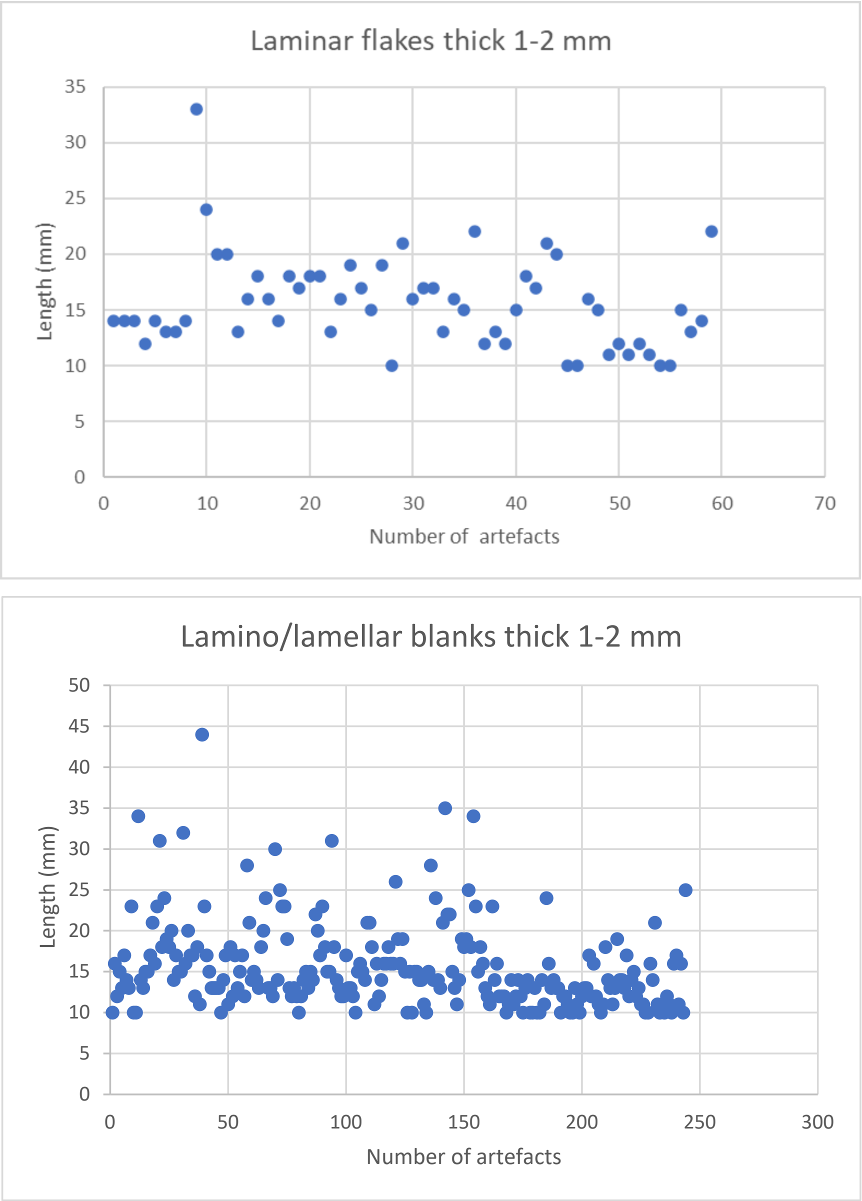


Figure 6.2 – Length values of full debitage blanks with a thickness of 1-2 mm from layer 8.

blanks are orientated systematically longitudinally.

6.2.1.1. Retouch methods

Unlike previous sites in which retouch methods were presented firstly according to the entire assemblage and then separately for each morpho-type, in this case, we decide to directly display results following the subdivision into curved backed points with natural base (Fig. 6.3 c) and Sauveterrian points (Fig. 6.3 a-b). The latter were further divided in narrow Sauveterrian points (Fig. 6.3 a) and wide Sauveterrian points (Fig. 6.3 b) according to the length-width ratio. The former have a ratio of 5:1 or higher, whereas the latter lower of 5:1. Their frequency index is presented in Table 6.4.

Table 6.4 - Backed point morpho-types.

	n
Narrow Sauveterrian points	32
Wide Sauveterrian points	10
Curved backed points with natural base	15
Pieces under construction	10
N.D	5
Total	72

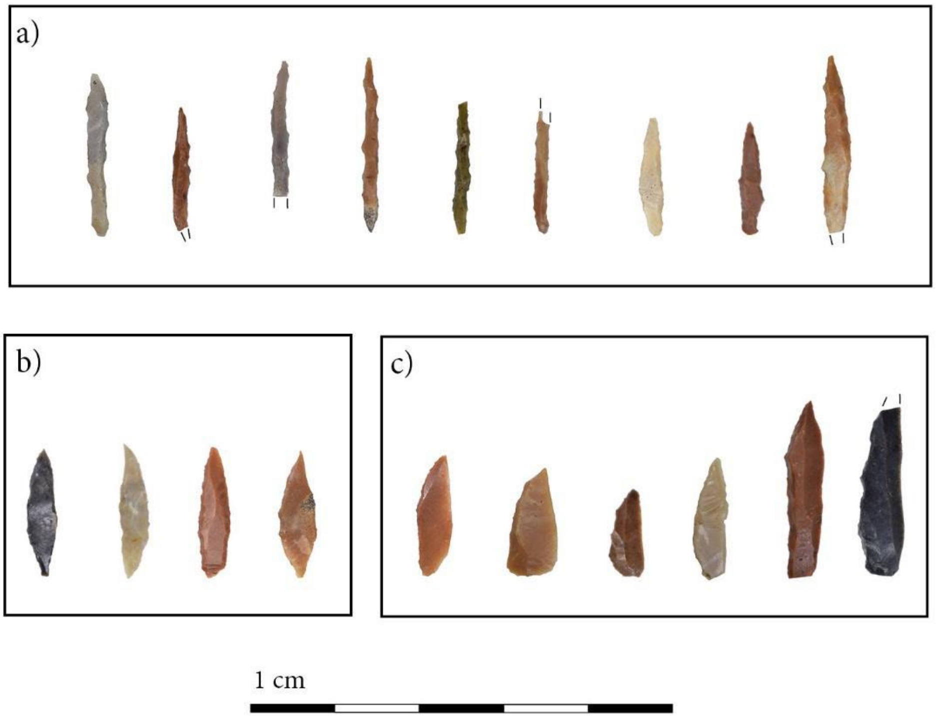


Figure 6.3 – Backed points morpho-types. a: narrow Sauveterrian points; b: wide Sauveterrian points; c: curved backed points with natural base.

6.2.1.1.1 Backed retouch

Sauveterrian points show a strong symmetric shape. The narrow type presents two rectilinear backs, whereas the wide one has both backs with a slightly convex delineation. Rarely Sauveterrian points have an asymmetric morphology. On the contrary, curved backed points with a natural base present a slightly convex, convex, or angular back delineation opposite to a rectilinear functional edge. With the term "angular" we indicate a back with a rectilinear delineation along the basal and mesial portion and oblique on the apex.

The relationship between blank dorsal ridges and the back (i.e. backed retouch invasiveness) was assessed only on backed points produced longitudinally on elongated blanks. Back invasiveness tends to vary according to both sought-after morphology (i.e. morpho-types) and the cross-section of blank selected. In case of narrow Sauveterrian points, which are generally manufactured from trapezoidal cross-section blank, the two backs achieved totally (or at least partially) the 1st and the 2nd dorsal ridge, respectively, producing a microlithic with a quadrangular cross-section (Fig. 6.4 a). Sauveterrian points produced on triangular/indeterminable cross-section blanks are a low number and they are attributable to the wide type.

Curved backed points are produced on both trapezoidal and triangular cross-section blanks. In the first case the back is systematically located over the 1st ridge crossing the 2nd one for shaping out a secant tip (Fig. 6.4 b), whereas in the second case backs are more variable: they can be, before (Fig. 6.4 c), adjacent (Fig. 6.4 d) or over (Fig. 6.4 e) to the main dorsal ridge. In the first two options the back crosses the main dorsal ridge on the apical portion delineating a secant tip.

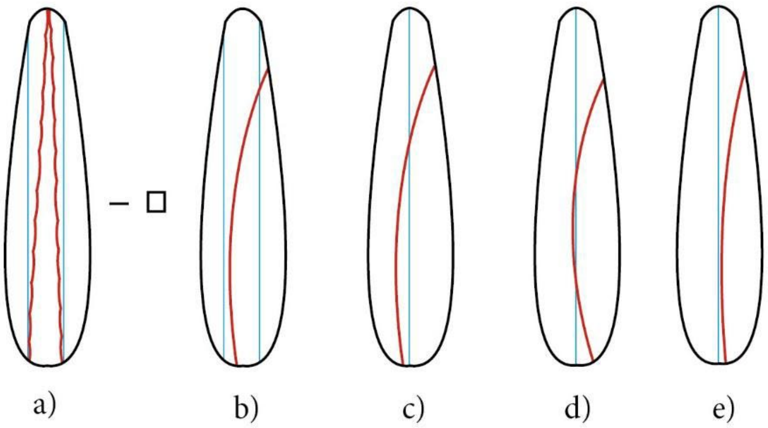


Figure 6.4 - Different modalities of delineating a backed point according to the cross-section blank and morpho-type. a: Sauveterrian point produced on trapezoidal cross-section blank with both backs located over the main dorsal ridges along the entire longitudinal axis; b: curved backed points with natural base produced on trapezoidal cross-section blank with the back located over to the 1st dorsal ridge and the apex shaped crossing the 2nd dorsal ridge; c-e: curved backed points with natural base produced on triangular cross-section blank with the back stopping before (c) adjacent (d) or over (e) the main dorsal ridge.

Cornering backed points produced transversally on flakes, the achievement of quadrangular cross-section is a guideline for backed retouch invasiveness. They are equally shaped in correspondence with the proximal (n=5), mesial (n=6) or distal (n=6) portion of the flake.

The backing process was applied by deep, direct and abrupt retouch (64,81%) or marginal, direct and abrupt (10,19%) (Tab. 6.5). Inverse detachments were occasionally flaked for delineating transverse proximal backs of Sauveterrian points produced on flakes with a pronounced bulb. The bulb convexity can be a hindrance for a direct retouch forcing to switch to an inverse one. Otherwiwse they are applied to remove micro-reflections occurs during the direct retouch.

Table 6.5 - Backed retouch extent, position and angle.

	n	%
Deep direct abrupt	70	64.81
Deep direct semi-abrupt	4	3.70
Marginal direct abrupt	11	10.19
Deep crossed abrupt	10	9.26
Marginal direct semi-abrupt	9	8.33
Deep inverse abrupt	2	1.85
Marginal inverse abrupt	1	0.93
Deep inverse semi-abrupt	1	0.93
Total	108	100

Compared to the Late Epigravettian sites analysed, in which inverse retouches can be useful to reduce armatures thickness, in Mondeval de Sora they do not have such a significance, because the angle between the back and the dorsal face is always around 90°. Thus, a calibrated thickness along the morphological axis of the artefact is controlled exclusively by a meticulous blank selection. The only exception is represented by three pieces: one is characterised by an apical inverse retouch used to thin the apex, the other two show a particular technical solution consisting in removing few detachments from the dorsal face using one of backs as retouch platform.

Complete Sauveterrian points were manufactured both with a single (n=11) or double point (n=8) shaped by the convergence of the two backs. Twenty are fractured and therefore it was impossible to verify their original morphology. In Sauveterrian bipoints the two tips do not appear to be interchangeable. One is generally more tapered than the other, indicating a specific orientation on the shaft. To point the apex of curved backed points occasionally marginal abrupt or semi-abrupt complementary retouches were applied. Few elements have an apical *piquant trièdre* attesting the use of a microburin blow technique to control length and to delineated tip of both curved back points and Sauveterrian points.

Backed points dimensions are presented in Table 6.6 according to different morpho-types.

Table 6.6 – Backed points dimension according to morpho-types.

	Narrow Sauveterrian points			Wide Sauveterrian points			Curved backed points		
	Len.	Wi.	Th.	Len.	Wi.	Th.	Len.	Wi.	Th.
Min. value	12	1	1	7	2	1	8	2	1
1st quartile	14,25	2	1	8	3	1	10	3,5	2
Medium	15,2	2,24	1,9	11,71	2,27	1,2	12,2	3,9	2
Median value	15	2	2	11,5	3	1	12	4	2
3rd quartile	17,5	3	2	14,75	4	1,75	15	4,5	2
Max. value	20	4	3	15	4	2	20	5	3
SD	2,524	0,683	0,592	3,521	0,788	0,483	3,898	0,883	0,654
Total backed points	15	33	33	7	9	9	9	15	15

6.2.1.2. Resumed pieces and pieces under construction

Backed points abandoned during the manufacturing process can be entirely referred to Sauveterrian points (n=10). They are produced transversally on flake (n=5) as well as longitudinally on microbladelets (n=5). Observing these artefacts two different retouching strategies were deducted:

- to shape two backs before defining one or two apexes
- to produce first a back and through the second one point the apex by a single sequence of removals

Exclusively two artefacts produced transversally on flake present clear morphological issues that explain their abandonment before finishing the manufacturing process: one records a thickness (3 mm) that exceed medium values generally selected, whereas the second one is characterised by a rounded edge with multiple micro-step terminating negatives in correspondence with the convexity of blank bulb resulting in the impossibility to carry on the back reduction.

Two different ways to resume a fracture were identified according to its position (apical vs. basal). Several Sauveterrian points have a tip characterised by a truncated profile as seen from a lateral view. During the 1st experiment (Chapter 3.2.1.2.3 Part 1) we observed that this morphology is generally related to an apex shaped by resuming an apical fracture merely by continuing the backing process. In one case a snap terminating bending fracture is still partially visible. By contrast, basal fractures are covered by transverse truncations (Fig. 6.5 a). In one case the resumed fracture is comparable to the equivalent of a *piquant trièdre* suggesting, pheraps, the recycling of a distal microburin for manufacturing a backed point (Fig. 6.5 b).

All these artefacts attest a relevant length reduction compared to the original blank.

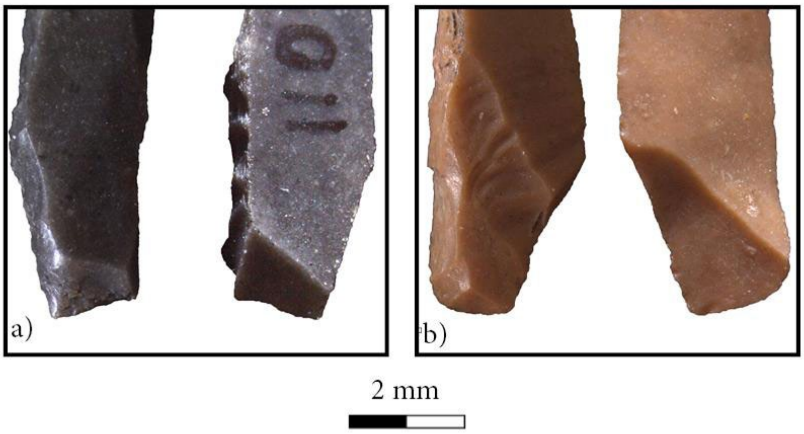


Figure 6.5 Resumed backed truncated points. a: double backed point with a transverse truncation covering a previous fracture; b: distal microburin transform into a backed truncated point (?).

6.2.2. Geometrics

The manufacturing process of geometrics is presented following the different steps of the *chaîne opératoire,* namely, bank selection, microburin blow and then shaping.

6.2.2.1. Blank selection

Geometrics were systematically produced from elongated blanks. Their original morphology was difficult to reconstruct due to the strong reduction involved both width and length. Nevertheless, a chief exploitation of full debitage lamino-lamellar blanks with a triangular cross-section can be assumed by observing microburins. Considering thickness interquartile range of both geometrics and microburins (1-2 mm; Tab. 6.7) and length variability of full debitage lamino/lamellar blanks with the same thickness values (Fig. 6.2), an exploitation of microbladelets shorter than 25 mm can be proposed. The occasional selection of longer blanks must be also taken into account. Microburins in which the original blank width was measurable (only proximal and mesial microburin were considered) attest values varying from 5 to 18 mm (interquartile range: 5,5 – 10,5 mm).

Table 6.7 - Thickness values of geometrics and microburins.

	Geometrics	Microburins
Minimum value	1	1
1st quartile	1	1
Medium	1,52	1,82
Median value	1	2
3rd quartile	2	2
Maximum value	3	4
Total	101	100

6.2.2.2. Microburin blow technique and notch production

A randomly sample of 421 microburins from layer 8 have been the object of a morpho-scopic analysis aimed at answering to several questions involving geometrics manufacture:

- which blank portions were mostly removed (distal vs. proximal)
- how many microburins were detached for each geometric
- how many geometric were obtained from a single blank
- what fracturing techniques (percussion vs. pressure/bending) was applied the microburin blow

It should be pointed out that microburins from layer 8 count a total of around 1200, therefore our sample might not be representative of such an amount.

Microburins analysed were removed both from the proximal and the distal portion (Tab. 6.8). Looking at the notch position according to the blank side an important lateralization was observed (Tab. 6.9): proximal microburins mostly have a right notch (75,90%), whereas distal microburins a left one (72,17%). Thanks to the 2nd experiential activity (Chapter 3.2.2. Part 1) we noted that a such notch lateralization can derive from three different production modalities:

- A) the removal of a single microburin (distal or proximal) for each geometric (Fig. 3.34 Part 1; 1st modality) by positioning the blank on the anvil edge always in the same position (the A holding modality for right-hand knappers; Fig. 3.29 c Part 1**)**.
- B) the shaping of two geometrics for each blank, in which the first one is produced by one proximal microburin and one distal microburin, whereas the second one is shaped in correspondence of the previously distal microburin by a proximal truncation and a further distal microburin (Fig. 3.34 Part 1; 4th modality).
- C) the shaping of two geometrics each blank by removing a proximal microburin, a distal microburin and a mesial microburin (Fig. 3.34 Part 1; 5th modality).

However, the B) option would require a quite important blank length (at least 30 mm as seen during experimentation), whereas the C), in addition to need an even longer blank, would yield an important amount of double microburins. Considering that in Mondeval de Sora blanks exploited are shorter than 25 mm and double microburins are rare, the A) option seems to be the most used for geometrics production.

The low number of right distal and left proximal microburins might result by different production modalities which were probably less emploied by Sauveterrian groups of Mondeval de Sora:

- the removal of both a proximal and a distal microburin to shape the geometric on the mesial portion of the blank. In fact only 13 geometrics conserve a double *piquant-trièdre.*
- the use of a single microburin by a left-hand knapper using the A holding modality.
- the use of a single microburin by a right-hand knapper using the B holding modality.
- the use of the B) option further mentioned by positioning the three notches on the same blank side (Fig. 3.34 Part 1; 4th modality).

A few double microburins (1,90% - Tab. 6.8) indicates that two geometrics (one distal and one proximal) can occasionally be obtained by one single blank if this was long enough (Fig. 3.34 Part 1; 3rd modality). Among them two different types were identified: the first one is characterised by two notches located one the same side, whereas the second one by two notches located oppositely.

Microburins length (only complete pieces were selected) give important information about the amount of blank removed by the microburin blow. The interquartile range varies between 7 mm and 11,5 mm. Any differences concerning length values were detected between proximal and distal microburins.

Table 6.8 - Microburin assemblage analysed from layer 8

	n	%
Distal	195	46.32
Proximal	212	50.36
N.D.	4	0.95
Double	8	1.90
From flakes	2	0.48
Total	421	100

Table 6.9 - Notch lateralisation according to distal and proximal microburins

	Distal		Proximal	
	n	%	n	%
Right	47	24.10	153	72.17
Left	148	75.90	59	27.83
Total	195	100	212	100

The identification of the force applied (percussion vs pressure/bending) for the microburin blow was based on the methodology developed during the 2nd experiment (Chapter 3.2.2. Part 1) which includes both a low and a high-power approach. This analysis was carried out on a sample of 100 microburins.

6.2.2.2.1. Low power approach

As shown in Table 6.10 and 6.11, the majority of microburins has no impact point and bulb (Fig. 6.6 a). These two features on the same microburin are highly diagnostic of a pressure/bending technique. Also the rest of the sample presents features which tend to appear with a pressure/bending technique rather than percussion, such as:

- linear impact point (Tab. 6.10; Fig. 6.6 b)
- diffuse bulb (Tab. 6.11; Fig. 6.6 e)
- fractures with a horizontal development (Tab. 6.12; Fig. 6.6 f)

On the other hand, features experimentally obtained by a percussion technique are rare or even absence, such as:

- multiple impact point (Tab. 6.10)
- pronounced bulb (Tab. 6.11)
- fracture without horizontal development (Tab. 6.12)
- notch with incipient cones located far from the edge
- rounded notch edge

The use of an organic tool was confirmed by the notch morphology which often presents residual indentations visible from the ventral face (Fig. 6.6 d) and negatives with large initiations (Fig. 6.6 c).

Table 6.10 - Impact point morphology.

	n	%
Isolated	1	1.00
Linear	8	8.00
Elongated	4	4.00
Small	22	22.00
Large	2	2.00
Multiple	-	-
Linear/isolated	1	1.00
Absent	55	55.00
Break	5	5.00
N.D.	2	2.00
Total	100	100

Table 6.11 - Bulb morphology.

	n	%
Absent	53	53.00
Diffuse	32	32.00
Pronounced	5	5.00
Punctual	4	4.00
Break	4	4.00
N.D.	2	2.00
Total	100	100

Table 6.12 - Profile delineation.

	n	%
Clear horizontal development	49	49.00
Slightly horizontal development	35	35.00
Without horizontal development	11	11.00
N.D.	5	5.00
Total	100	100

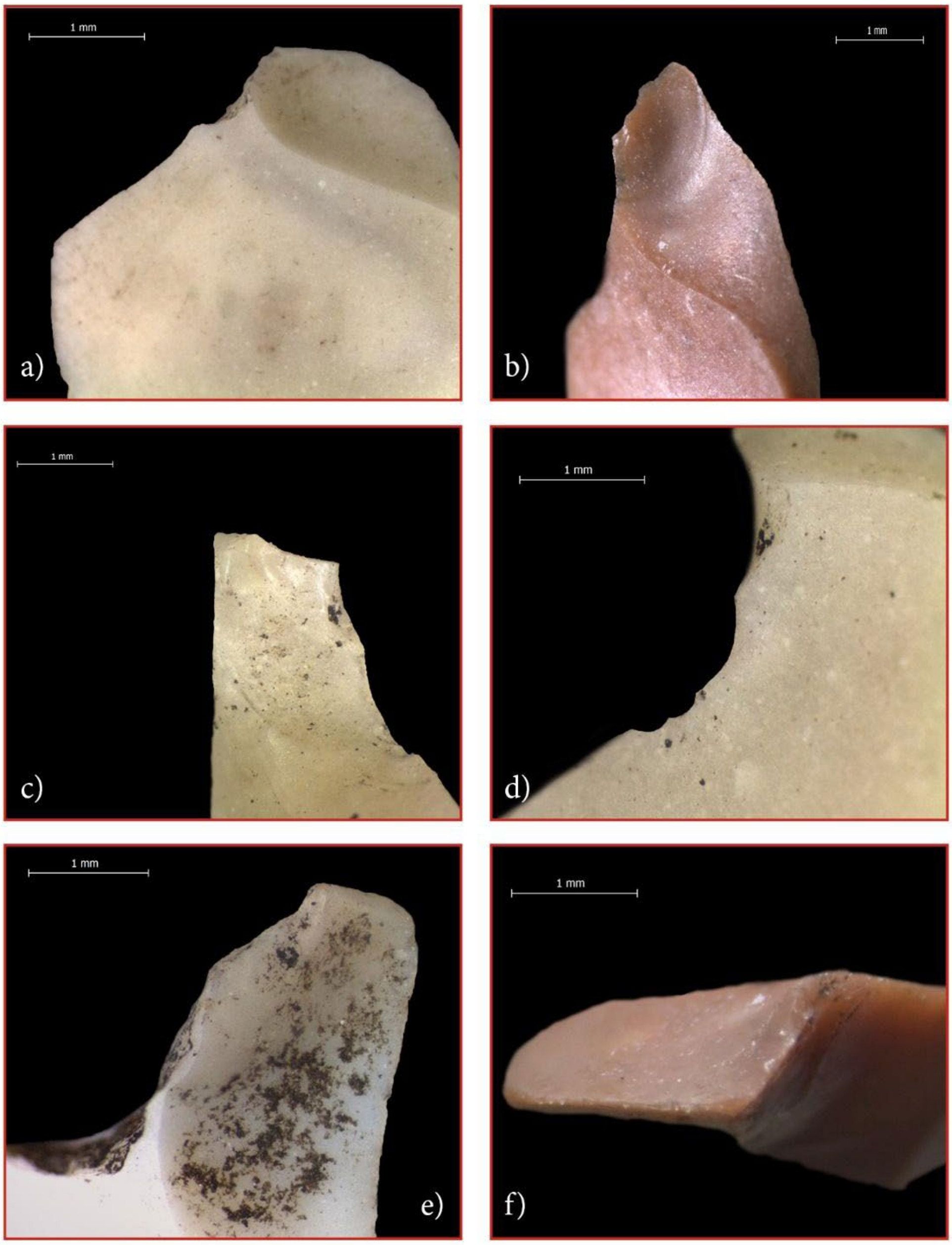


Figure 6.6 – Diagnostic criteria of a pressure/bending technique applied by an organic tool. a: no impact point and bulb; b: linear impact point; c: large initiation of a notch negative; d: residual indentations visible from the ventral face; e: diffuse bulb negative; f: fracture with a semi-abrupt transverse inclination and a horizontal development.

6.2.2.2.2. High power approach

In order to achieve a higher degree of reliability on fracturing technique identification, 43 microburins were analysed through a metallographic microscope. Each of them was cleaned with neutral soap, water and an ultrasonic cleaner for 15 minutes.

Only three microburins presented micro-traces relate to notch fabrication. They consist of linear polishes located on the ventral face near the notch with a transverse or oblique orientation compared to the retouched edge. Their morphology is similar to those experimentally produced by an antler retoucher (Fig. 6.7). Any microburins shown traces diagnostic of a mineral one, confirming the use of a pressure applied by an organic tool as main technique to achieve a *piquant-trièdre* fracture.

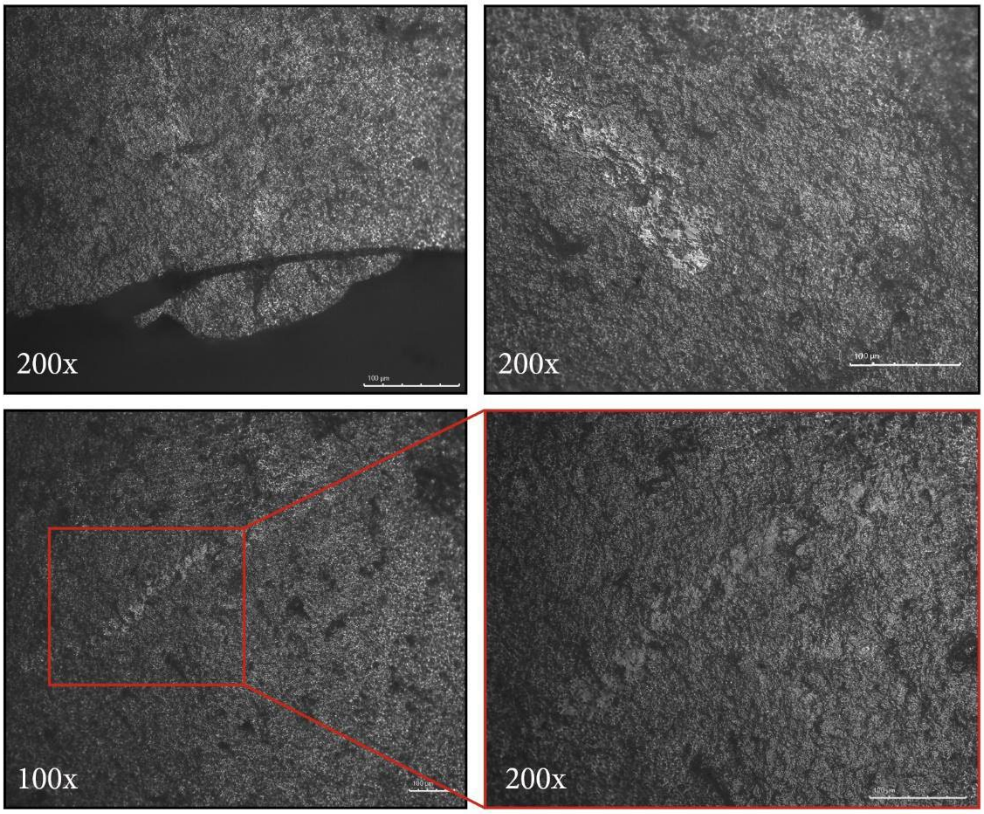


Figure 6.7 – Backing micro-traces on microburins comparable with those experimentally produced with an antler retoucher.

6.2.2.3 Retouch methods

6.2.2.3.1. Backed retouch

After the microburin fracture the back reduction is carried out by applying a deep and abrupt retouch (Tab. 6.13). Marginal, direct and abrupt retouches were used only when microlithics are produced in correspondence with the distal portion of the blank. Crossed retouchers are rare and related to thickness values of 2-3 mm.

The backed retouch reduces the original blank width by more than half. As a matter of fact, backs (or truncations in case of triangles) are almost systematically positioned over the main dorsal ridge in triangular cross-section blanks or over the 1st ridge in trapezoidal ones (Fig. 6.8). Once the back overpasses the main dorsal ridge, the back angle tends to vary between 45° and 70°. Hardly ever it is around 90°. As confirmed by the experimental activity, the back angle is strongly connected with the functional edge angle: the more the latter is open, the less the back is abrupt. This interconnection happens when the artefact is laid down with the dorsal face making complete contact with the anvil surface while applying a perpendicular retouch (Fig. 6.9).

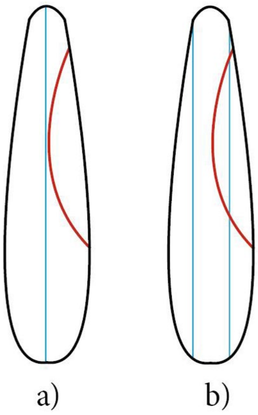


Figure 6.8 – relationship between back and main dorsal ridge according to cross-section blank. a: triangular cross-section blank; b: trapezoidal cross-section blank.

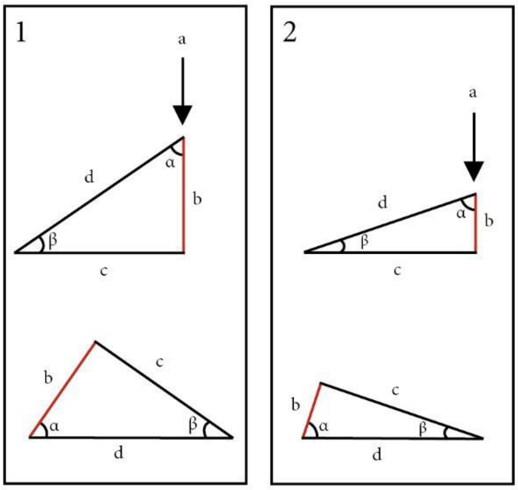


Figure 6.9 – The relation between the angle of the backed retouch and the angle of the functional edge. 1: a functional edge with an opener angle corresponds to a less abrupt backed retouch; 2: a functional edge with a closer angle corresponds to a more abrupt backed retouch; a: retoucher; b: back; c: dorsal face; d: ventral face; α: backed retouch angle; β: functional edge angle.

Table 6.13 - Backed retouch extent, position and angle.

Segments	n	%
Deep direct abrupt	22	64.71
Marginal direct abrupt	5	14.71
Deep crossed abrupt	5	14.71
Marginal direct semi-abrupt	2	5.88
Total	34	100
Triangles		
Deep direct abrupt	77	57,47
Deep direct semi-abrupt	12	8.96
Marginal direct abrupt	27	20.15
Marginal direct semi-abrupt	3	2.24
Deep crossed abrupt	4	2.99
Marginal crossed abrupt	1	0.75
Deep inverse abrupt	3	2.24
Deep inverse semi-abrupt	1	0.75
Unretouched *piquant trièdre*	6	4.48
Total truncations	134	100

Geometrics are produced in correspondence with the mesial (55,88%) or the distal (22,55%) portion of the blank. The proximal one is systematically removed by the microburin blow or by retouching. Twenty-three artefacts show a *piquant trièdre* (eight are distal, twelve are proximal and two are indeterminable). Thirteen have a double *piquant trièdre,* attesting the sporadic used of more than one microburin on the same blank. Rarely the *piquant trièdre* is left completely unretouched (n=6). To adjust the fracture delineation few marginal detachments are generally flaked. In almost half of the assemblage the functional edge is modify by complementary retouched applied all along the edge. They tend to be marginal, direct and semi-abrupt.

As regards the entire geometric assemblage, length shows an interquartile range varying from 8 to 11 mm, width from 3 to 4 mm and thickness from 1 to 2 mm. Medium values are respectively 9,7 mm, 3,4 mm and 1,5 mm (Tab. 6.14).

Table 6.14 - Geometrics dimensional classes of length, width and thickness.

	Length	Width	Thickness
Minimum value	6	2	1
1st quartile	8	3	1
Medium	9.73	3,4	1,5
Median value	10	3	1
3rd quartile	11	4	2
Maximum value	15	6	3
SD	2.457	0.944	0.592
Total	92	101	101

6.2.2.4. Morpho-types

The geometrics assemblages can be divided into three main morpho-types (Tab. 6.15): scalene triangles, isosceles tringles and segments.

- **Scalene triangles** are the most attested. The backing process involves the fabrication of two oblique truncations characterised by a different length and orientation aimed at pointing out two tips: an apical one (1st apex) and a lateral one (2nd apex). More frequently the shorter truncation is proximal and the longer one is distal (64,58%). When triangles are manufactured from the distal portion of the blank, the distal truncation could have (n=13) a more parallel orientation with respect to the morphological axis of the blank. The two truncations converge forming an angle always greater than 90°. The length ratio between the two truncations defines two different subtypes: short scalene triangles (width-length ratio ≤ 1:2) (Fig. 6.10 n. 1-4) and elongated scalene triangles (width-length ratio > 1:2 (Fig. 6.10 n. 5-8). The latter can be related to the *Triangle scalène allongé* and *Triangle scalene allongé à petite troncature courte* (GEEM, 1969). Concerning the size, scalene triangles have a length varying between 6 mm and 14 mm (interquartile range: 8-11 mm), a width between 2 mm and 5 mm (interquartile range: 3-4 mm), and thickness between 1 mm and 3 mm (interquartile range: 1-2 mm)
- **Isosceles triangles** are characterised by two truncations with an equal orientation and length. Two different morphologies were detected: **elongated isosceles triangles** and **short isosceles triangles**. The former has a width-length ratio of at least 1:3 (Fig. 6.10 n. 12-14), whereas the latter have a width-length ratio lower than 1:3 (Fig. 6.10 n. 9-11). Half of the assemblage (n=7) shows a double *piquant-trièdre* suggesting an intensive use of a double microburin blow for producing this specific item. Their dimensions do not show significant differences compared to scalene triangles, except for a slight minor length: length records a minimum and maximum value respectively of 6 mm and 13 mm (interquartile range: 7-9,75 mm), width of 2 mm and 6 mm (interquartile range: 3-4 mm) and thickness of 1 mm and 2 mm (interquartile range: 1-2 mm).
- **Segments** have a slightly convex back delineation (i.e. crescents) or rarely trapezoidal. Length varies between 6 mm and 15 mm (interquartile range: 8-12 mm), width between 2 mm and 5 mm (interquartile range: 3-4 mm) and thickness between 1 mm and 3 mm (interquartile range: 1-2 mm). By observing crescents different morphologies were detected depending on back delineation. **Symmetric crescents** have an elongated shape with two symmetric apexes and a backed retouch with a symmetric curvature along the morphological axis of the blank (Fig. 6.10 n. 19-20). **Asymmetric crescents** have a backed retouch with an asymmetric curvature delineating two asymmetric apexes, an apical one (1st apex), frequently distal, and a lateral one (2nd apex). In more than half of the analysed sample the functional edge is delineated by complementary retouches. (Fig. 6.10 n. 15-18). **Large crescents** are characterised by a backed retouch extremely convex which do not shape any apexes. Width-length ratio is around 1:2 (Fig. 6.10 n.

21-22).

Table 6.15 - Morpho-types attested at Mondeval de Sora and relative frequency in layer 8. Crescents/isosceles triangles (n=5) were not counted.

	Scalene triangles	**Isosceles triangles**
	n	**n**
Short	35	11
Elongated	12	4
N.D.	4	-
Total	51	15
Symmetric crescents	10	
Asymmetric crescents	13	
Large crescents	4	
Trapezoidal segments	2	
Total	27	

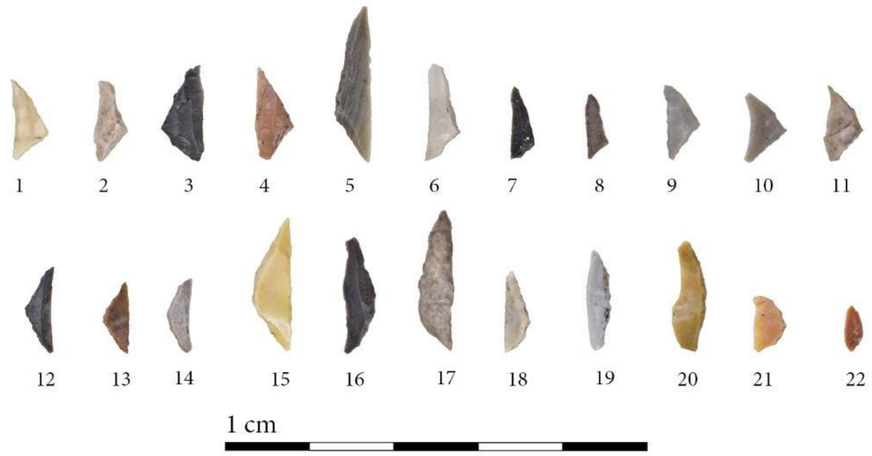


Figure 6.10 - Geometrics morpho-types. 1-4: short scalene triangles; 5-8: elongated scalene triangles; 9-11: short isosceles triangles; 12-14: elongated isosceles triangles; 15-18: asymmetric crescents; 19-20: symmetric crescents; 21-22 large crescents.

6.2.2.5 Resumed pieces and pieces abandoned under construction

Four pieces resumed after an unintentional breakage were identified. One is an asymmetric crescent showing a distal transverse truncation aimed at resuming a previous fracture. Conversely, three have a snap terminating bending fracture with an oblique orientation partially covered by a following retouch. They are probably the results of a failed microburin blow that did not preclude the successful production of the geometric.

About the two pieces discarded during the production process, the first one shows a proximal *piquant trièdre* and an unfinished distal truncation (Fig. 6.11 a). The second one reveals a distal *piquant trièdre* partially covered by truncation and an unfinished proximal portion with a bulb still visible (Fig. 6.11 c). In both cases the microburin blow was applied to remove only one of the two extremities, whereas the other was reduced by retouching. By observing Figure 6.11 b, it is possible to appreciate a *piquant trièdre* fracture interrupting the complementary retouch. This evidence indicates a modification of the functional edge before applying the microburin blow. The occasional marginal retouch opposite to the notch observed on some microburins could be the result of this specific situation.

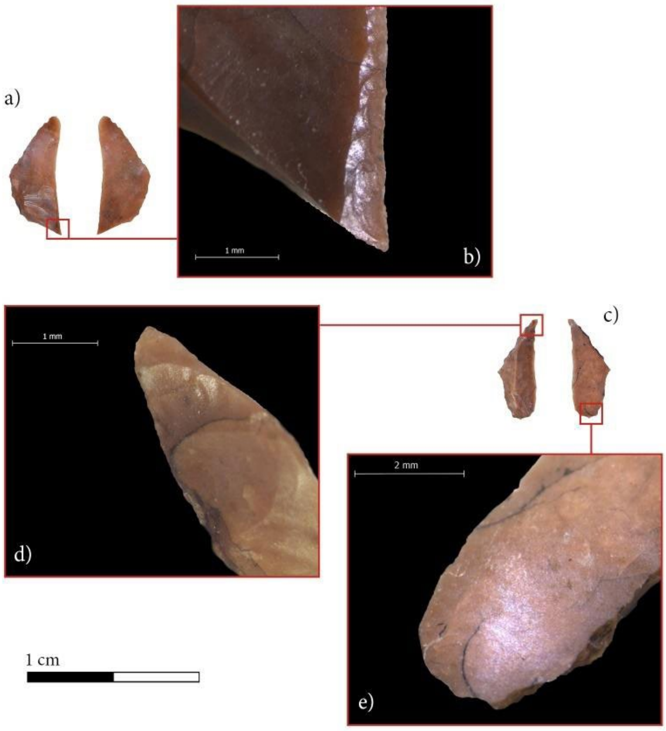


Figure 6.11 - Pieces abandoned during construction. a: geometric produced on the distal portion of the blank; b: detail of the complementary retouch interrupted by the *piquant trièdre* fracture; c: geometric produced on the proximal portion of the blank; d: detail of a *piquant trièdre* partially resumed by retouch; e: detail of the blank bulb.

6.2.3. Backed truncated bladelets

Backed truncated bladelets analysed amount to a total of 35 and they have a minor role compared to geometric and double backed points on the weapon equipment of Sauveterrian hunters-gatherers groups of Mondeval de Sora.

6.2.3.1. Blank selection

Blanks selected are full debitage lamino-lamellar blanks. Three artefacts attest the exploitation also of natural backed blanks. Profiles are largely rectilinear, rarely slightly concave. Butts are systematically removed by truncation, whereas in those rare cases in which the distal portion was left untouched it is possible to see the selection of hinged blanks (n=2). The cross-section blank is triangular, hardly ever trapezoidal. A calibrated thickness along the entire mor-

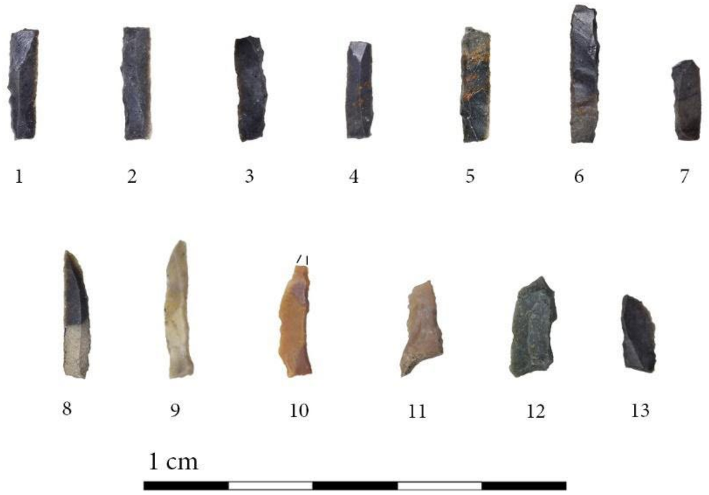


Figure – 6.12 Backed truncated bladelets. 1-10: A type; 11-13: B type.

phological axis, that does not exceed 2 mm, seems to be the most important parameters that guide blank selection. The comparison of thickness values between backed truncated bladelets and the previously presented categories of full debitage lamino-lamellar blanks from layer 8 (Fig. 6.2) argued in favour of the selection of microbladelets shorter than 25 mm.

6.2.3.2. Retouch methods

Backs are rectilinear and produced by applying deep (68,57%) or marginal (20,00%) direct abrupt retouch. Backs with a semi-abrupt retouch are rare, whereas those shaped by a crossed retouch are lacking. The back invasiveness is strongly related to the achievement of a standardised width of 3-4 mm. The backing process reduces around half of the original blank size positioning the back over or adjacent to the main dorsal ridge in case of triangular cross-section blanks and over the 1st dorsal ridge or adjacent to the 2nd with trapezoidal ones. Two main morpho-types were identified:

- the **A type** (Fig. 6.12 n. 1-10) has a single or double transverse (rarely oblique) truncation. Few artefacts have a single proximal truncation opposite to a naturally pointed distal portion (Fig. 6.12 n. 8-10). In this category the role of truncations seems to change according to their invasiveness. Deep abrupt or semi-abrupt truncations are useful to: control artefacts length, shape the artefact in correspondence with the most regular blank portion and remove the butts and the bulb. On the other hand, marginal abrupt or semi-abrupt are almost exclusively applied slightly modify the distal portion. The cutting edge has always a rectilinear delineation achieved by applying a single sequence of marginal complementary retouches (88,89%) all along the edge (79,17%). Only one baked bi-truncated bladelet shows a truncation covering a *piquant trièdre* fracture, suggesting the use of a microburin blow technique to reduce blank length.
- the **B Type** is a backed truncated bladelet with a single, proximal and obtuse truncation

(Fig. 6.12 n.11-13). Its morphology is comparable to scalene triangles, except for the fact that the back and the functional edge do not converge shaping a tip. Any complementary retouch is applied. The oblique truncation is aimed at controlling the artefact length and delineating a sort of lateral apex.

Dimensional data of backed truncated bladelets are presented at Table 6.16 divided between the two main morpho-types.

Table 6.16 - Backed truncated bladelets dimensional classes of length, width and thickness according to morpho-types.

	B type			A type		
	Length	Width	Thickness	Length	Width	Thickness
Minimum value	9	3	1	7	3	1
1st quartile	9	3,5	1	10	3	1
Medium	9,8	4	1,5	12	3,5	1,3
Median value	10	4	1	12	3	1
3rd quartile	10	4,5	2	14	4	2
Maximum value	12	5	3	18	6	2
SD	1,069	0,816	0,868	2,685	0,692	0,485
Total	7	7	7	23	28	28

6.2.4. Backing techniques analysis

6.2.4.1. Low power approach

As for backed points, a pressure both applied by a stone and an organic retoucher is the most employed backing technique. Backs are indeed characterised by a linear longitudinal profile and regular, symmetrical and aligned removals. Some examples of backed points presenting features diagnostic of these two backing techniques are shown in Figure 6.13 and 6.14 a. A major exploitation of pressure rather than percussion can be easly explained by the low values of thickness and width reached by Sauveterrian backed points that make a percussion technique inappropriate due to its high fracture index and low degree of precision. In fact, the use of soft stone percussion on anvil was limited to a few situations:

- to modify the thicker portions (around 2-3 mm) of longitudinal backed points (Fig. 6.14 c).
- to overpass the bulb/butt portion in case of proximal transverse backs (Fig. 6.14 b).
- to begin the reduction process of transverse baked point or longitudinal backed point produced on large lamino/lamellar blanks, as attested by pieces abandoned in construction.

Also geometrics and backed truncated bladelets are mainly manufactured by a pressure technique (Fig. 6.15 and 6.16). Soft stone percussion on anvil was detected only on three pieces characterised by a thickness of 2-3 mm. The higher selection of an organic compressor compared to a lithic one for applying a pressure technique could depend on several factors: firstly, since the notch production and the microburin fracture were achieved by a pressure with an organic retoucher, it stands to reason that the shaping process was carried out without changing the retoucher. Moreover, thanks to the microburin blow and dimension of blanks selected, the backing process needed to reach the required morphology was relatively brief, making irrelevant the major disadvantage of the pressure with an organic tool, namely a low operating speed. The pressure by soft stone was probably used when a more intensive reduction process was necessary, taking advantage of a higher operating speed while maintaining a good degree of precision. Figure 6.16 shows a distal truncation produced by pressure by soft stone (perhaps without a microburin fracture) and a proximal truncation shaped by a *piquant trièdre* fracture where residual indentations diagnostic of pressure with organic tool are visible on what is left of the notch.

Complementary retouches were systematically produced through a pressure technique.

6.2.4.2. High power approach

After the cleaning process a sample of 30 armatures were analysed by a metallographic microscope. However, only one backed point and one geometric yielded micro-traces maybe related to the backing process. They are marginal polishes that are not particularly developed and not diagnostic of a specific technique. The low number of armatures that preserved micro-traces is probably related to the low thickness values of Sauveterrian microlithics and therefore to the low force applied during retouching.

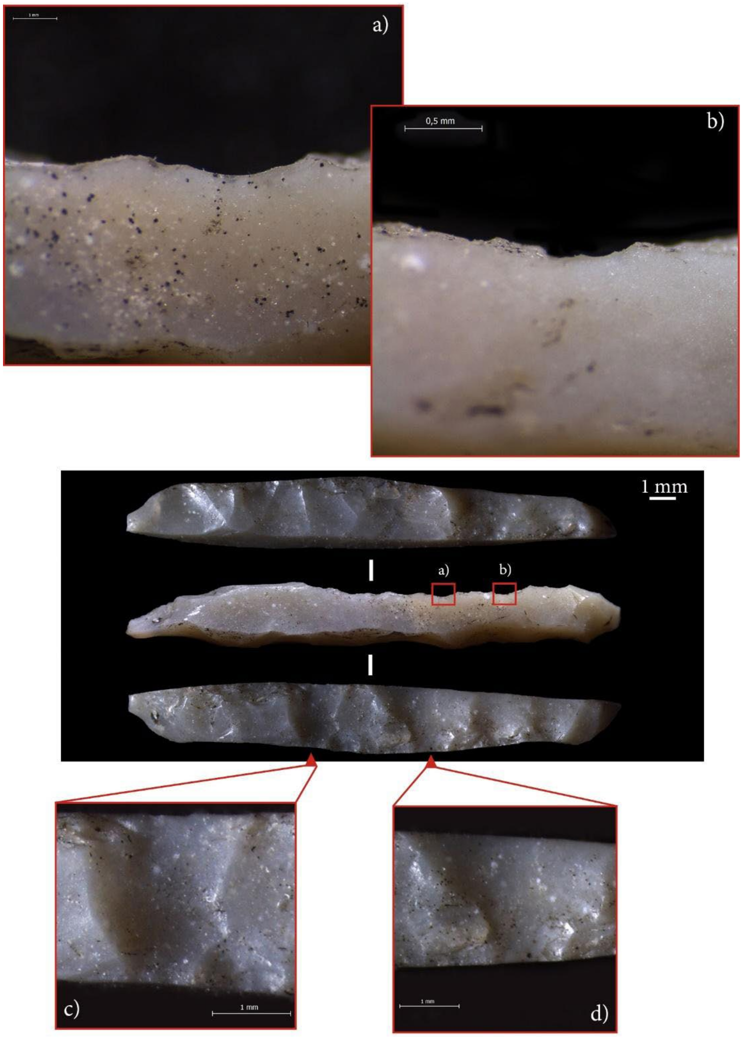


Figure 6.13 – Sauveterrian point shaped applying pressure by an organic tool. a-b: residual indentations; c-d retouch negatives with a large initiation and a fresh edge.

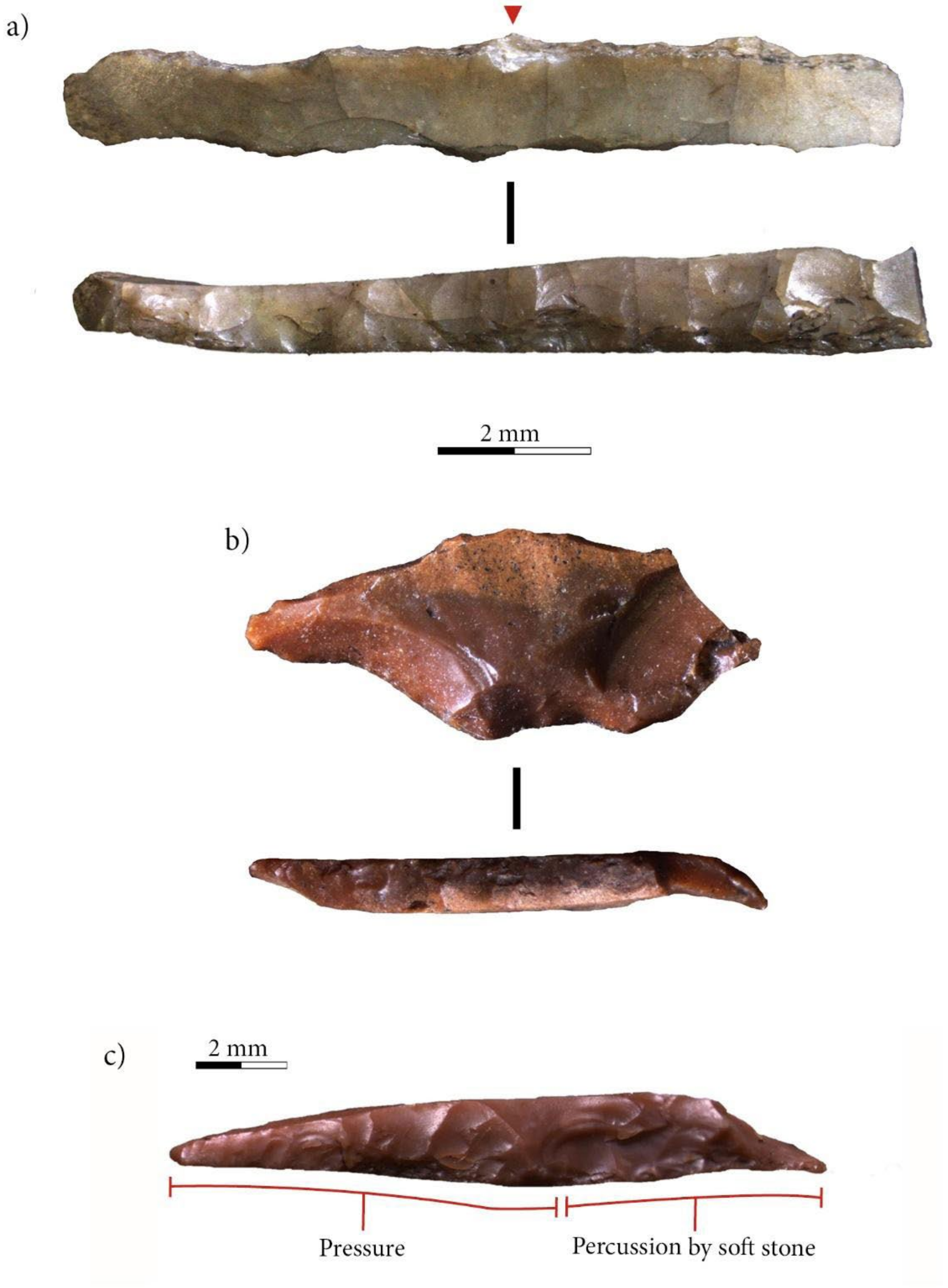


Figure 6.14 – Sauveterrian points. a: Back with a linear longitudinal profile, regular, symmetrical and aligned removals and portions with a rearward and rounded edge (red triangle) diagnostic of pressure by soft stone; b: Transverse Sauveterrian point with the distal back produced by pressure by soft stone and the unfinished proximal one by soft stone percussion on anvil; c: mixed technique on the same back.

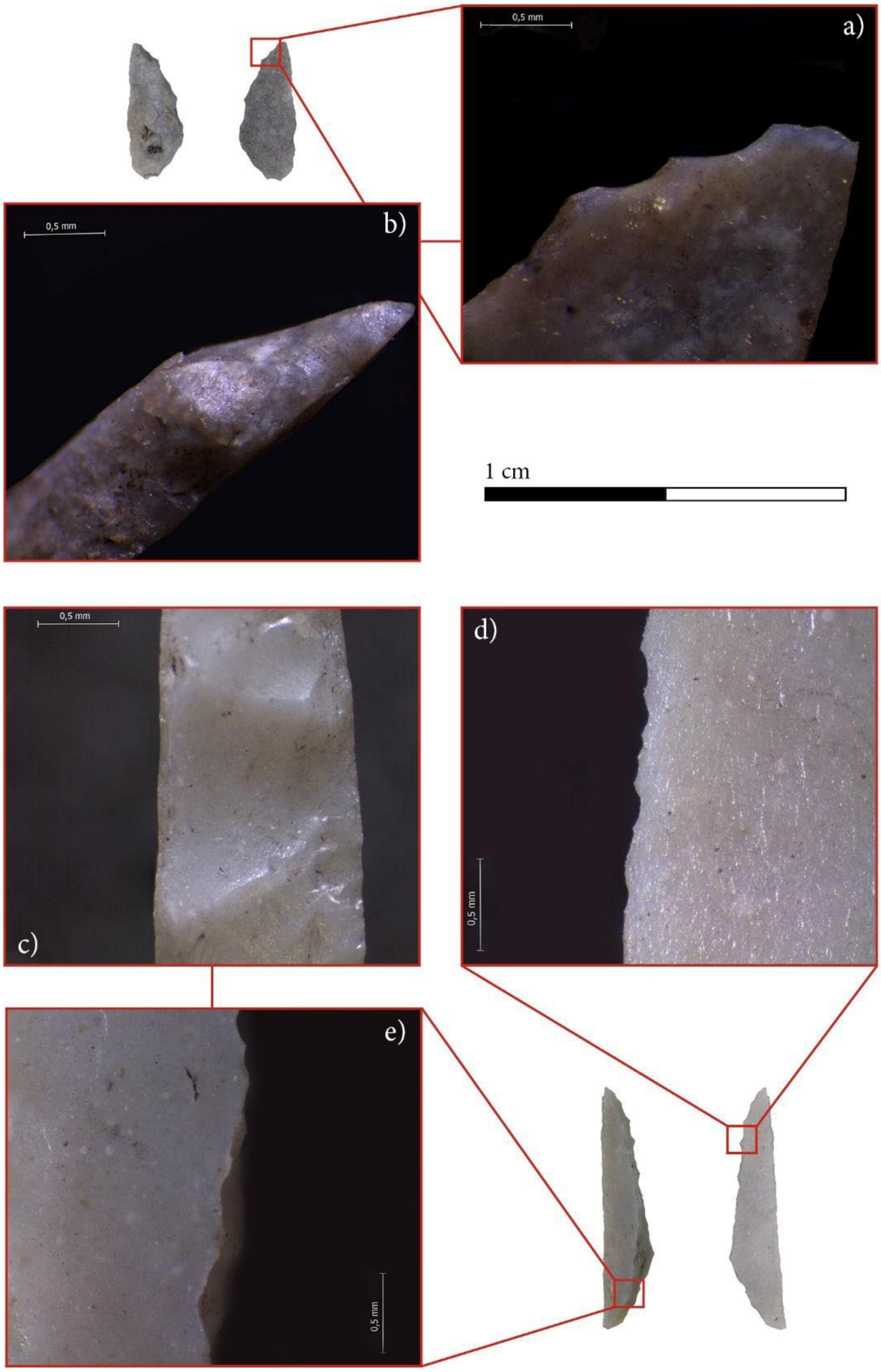


Figure 6.15 – Scalene triangles shaped applying pressure by an organic tool. a, d, e: residual indentations; b: retouch negative with a bending initiation; c: retouch negative with a large initiation.

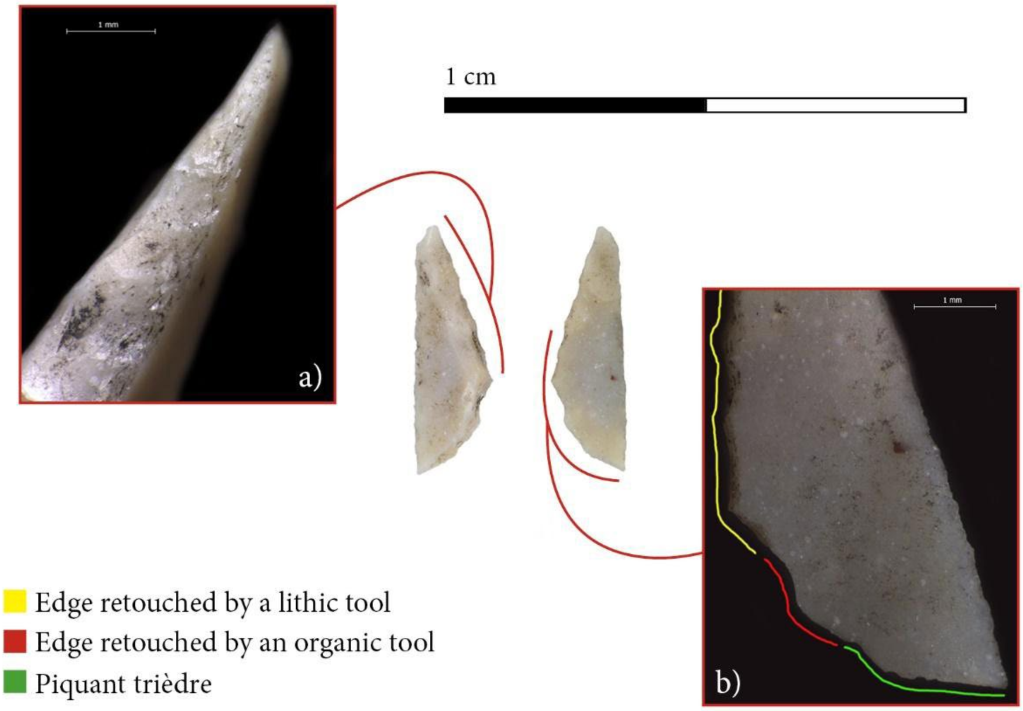


Figure 6.16 – Scalene triangles shaped by a mixed technique. a: rounded edge associated with regular removals diagnostic of a pressure by soft stone; b: comparison between the fresh edge of the notch produced by pressure by an organic tool (red line) and the rounded edge of the distal truncation produced by pressure by soft stone (yellow line). The green line indicates the *piquant trièdre* fracture.

6.2.5. Diagnostic impact fractures

16 armatures yielded diagnostic impact fractures. 6 are backed points, 5 are geometrics and 5 are backed truncated bladelets. On backed points traces are localised both on the tip (n=2) and the base (n=3) (Tab. 6.17). They were attributed to feather terminating bending fractures (n=1), bending transverse fractures (n=2), burin-like spin-off (n=1) and burinations (n=1). They were identified both on Sauveterrian points (Fig. 6.17) and curved backed points. According to L. Chasnaux (2014), these types of damage are well suitable with an axial position on the shaft. The only exception is a burination fracture removing the tip of a curved backed point which is poorly attested on axial backed points (Chasnaux, 2014; p 122), suggesting perhaps, a latero-distal or lateral position.

As regards geometrics, diagnostic impact fractures were identified on four artefacts (Tab. 6.17). Burinations diagnostic of a lateral or latero-axial hafting method (Chasnaux, 2014) were detected on the 2nd point of two asymmetric crescents (Fig. 6.18 b) and an elongated scalene triangle (Fig. 6.18 a). By contrast, bending fractures with a *languette* ≥ 2 mm splitting microliths on two parts diagnostics of an axial or latero-distal hafting (Chasnaux, 2014) are present on an elongated scalene triangle (Fig. 6.18 c) and on an unidentified geometric.

Backed truncated bladelets yielded five fractures related to the use of projectile implement (35,29%; Tab. 6.17). One was identified on an artefact belonging to the B type and it consists in a short step-terminating *languette* associated to several scars starting from the convergence between the truncation and the functional edge suggesting a lateral hafting modality where the lateral point plays a retentive role. The other four pieces belonging to the A type. They yielded step terminating bending fractures with a *languette* of 2 mm (n=2), burin-like spin-off fractures (n=1) and burinations (n=1). Artefacts belonging to the B type were probably hafted laterally on the shaft.

According to Pétillon et al. (2011), which carried out an experimental activity aimed at investigaing Magdalenian composite projectile tips, a special care must be given to the design of the head items in case of a microlithics row with a sub-parallel position with respect to the shaft. This armature should present a curved cutting edge and a pointed extremity in order to avoid failure in penetration which can be fatal to the whole row. Backed truncated bladelets with curved cutting edge and a pointed extremity opposite to a truncation documented in Mondeval de Sora (Fig. 6.11 n. 8-10) could have been used for this specific function of head item. One of them conserved a single scar with a step termination orientated oblique towards the truncation.

Table 6.17 - Diagnostic impact fractures variability according to each type of geometric. The percentage calculated with respect to the total number of fractures of each type.

Backed points	**n**
Feather terminating bending with *languette* ≥ 2 mm	1
Hinge/feather/step terminating transverse bending with *languette* ≥ 2 mm	2
Burin-like spin-off ≥ 2 mm	1
Burination ≥ 2 mm	1
Edge scars	1
Total fractures	**6 (13.95%)**
Geometrics	
Step terminating bending with *languette* ≥ 2 mm	2
Burination ≥ 2 mm	3
Total fractures	**5 (12.82%)**
Backed truncated bladelets	
Step terminating bending with *languette* ≥ 2 mm	2
Burin-like spin-off ≥ 2 mm	1
Burination ≥ 2 mm	1
Edge scars	3
Total fractures	**7 (35.29%)**

Figure 6.17 – Sauveterrian points presenting diagnostic impact fractures. a: burin-like spin-off fracture; b: transverse bending fracture.

Figure 6.18 – Geometrics presenting diagnostic impact fractures. a-b: burination fracture; c: step terminating bending fracture.

Part 3 – Synthesis of results, discussion and conclusion

In this part the synthesis of results obtained from the six analysed sites included in a overview of the Late Glacial and the Early Holocene is presented. Data were obtained combining qualitative (including analysis at low and high magnifications) and quantitative approaches. This combined methodology is generally used in use-wear analysis, while here it is applied to the production of lithic artefacts. Results are firstly illustrated according to each analysed area (i.e. South-Western France and North-Eastern Italy) and then an attempt of comparison between the two areas is developed. Concerning South-Western France, data from Troubat and Pont d'Ambon are presented by merely following the classic chrono-cultural repartition (Magdalenian, Azilian, etc.). These two sites cover the chronological span between the Middle Magdalenian and Early Laborian (Fig. 1.1). The Middle Magdalenian layers 13-11 of Troubat yielded only a few fragments of backed tools and therefore they have been excluded from the discussion. Layer 10-8 are dated to the end of the Oldest Dryas (15847-15336 cal BP and 15601-15146 cal BP) i.e. to the transition between the Early and Late Upper Magdalenian, while layer 7 is dated to the Allerød (14077-13675 and 13552-13156). The radiocarbon dates of this latter are not unanimously accepted because too young. The Late Azilian layer 6 is dated to the Younger Dryas. The majority of the radiocarbon dates of Pont d'Ambon were performed in the 70s' and 80s' and they are not entirely reliable. The Early Azilian occupation (layer 3B) is referred to the B-A Interstadial (14225-13714 cal BP and 13876-13242 cal BP), while the Late Azilian layer 3A to the end of the Allerød (layer 3A: 13320-13101 cal BP). The Late Azilian layer 3 and the Early Laborian layer 2 are both dated to the Younger Dryas-Preboreal transition (layer 3: 12677-11048 cal BP and 12427-10476 cal BP; layer 2 12848-12588 cal BP, 11935-11605 cal BP, 11804-10366 cal BP). Any Late Laborian and Sauveterrian French sites have been analysed.

As far as Northern-Eastern Italy is concerned, we analysed armatures from three Late Epigravettian sites and from layer 8 of Mondeval de Sora, referred to the Middle Sauveterrian (10583-10407 cal BP and 10716-10556 cal BP). The Late Epigravettian sites are presented according to the chronological division proposed by C. Montoya (2004, 2008) and then revised by A. Tomasso (2014). Riparo Tagliente covers both the ER1 and ER2 and Riparo Biarzo the beginning of the ER3 (Fig. 1.2). Riparo Soman is traditionally divided into two phases (Fig. 1.2): the former dated to the Bølling-Allerød transition (ER2) through one radiocarbon date (14146-13404 cal BP), the second one to the Younger Dryas by four radiocarbon dates (ER3). The lack of differences from a typological and technological viewpoint between armatures of the two phases, the strong divergences of phase I with the recent phase of Riparo Tagliente (layer 8-10:14572-13430 cal BP), added to the presence of several types more frequently attested in the ER3 rather than ER2 (e.g., microgravettes with transverse or oblique basal truncation, symmetric backed truncated bladelets - c.f. segmenti trapezoidali – and bi-truncations) calls into question the radiocarbon date referred to the beginning of the Allerød. Furthermore, any important variation in faunal remains was recorded (Tagliacozzo and Cassou, 1994) and the anthropic deposit was mainly composed of coarse breccia detached from the rock-shelter vault due to thermoelastic phenomena suggesting a formation under the control of a rather cold climate (Younger Dryas?) (Battaglia et al., 1994). For these reasons we have chosen to consider Riparo Soman as a unique assemblage referred to the ER3, obviously maintaining some reservations about the existence of an occupational phase dated to the (end?) Allerød. Further investigations and new radiocarbon dates are necessary to validate this hypothesis. Any of the analysed sites is dated to the Terminal Epigravettian.

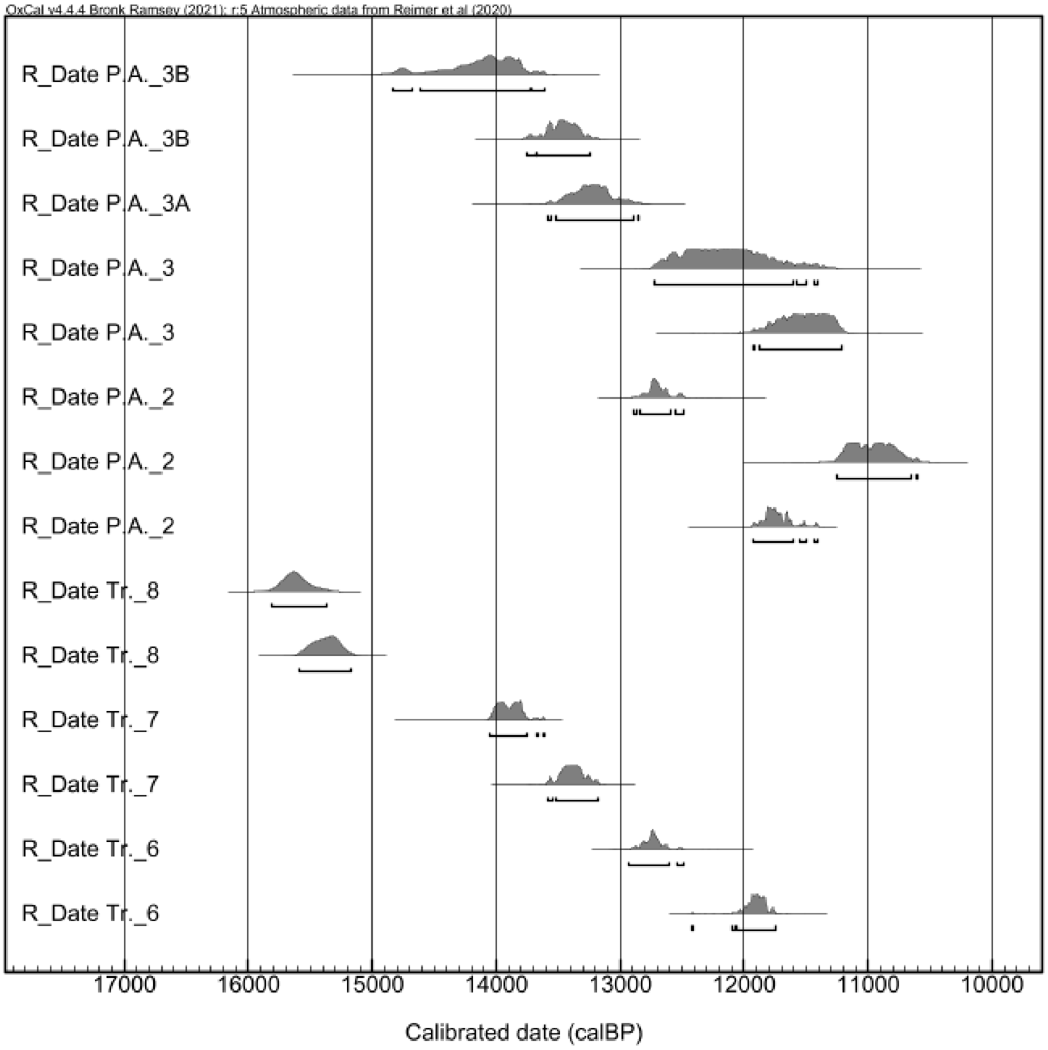


Figure 1.1 – Radiocarbon dates of layers of French sites analysed . Troubat (Tr.) and Pont d'Ambon (P.A.).

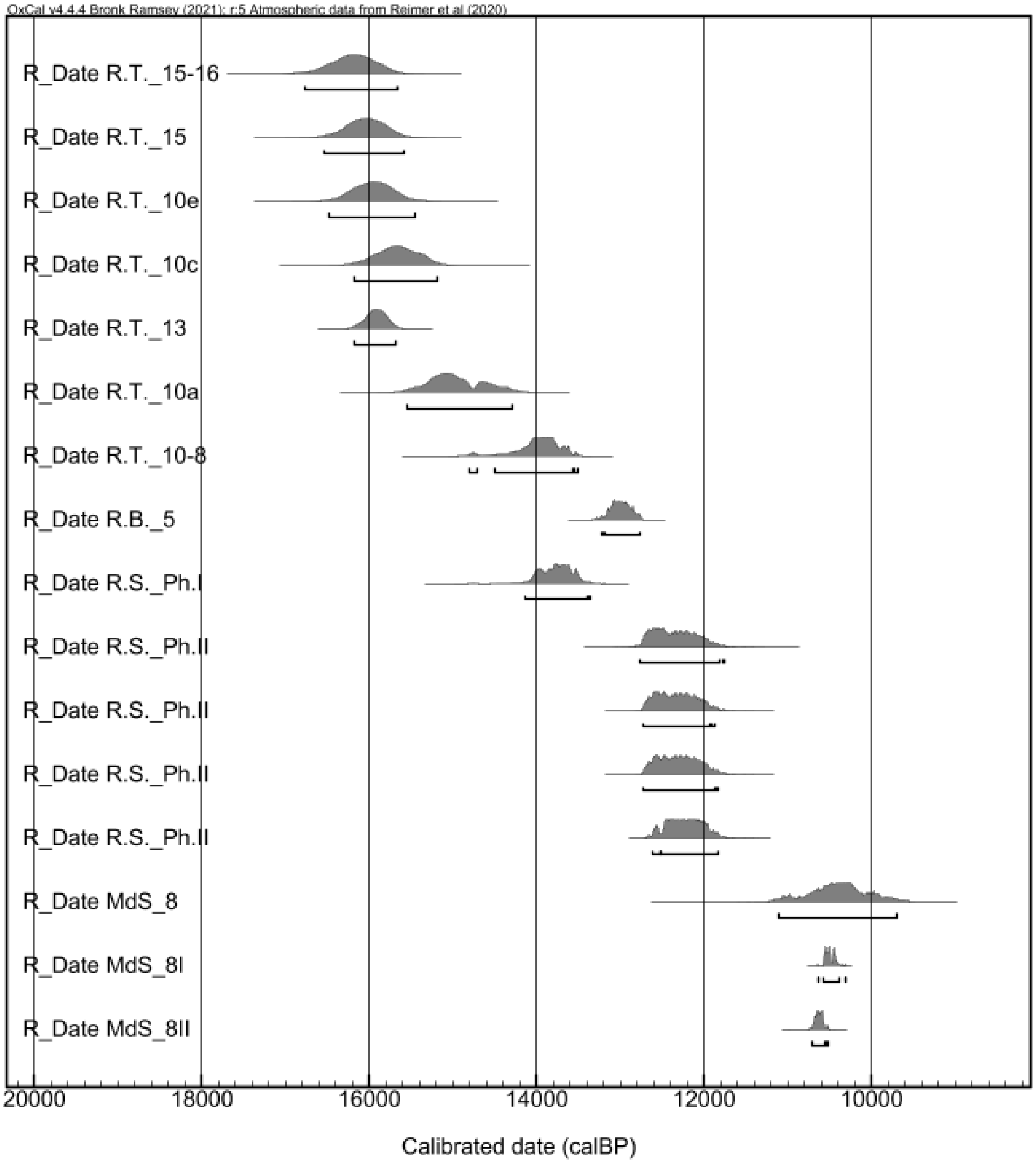


Figure 1.2 – Radiocarbon dates of layers of Italian sites analysed. Riparo Tagliente (R.T.), Riparo Biarzo (R.B.), Riparo Soman (R.S.), Mondeval de Sora (MdS).

Chapter 1 – A continuously transforming society: lithic armatures production during the Late Glacial in the French Western Atlantic area

1.1. Upper Magdalenian (Last part of GS-2/beginning of the GI-1)

The Upper Magdalenian deposits of Troubat do not show any significant changes in the *chaîne opératoire* of armatures production along the stratigraphic sequence. Blank selection, retouch methods and backing techniques remain similar, revealing a certain homogeneity at the transition between the Early Upper Magdalenian and the Late Upper Magdalenian. The armatures assemblage is composed exclusively of well-standardised lateral projectile implements: backed truncated bladelets, three different morphologies of backed bladelets (narrow pointed backed bladelets, pointed backed bladelets and not pointed backed bladelets) and a small collection of scalene triangles manufactured without the microburin blow technique are the main attested types. The only remarkable variation along the Magdalenian sequence that deserves to be highlighted is the almost disappearance of triangles in layer 7 in which only one item was counted. Furthermore, any lithic point was recorded confirming the distinction between two different areas encompassing South-Western France as previously highlighted by M. Langlais (2018): the Aquitaine plains and the foothills of Quercy with lithic points and the Pyrenees and the Languedoc region without lithic points.

In Troubat armatures are produced on narrow (< 10 mm) and thin (1-2 mm) full debitage microbladelets (length < 36 mm). The shaping process is poorly invasive and occurs by a single sequence of marginal and direct retouches or at most by adding a second slightly deeper retouch sequence. The blank is hardly ever turned over in order to apply a crossed retouch. A marginal, direct and semi-abrupt complementary retouch is sometimes applied on backed bladelets and backed truncated bladelets to modify the edge opposite to the back. The entire shaping out process was performed by organic pressure. Less frequently traces observed on backs indicate the use of a stone retoucher. The application of one or two marginal and direct truncations seems to be an occasional solution useful to slightly adjust artefact length and to remove the butt and bulb of the blank. Their orientation tends to be transverse or oblique forming an obtuse angle with respect to the back. The fact that only three backed truncated bladelets were found completed does not allow us to fully understand their morphology. Scalene triangles are systematically oriented with the first apex on the distal portion.

The armatures variability attested in Troubat perfectly reflects that of other Pyrenean sites. Belvis (Sacchi, 1994), Parco level II (Langlais, 2010), La Vache (Schmider, 2003) and Rhodes II (Fat Cheung, 2015) confirm a hunting equipment mainly composed of pointed backed bladelets, backed truncated bladelets and scalene triangles. Moreover, these armatures assemblages present a blank selection (thin and narrow microbaldelets sometimes obtained by a debitage "*sur tranche*"), a backing process (marginal and direct retouches) and sizes consistent with those of Troubat, showing a certain homogeneity in both the ways of arrowheads are designed (i.e. organic points and lateral lithic implements) and in their modalities of production in the entire Pyrenean region. The only morpho-type missing at Troubat is the "*lamelle à dos denticulée*".

The lack of lithic points in the Pyrenees, rather than being the result of a real cultural demarcation, may be influenced by the constraints of locally available raw materials which are of low knapping quality and in form of small blocks (Fat-Cheung, 2015; Lacombe, 2005; Simonnet, 2007, 2003, 1999). In fact, unretouched and transformed blades are often imported while the local production is smaller in size (Langlais et al., 2016). Since lithic points are produced on a larger dimensional class blanks (small blades) compared to lateral projectile implements (microbladelets) (Langlais, 2007; Langlais et al., 2016) and being highly susceptible to impact damages, as evidenced by several experimental programs (e.g., Duches, 2011; Borgia, 2006), it would not be a functional strategy - in economic terms - employing such a "precious" resource as a blade for a short-term item as projectile points are.

Taking into account the backing techniques applied, the only data referred to this period come from the unité d'habitation Q31 of the open-air site of Étiolles (Pelegrin, 2004). J. Pelegrin proposed for the production of 10 armatures the use of both pressure by an organic tool and soft stone percussion on anvil. Unfortunately, the small size of the sample does not allow verifying which technique was the most employed one. The absence of residual indentations typical of pressure with an organic compressor observed in one artefact has been interpreted by Pelegrin (2004) as the result of trimming of the back by abrasion during the finalisation phase. At Troubat, the absence of these morphologies associated with regular, symmetrical and aligned removals has been correlated to the occasional use of pressure technique with a soft stone retoucher.

1.2. Early Azilian (first part of GI-1)

Looking at the Early Azilian layer of Pont d'Ambon, the complete renovation of the hunting equipment compared to the Upper Magdalenian involves also a drastic change in both blanks selection and retouch methods. The only aspect of continuity is a certain normalisation of the blanks selected, although their size strongly increases forcing knappers to shape armatures by a more invasive backing process. Lateral inserts stop being produced in favour of an exclusive manufacture of lithic points. Two different morpho-types were identified: curved backed bipoints and curved backed monopoints. The arrowhead is thus conceived with a single item hafted in a latero-distal position. The 1st apex has a perforating function while the 2nd apex plays both a retentive and cutting role.

Projectile points are produced exclusively on full debitage lamino/lamellar blanks with a variable profile (slightly curved or rectilinear) and a fairly flat cross-section. The thickness is moderately calibrated along the morphological axis (3-4 mm) and the length is standardised (50-70 mm), whereas the width is more variable (8-20 mm). The backing process normally starts from the distal apex and progressively advances towards the mesial portion. Then it can continue through a single sequence of removals reaching the opposite extremity or by a second retouch phase from the proximal portion. In case of thin and narrow blanks the curved back is marginal in the mesial part and deeper in correspondence of the two extremities. By contrast, when wider and thicker blanks were selected the backing process is deep all along the edge. Crossed retouches are applied to thin apexes only when backs thicker than 3 mm cross the main dorsal ridge on triangular cross-section blanks or the 2nd dorsal ridge in trapezoidal cross-section ones. The functional edge is naturally rectilinear and thus hardly ever modified by complementary retouches. The increase of blanks size (length, width and thickness) compared to the previous period (Upper Magdalenian) causes a shift in backing techniques too. Soft stone percussion on an organic anvil becomes the most widely used. Pressure was still employed to modify thinner and narrow blanks with a more marginal retouch and for shaping apexes, but it was applied through a stone retoucher. The organic compressor is no longer employed. The strong increase in the use of a mixed technique on the same artefact is probably due to the facility to switch from one gesture (percussion) to the other (pressure) with the same retoucher.

The Early Azilian seems to be one of the few European Late Glacial cultural facies in which armatures are not indicators of regionalist trends. As a matter of fact, the main traits observed in layer 3B of Pont d'Ambon are the same recorded across the entire Early Azilian territory (Bodu and Mevel, 2008; Bodu and Valentin, 1997; Naudinot et al., 2018, 2017a; Valentin, 2006; Fat Cheung et al., 2014; Mevel, 2013) with the exception of the Central and Eastern part of the Pyrenees (Fat Cheung, 2015, 2020; Fat Cheung et al., 2014). N. Naudinot and L. Mevel observed the use of soft stone percussion on anvil as backing technique for armatures production in Rocher de l'Impératrice (Naudinot et al., 2017a) and La Fru layer 2 aire 1 (Mevel et al., 2014), confirming the disappearance of retouchers made on bone or antler. This change is perfectly aligned with the general and progressive decrease of hard animal tissue exploitation between the Upper Magdalenian and the Early Azilian. Even knapping techniques attest the shift between an organic hammer to a mineral one giving way to a lithic production entirely managed by stone tools. Is this diffusion of standardised norms in armatures production representative of a more cultural homogeneity of the Early Azilian compared to other periods ? Or is the presence of different ethnic identities to be searched within other aspects of human groups daily life? This would be an interesting line of research that needs to be better examined in the future, especially if compared to the Late Azilian in which, as we will observe, the morphological and technological variability across space significantly increases.

1.3. Late Azilian (end of GI-1/beginning of GS-2)

The Allerød period coincides with other important variations in armatures production. Curved backed bipoints completely disappear and curved backed monopoints change in many technological and morphological aspects. In layer 3A of Pont d'Ambon they are obtained by heterogeneous and thick (interquartile range: 4-6 mm) blanks (elongated flakes or irregular lamino-lamellar blanks) and shaped out by an even more invasive backing process compared to the Early Azilian phase. If the selection of a large blank array provokes a decrease of the degree of standardisation in backed points size, their morphology is fairly homogeneous attesting to an almost unique type of gear: a curved-backed monopoints with an oblique retouched base. The retouching process occurs through two opposite sequences of deep and direct retouch: the first one from the apex towards the mesial portion, the second one from the base. A last sequence of inverse retouches is occasionally applied to thin the apex. The back delineation is curved and it follows the main dorsal ridge of the blank in the mesial and basal portion crossing it in the apical extremity for shaping the tip and thus strongly reducing the length of the original blank. Sometimes a *piquant trièdre* fracture on the apical portion was intentionally created and then resumed by retouching. The base is delineated by an oblique, deep and direct complementary retouch/truncation aimed at creating a sort of basal tang by removing the butt and bulb of the original blank. Also the proximal portion is occasionally removed by a controlled fracture. Curved backed points were hafted in a latero-distal position in order to play both a perforating and tearing/slashing function. These double purpose of lithic points, together with a curved back and crossed retouch used to thin apexes, represent the main elements of continuity between the Early and Late Azilian.

The normalisation of backed points through retouching rather than investing in blank standardisation results in a sharply increase of the use of soft stone percussion on anvil and a consequent decrease of pressure by soft stone. If during the Early Azilian the different thickness of blanks selected was managed by variating the mode of application of the force (percussion vs. pressure), in layer 3A is the anvil raw material to change (stone vs. organic). A stone anvil was used for reducing extremely thick blanks, thus exploiting the effect of the recoil. The use of an organic anvil, due to its superior capacity to absorb the percussion force, was used for reducing thinner blanks that rarely involve values lower than 3 mm.

Layer 3 of Pont d'Ambon coincides with the beginning of the Younger Dryas (actually radiocarbon dates cover a large span of time, approximately from 12700 to 10500 cal BP) and the appearance of a series of backed points produced by exploiting the entire length of regular bladelets. The exploitation of elongated flakes strongly decreases. The back is rectilinear or slightly curved and achieves totally or partially the main dorsal ridge. Two new morpho-types were identified: an elongated backed point with often a marginal complementary retouch opposite to the back (in two cases such a retouch is inverse and flat showing features strictly diagnostic of pressure with an organic tool) and a type of bipoint with a symmetric shape. Diagnostic impact fractures observed suggest an axial hafting modality of these backed points.

The opportunistic backed points production characteristic of the Late Azilian is pushed even further in layer 6 of Troubat due to the low quality and small dimension of the local raw material flaked (Fat Cheung, 2015). Blanks selected (thick and wide microbladelets, laminar flakes and flakes) are extremely irregular and the backing process poorly controlled resulting in a high morphological variability. The only elements that seem to drive the manufacturing process are a certain robustness in blank selection (3-4 mm), a strong length reduction compared to the original blank and the creation of a well-delineated tip by a curved back and a crossed retouch applied by soft stone percussion on anvil. However, although the main guidelines of the Late Azilian armatures production are documented, some features diverge compared to Pont d'Ambon: the backed points size are significantly smaller, curved backed monopoints are without a basal retouch (suggesting a more flexible hafting method) and Fusiform backed points are attested. This type is typical of the Pyrenean region and they have a symmetric shape with an apex and a base having an axial position compared to the morphological axis of the blank. The symmetry is given by both a slightly curved back and unretouched cutting edge or by an additional retouch phase (opposite to the backed retouch) in the basal, mesial and/or apical portion (i.e. deep complementary retouch or even a second total back). At a general level curved backed points and fusiform backed points should be considered as variants of the same idea of projectile point, with the latter being produced on wider and shorter blanks and the former on more elongated ones.

The analysis of Troubat and Pont d'Ambon thus allowed to highlight four main tendencies in armatures production during the Late Azilian:

- At a general level the Pyrenees and the Aquitaine Basin seem to respond to a same conceptual scheme involving poorly standardised blanks and an invasive backing process applied by soft stone percussion on anvil for the production of curved backed monopoints. Actually, this practice is well-known in the entire Western Atlantic area as already claimed by several Authors (Fat Cheung 2014; Fat Cheung et al. 2014; Naudinot, 2008; Naudinot et al., 2017b, 2019; Valentin 2006;).
- The second trend consists of a strong specificity of the Pyrenees region compared to the Late Azilian *sensu* Aquitaine Basin. In fact, the same backed points variability of Troubat layer 6 (i.e. curved backed points and fusiform backed points) was observed only in the other Pyrenean sites, such as Balma Margineda, Rhodes II, La Tourasse, Poeymaü and Mas d'Azil (Fat Cheung 2020, 2015, 2014; Barbaza 1996, 2009). On the other hand, the most attested morpho-type in Pont Ambon layer 3A (i.e. curved backed monopoint with an oblique retouched base, namely *Pointes à base rétrécie sensu* Célérier 1993b) is dominant also in several neighbouring sites, such as Abri Murat, Rochereil, Pégourié, Morin and Pagès (Fat Cheung, 2014; Fat Cheung et al., 2014), but it is lacking in the Pyrenees. Further north the layer 3 of Bois Ragot, next to a predominance of curved backed points with an unretouched base (*Pointe Azilienne banale sensu* Célérier 1993b), records only 20% of curved backed monopoint with an oblique retouched base (Valentin, 2006). Indeed, moving from the Aquitaine Basin this morpho-type seems to decrease (e.g., Chalognes, Naudinot, 2008; Closeau *phase tardive*, Bodu and Valentin, 1997) or even disappear (e.g., La Fru, Mevel et al., 2014; Rekem, De Bie and Caspar, 1996).
- In the entire Southwest French (Fat-Cheung et al., 2014), as well as in the Northwest

(Marchand et al., 2009; Naudinot, 2008, 2013), lateral projectile implements are absent (Fat-Cheung et al., 2014). Outside the examined area, and in particular in techno-complexes referred to the recent phase of the *Federmesser* (Allerød), the association between curved (sometimes rectilinear!) backed points and backed bladelets or backed truncated bladelets is well documented (Fig. 1.3). See as example the site of Saleux (Coudret and Fagnart, 2015, 2004), the upper levels of Hangest-sur-Somme III-1 (Coudret and Fagnart, 1997; Naudinot et al., 2019) and Marais de Conty (Coudret and Fagnart, 2012) in the Somme Valley, Cornet in Bretagna (Valentin et al., 2004), Closeau upper levels "*deuxième tendance*" in the Paris Basin (Bodu and Valentin, 1997) or even Rekem (De Bie and Caspar, 1996) in Belgium. Several backed bladelets are recorded also in the Western Alps (Mevel et al., 2014), Château-d'Œx (Swiss) (Crotti et al., 2016) and in the Rhineland (Germany) (Baales and Street, 1996), although in this latter case Authors affirmed that some of them might be medial fragments of broken backed points. The significance of this contraposition between a Western Late Azilian without lateral implements (Pyrenean, Aquitaine, Bretagne and Pays de la Loire) and an Eastern Late Azilian (Normandie, Paris Basin, Somme Valley, Western Alps) with lateral implements has never been properly discussed. Could it be related to a more intense social networks and interactions between Eastern Azilian groups and those belonging to the Late Epigravettian in which lateral inserts dominate armatures assemblages?

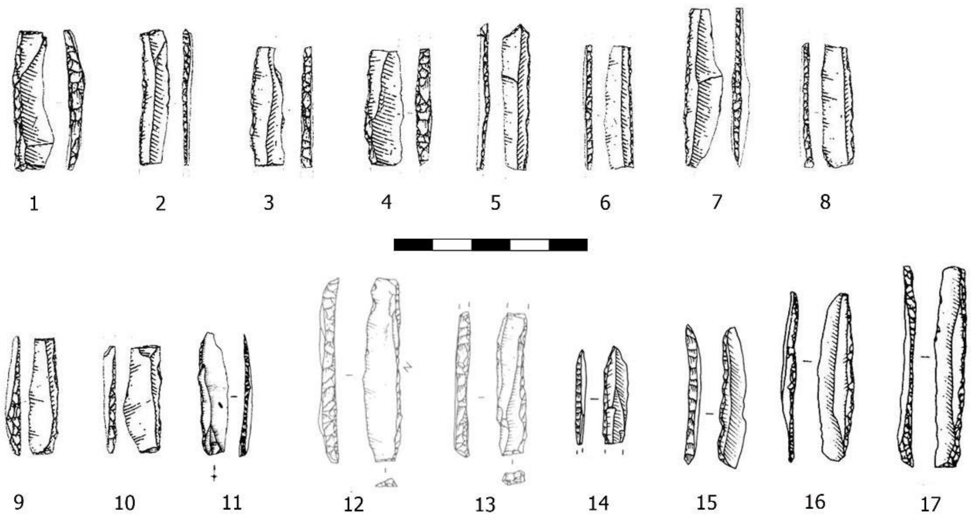


Figure 1.3 - Saleux (Naudinot et al., 2019); 11 Rekem (De Bie and Caspar, 1996); 12-13 Closeau upper levels (Bodu and Valentin, 1997), 14-15 Cornet (Valentin et al., 2004); 16-17 Hangest-sur-Somme III.1 lower levels (Naudinot et al. 2019).

- Finally, the study of the layer 3 of Pont d'Ambon allowed identifying an anecdote Late Azilian phase probably referred to the first part of the Younger Dryas. It is characterised by a backed points assemblage that seems to partially anticipate features normally observed starting from the Early Laborian: the appearance of some elongated rectilinear backed points produced on more regular blanks and, albeit occasionally, the return of a pressure applied by an organic retoucher. Should this phase be considered as an intermediate step towards the "Laborianization" of lithic armatures or does it represent an independent phase that is currently poorly known? What is most intriguing of these elongated backed points is the sporadic use of an inverse and flat complementary retouch to modify the base or the cutting edge. To the best of our knowledge this practice has never been mentioned by studies focused on the Late Azilian, while it is a key element of armatures belonging to the Epigravettian. In future research would be interesting to verify if differences between layer 3A and 3 of Pont d'Ambon are confirmed also by debitage objectives and reduction schemes.

1.4. Early Laborian (GS-2)

The beginning of the Early Laborian represents the third major break in the Late Glacial sequence of the South-Western France. The projectile weapon is conceived as a composite tip formed by the association between an apical backed truncated point (*Malaurie* point) and one or more lateral rows of backed bi-truncated bladelets (*rectangles*) hafted with a parallel position to the shaft. With respect to the Late Azilian, in which the technological behaviour was essentially aimed to simplify and speed up the production process, Early Laborian armatures attest to a remarkable technical effort in terms of time and accuracy in both blanks production and shaping. Armatures from layer 2 of Pont d'Ambon are manufactured from highly sophisticated full debitage blades and bladelets, which are characterised by a straight profile, a calibrated thickness (3-5 mm) and a rather variable width. The deepness of the backing process is strictly related to the achievement of a specific width class (9-10 mm). It varies from marginal, direct and semi-abrupt to deep, direct and abrupt, even if the latter rarely reaches half of the original blank width. Inverse backed retouches are used exclusively in *Malaurie* points with a thickness ≥ 3 mm and they are located where the back overpass the main dorsal ridges to point the apex. Delineation of the back and the cutting edge as well as the apex position according to the morphological axis of the blank define two main morpho-types of *Malaurie* points: axial *Malaurie* points and déjeté *Malaurie* points. The apex position can be either proximal or distal and the truncation has a transverse orientation. Backed bi-truncated bladelets have almost systematically a rectilinear back and two transverse truncations. A few single backed truncated bladelets were also identified. The functional edge is never modified by complementary retouches. Both *Maluarie* points and rectangles have an extremely normalised width and thickness, while length remains variable. This variability can be explained, at least partially, by a strong recycling process that affects armatures length following three different modalities:

- re-shaping of fractured backed bi-truncated bladelets
- re-shaping of apical fragments into complete *Malaurie* points
- re-shaping of basal fragments of *Malaurie* points into backed bi-truncated bladelets

Even the backing techniques adopted radically change compared to the previous phase: pressure by an organic tool returns to be used as an independent technique for the application of a marginal backed retouch and in combination with soft stone percussion on anvil for deeper retouch. In this last case the pressure technique was employed mostly in the final reduction stage in order to regulate and standardise the armature shape.

Although publications presenting detailed data about manufacture modalities of Early Laborian armatures are still missing, backed bi-truncated bladelets and *Malaurie* points have always been described as produced on regular blades or small blades by a rectilinear or slightly curved back with no preferential back lateralization as well as apex orientation. Truncations are almost systematically transverse (Langlais et al., 2014a, 2014b, 2015; Naudinot, 2013, 2010, 2008; Naudinot and Jacquier, 2014). All these features are perfectly consistent with Late Laborian armatures from Pont d'Ambon. Furthermore, even if M. Langlais et al. (2020) pointed out differences in blank dimensions and accuracy in the shaping phase from one site to another, variability of thickness and width of at least three Southwestern sites (La Borie del Rey, Camping-du-Saut and Peyrazet) yielded the same values of those of Pont d'Ambon. Length is always highly flexible. For the time being any other information regarding backing techniques is available.

Another important common aspect between armatures from layer 2 of Pont d'Ambon and those from other sites is the recycling of projectile implements. Re-using of fractured *Malaurie* points as *rectangles* has already been proposed by M. Langlais (Langlais, 2007 p. 393; Langlais et al., 2015, 2014b, 2014a), but thanks to our analysis we demonstrated that this recycling process was even more complex. Actually, this technical behaviour is likely connected to the way armatures and therefore arrowheads/javelin are conceived. Both *Malaurie* points and backed bi-truncated elements are characterised by a similar morphology and size that allow not only to easily re-shape artefacts after a major breakage, but also to interchange their role on the shaft. It is a highly effective strategy in economic terms avoiding to restart the production process after few uses. This is very advantageous considering the high technical effort required to produce blanks as well as armatures themselves. This aspect becomes even more interesting if it is related to the general development of an important maintenance and recycling systems of domestic tools (Langlais et al., 2020; Naudinot and Jacquier, 2014, 2015), as well as to an increase of long-distance hunting parties and a general change of mobility patterns based on an intense raw material circulation and spatio-temporal segmentation of activities (Naudinot, 2013, 2010; Naudinot and Jacquier, 2014, 2015; Naudinot et al., 2019; Valentin, 2008). Recycling of those backed truncated fragments that - from a merely morphological viewpoint - do not present any difference compared to complete backed bi-truncated bladelets must be considered, too. In fact, a snap bending fracture is a perfect truncation.

Table 1.1 **-** Main trends of armatures production along Late Glacial in South-Western France. Tr. = Troubat; P d’A. = Pont d’Ambon.

		Upper Magdalenian	**Early Azilian**	**Late Azilian**			**Early Laborian**
		Tr. layer 10-7	P. d’A. layer 3B	P. d’A. layer 3A	P. d’A. layer 3	Tr. layer 6	P. d’A. layer 2
Blank selection	*Blank category*	Microbladelets	Blades and bladelets (i.e. small blades)	Blade, bladelets and elongated flakes	Microbladelets, Bladelets, blades	Microbladelets, elongated flakes, flakes	Bladelets and blades
	Blank morphometric features	Narrow and thin	Wide and thick	Wide and thick	Wide and thick	Wide and thick	Wide and thick
	Regularity	Regular		Irregular	Regular and Irregular	Irregular	Regular
Backing	*Relation between back and main dorsal ridge*	Before the main dorsal ridge		Before the main dorsal ridge	Variable	Before the main dorsal ridge	Before the main dorsal ridge
	Invasiveness	Low	High				High or low according to blank width
	Back delineation	Rectilinear	Curved	Curved	Curved or rectilinear	Curved	Rectilinear
	Backed retouch extent, position and angle	Marginal direct semi-abrupt	Deep direct or crossed abrupt	Deep direct or crossed abrupt	Deep direct or crossed abrupt	Deep direct or crossed abrupt	From marginal, direct and semi-abrupt to deep, direct or crossed and abrupt
	Apex orientation	-	Distal and proximal	Distal	Distal	Distal	Distal and proximal
Finalisation	*Complementary retouches localization*	All along the edge	-	Basal	Basal or apical	Basal, mesial and/or apical	-
	Complementary retouches extent and position	Marginal direct semi-abrupt	-	Deep, direct and abrupt	From marginal direct semi-abrupt to inverse and flat	Deep, direct and abrupt	-
	Truncations	Marginal and direct	-	Deep, direct and abrupt	Deep, direct and abrupt	-	From marginal, direct and semi-abrupt to deep, direct and abrupt
Main objectives		- Backed bladelets - Backed truncated bladelets - Isosceles triangles	-Curved backed bipoints -Curved back monopoints	Curved-backed monopoints with retouched base	- Curved-backed monopoints with retouched base - Rectilinear backed points - Curved backed bipoints	- Fusiform backed points - Curved backed points	- Backed truncated points - Backed bi-truncated bladelets
Size in mm (interquartile range)		10-24x2-6x1-2	41-49x9-11x3-4	35-45x11-13x4-6	35-42x9-10x4-6	21-28x7-10x3-4	MP: 33-45x9-10x3-5 R: 21-32x9-11x3x4
Resumed pieces		Low frequency		High frequency due to fractures originate by the backing process	Low frequency	Low frequency	High frequency due to re-using and maintenance phases

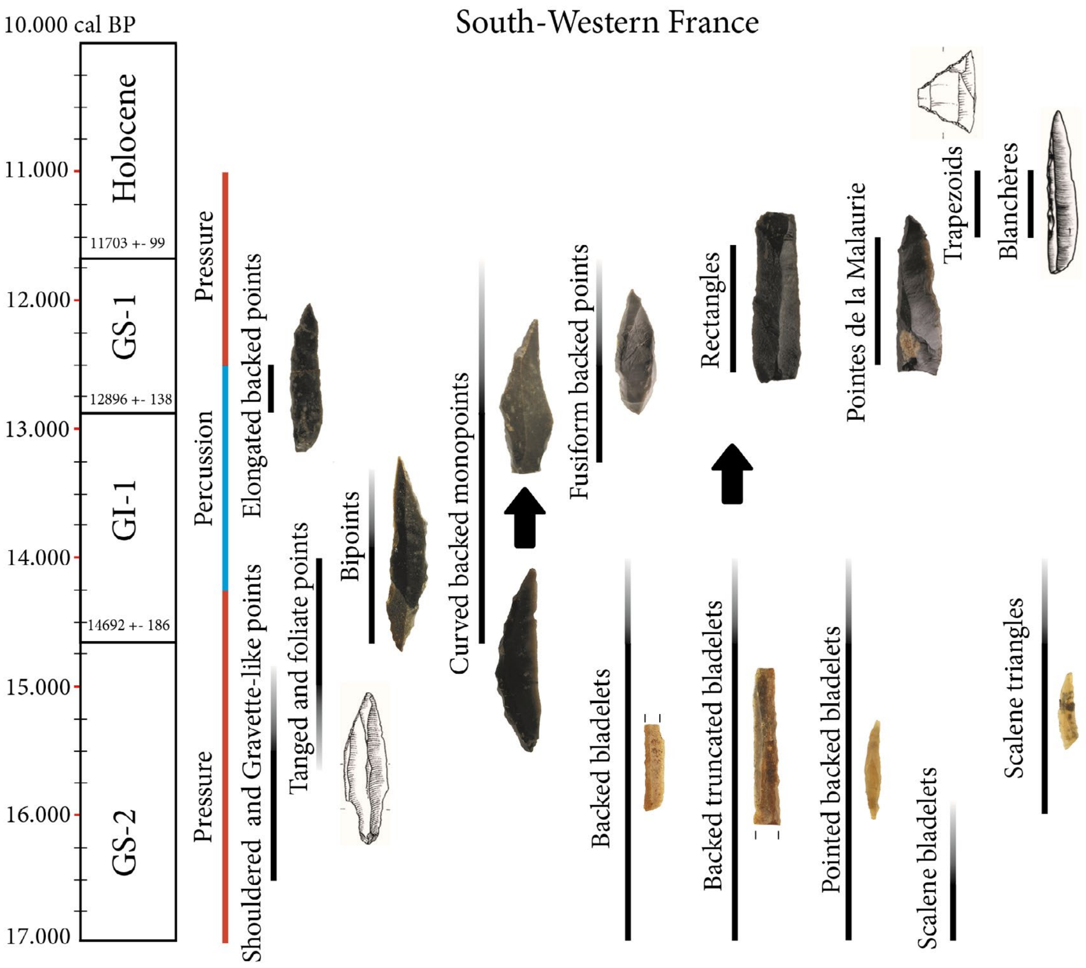


Figure 1.4 - Armatures development and backing techniques variations in South-Western Frace throughout the Late Glacial and the Early Holocene.

Chapter 2 – Changes within continuity: armatures production between the Late Epigravettian and the Sauveterrian

2.1. The Late Epigravettian at the end of the GS-2 (ER 1)

During the ancient phase of Riparo Tagliente the aim of the production process focuses on the exclusive search of narrow (interquartile range: 4-7 mm), thin (Interquartile range: 1-3 mm) and standardised elongated backed points (cf. *Microgravettes*), few shouldered points and backed bladelets hafted laterally on the shaft. These projectile implements are manufactured on homogeneous and rectilinear microbladelets (length ≤ 35 mm), rarely bladelets (length 36-59 mm), characterised by a calibrated thickness and regular edges. Remarkably high is the percentage of hinged lamino/lamellar blanks used (35%) for the production of backed bladelets.

The backed retouch is rectilinear and performed by deep, direct and abrupt retouches located over or adjacent to the main dorsal ridge of the blank. In accordance with the low thickness values of selected blanks (< 4 mm) armatures are rarely shaped by a crossed retouch. The backing process firstly occurs by shaping the distal extremity (with an apex in case of backed points) and then by retouching progressively the blank along its longitudinal axis by one single sequence of direct retouches. The cutting edge tends to be slightly convex and it is sometimes modified by direct and semi-abrupt or inverse and flat complementary retouches to better delineate the apex or more rarely the base. Backed truncated points are rare and the basal truncation - when it is present - is aimed at resuming previous fractures.

Backed truncated bladelets are sporadically attested and seem to represent an occasional morphology which is often the result of a recycling process as suggested by the high frequency of resumed fractures on this type of gear. Truncations are single (hardly ever double) and with a variable orientation. Truncations might also be the result of a circumstantial practice aimed at adapting the backed bladelet length in case of the replacement of a broken element on the shaft.

The retouch technique mostly adopted is the pressure, applied by both an organic (less frequent) and a stone compressor (more frequent), for the entire manufacturing process. High magnification analysis argued in favour of an organic compressor made of antler. Soft stone percussion on an organic anvil is occasionally documented.

In Northern Italy this first phase of the Late Epigravettian is poorly documented and the oldest layers (17-11) of Riparo Tagliente are the only evidence attested so far. Archaeological sites having yielded Epigravettian evidence dated to the same period can be found in the Balkans and Central and Southern Italy. During this span of time the eastern Adriatic coast shows a completely different situation with the transition from an Epigravettian with shouldered points (Early Epigravettian) to an Epigravettian with curved backed points (Late Epigravettian) (Kozlowski, 1999; Montet-White and Kozlowski, 1983; Vukosavljević et al., 2011). At the same time, the Italian peninsula undergoes a phenomenon of regionalization (Martini, 2007; Palma di Cesnola, 1983). Sites of Southern Italy dated to this period usually come from old field research and usually only typological data are available. By the way a certain similarity in backed points and backed bladelets production has been observed (e.g., frequency index, morphological standardisation, low thickness of selected blank and straight-backed retouch) (Martini et al., 2007, 2002; Palma di Cesnola, 2007; Palma di Cesnola et al., 1983; Ricci et al., 2019). Backed truncated bladelets, sometimes even with double symmetric truncations are attested almost exclusively in Puglia (Paglicci layer 7-5, Le Mura layer F-D; Palma di Cesnola, 1993) along with some crescents and triangles. Moving to central Italy, the Tuscan site of Grotta delle Settecannelle (Viterbo) dated to the transition between the Older Dryas and the Bølling (layer 10) shows an armature assemblage composed of backed points and backed bladelets. Backed truncated bladelets are almost absent (Ucelli Gnesutta et al., 2006). In the Marche, the open-air site of Baracche (date) yielded only one *Microgravette* (Peresani et al., 2005). The only information regarding backing techniques referred to this period come from the site of Grotta del Pozzo (Aquila, Italy), dated to the Early Epigravettian and to the first phase of Late Epigravettian (GS-2 / GI-1 transition). As seen for Riparo Tagliente, Authors (Mussi et al., 2008) have highlighted the use of pressure technique for the production of *Gravettes and Microgravettes*.

2.2. The Late Epigravettian during the first part of GI-1 (ER 2)

The upper layer of Riparo Tagliente (layers 10-4) marks an important transformation in lithic armatures at the transition between the final phase of GS-2 and the first half of GI-1. As far as backed points are concerned, the technological analysis highlights the occurrence of important changes involving all the three steps of the manufacturing process (i.e. blanks selection, backed retouch and finalisation) resulting in a "new" backed point type ("wide backed points", type A and B) which develops next to the more traditional Epigravettian-like *Microgravettes* ("elongated backed points"). Wide backed points are more robust and larger and with a width-length ratio lower than 1:5. The B type (the most attested one; Fig. 1.2 B) is generally obtained from heterogeneous blanks, mostly thick, elongated flakes or irregular lamino-lamellar blanks. Shouldered points are no longer manufactured, while few large crescents appear (Fig. 1.2 F).

The progressive increase of thick and width of blanks selected causes an adaptation of the retouch methods (Fasser et al., 2022):

- backed points start to be normalised by a higher technical investment in their façonnage phase, thus there is a greater size difference between the finished artefact and the original blank. Furthermore, "wide backed points" from layer 7-4 have often a fracture resumed by an inverse abrupt or semi-abrupt complementary retouch which may indi-

cate an intentional reduction of the blank through fracturing
- the backed retouch becomes more often curved and applied by crossed retouches
- apexes are sometimes formed by a back that crosses the main dorsal ridge
- the basal portion is frequently modified by either a complementary retouch or transverse and convex truncations (c.f. "wide backed truncated points")
- proximal backed points increase starting from layer 7-4

Also the modalities of application of retouch (i.e. retouch sequences) become more variable: the backed retouch occurs no longer just by one single sequence of removal (as in layer 17-11), but also by two independent sequences (the first one from one extremity encompassing the distal half, the second one from the other one) or even by several chaotic sequences.

The uppermost layers of Riparo Tagliente (layers 6 to 4) mark also the beginning of a progressive standardisation of backed truncated bladelets that deeply affect blank selection, retouch methods and shape. Starting from the underlying layers this type of gear becomes more common and normalised both from a dimensional (thickness and width, while length remains flexible being manufactured on both microbladelets and bladelets) and morphological viewpoint (rectilinear profile and double truncation). However, truncation orientation remains variable, designing more frequently an asymmetric shape. Some of them are even inverse and flat. Also for these items an intentional fracturing to shorten blanks has been proposed. By contrast, backed bladelets do not record major changes, besides a slight increase of width and thickness.

The change in blanks selection and retouch intensity involves an adaptation of backing techniques: the two pressure techniques decrease significantly, whereas percussion on anvil increases becoming the main technique applied by the Late Epigravettian groups of Riparo Tagliente. Complementary retouches, especially those with a flat and semi-abrupt angle continue to be applied through pressure.

Considering the surrounding area, variations identified at Riparo Tagliente seem to be partially confirmed by other Venetian-Friulian pre-Alpine sites. At Grotta del Clusantin, dated to the Bølling, backed points are produced from regular blanks with an even thickness (Duches and Peresani, 2010), whereas at Val Lastari (Allerød) and Villabruna A (end of Bølling-beginning of Allerød) backed points are manufactured from a larger blank array that involves higher thickness values following the trend recorded in Riparo Tagliente (Montoya, 2004). Observing the drawings of armatures at Riparo Battaglia (Broglio 1964) , a certain variability in backed points production can be envisaged too.

All these sites yielded backed bladelets and backed truncated bladelets, but the latter have a double symmetric truncation and a fairly normalised morphology only in the undated uppermost layers of Villabruna A and in Val Lastari, confirming the progressive standardisation of this type of item throughout the interstadial. This trend is verified also in the Marche region where the only known site (Grotta della Ferrovia, Esino Valley) dated to the beginning of the Allerød yields an important assemblage of backed truncated bladelets with both single and double truncations (Broglio and Lollini, 1981; Peresani and Silvestrini, 2007). This type of gear plays an important role also in the rest of the Adriatic area, e.g. Paglicci layer 4-2 (Puglia) (Palma di Cesnola et al., 1983; Palma di Cesnola, 2007) and Grotta della Continenza (Fucino Basin) where it appears starting from layer 38, therefore after 14000 cal BP (EP2 units 40-35) (Boschian et al., 2017). On the Tyrrhenian coast, backed truncated bladelets are poorly documented (Martini et al. 2007; Tozzi and Dini, 2007).

Typological studies conducted on the sites from Central and Southern Italy do not allow to evaluate changes in backed points production compared to the previous phase, besides the appearance of some double backed points in the Tyrrhenian coast (Tozzi and Dini, 2007) and of *Microgravettes* with an oblique basal truncation in the Marche region (Peresani and Silvestrini 2007). Any information concerning retouch methods and blank selection is available.

The change from a pressure retouch technique to a percussion one at the transition between the end of the GS-2 and the GI-1 observed in Riparo Tagliente is confirmed by the studies of C. Montoya in the Venetian sites of Villabruna A and Val Lastari (Montoya, 2004).

As already mentioned, starting from the last part of GS-2 (around 17000-15000 cal BP), the Balkans attest the spread, along with the traditional Epigravettian *Microgravettes* and backed bladelets, of crescents and curved backed points (often called Azilian Points) (e.g., Kopacina Cave, Sandalja II, Badanj) (Montet-White and Kozlowski, 1983, Kowlowski, 1999; Vukosavljević et al., 2011; Borić et al. 2021). Some of these items have morphological and technological similarities with those of the recent phase of Riparo Tagliente (Fig. 2.1) and also in this case the high variability in backed points production seems to be related to a loss of homogeneity and regularity in blanks selection. Such evidence may suggest a diffusion of thick and wide curved backed points from the Balkans towards west.

A similar trend can be detected in the sites of South-Eastern France dated to the Allerød and originally referred to the "Valorguien" by Escalon de Fonton (1972) but successively attributed by C. Montoya (2002, 2004) to the Late Epigravettian. As at Riparo Tagliente, these assemblages present in association with Microgravettes ("elongated backed points" at Riparo Tagliente) a wider and thicker type (*Pointe d'Istres*) characterised by a slightly curved back and a more symmetric shape (Escalon de Fonton 1972; Onoratini, 1982). From a morphological viewpoint some *Pointes d'Istres* resemble "wide backed points"of Riparo Tagliente-. Even the variant called by Escalon de Fonton (1972) *Pointe d'Istres à base arrondie* is similar to "wide backed truncated points" Type B with a convex basal truncation. According to C. Montoya (2002), Microgravettes and Pointes d'Istres correspond to the same idea of backed point, with the latter being produced on less standardised and irregular blanks.

2.3. The Late Epigravettian at the transition between the end of GI-1 and GS2 (ER 3)

The morphological heterogeneity in backed points production is still present in Riparo Biarzo (UD) where the two main morpho-types identified in the recent phase of Riparo Tagliente (Elongated backed points Type A and Wide backed points Type A and B) are documented with

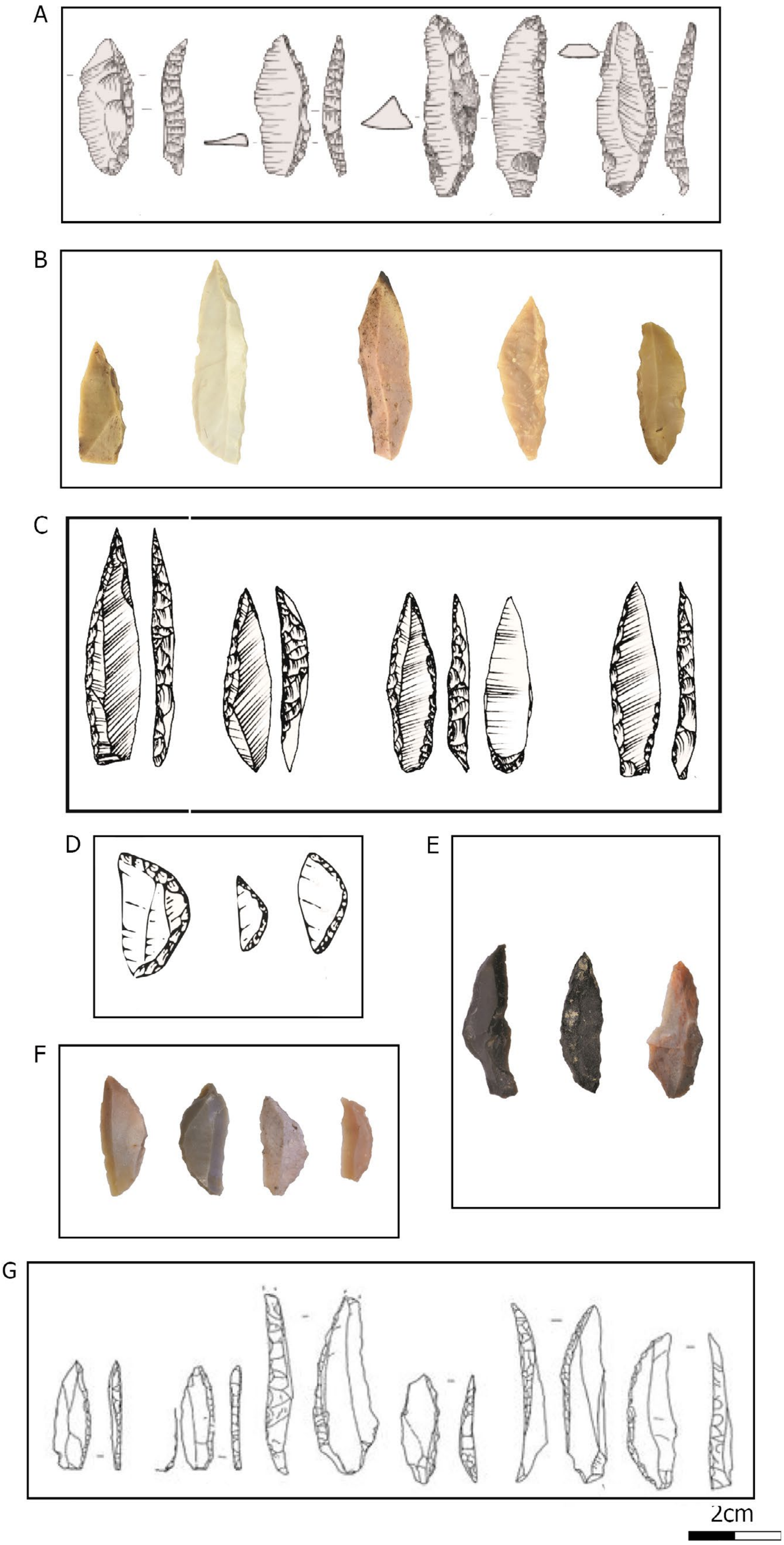


Figure 2.1 - A: Curved backed points from Kopcina Cave (Vukosavljević et al., 2011); B: Wide backed points Type B from the recent phase of Riparo Tagliente; C: *Pointe d'Istres* (Escalon de Fonton, 1972); D: Crescents from Badanj (Montet-White and Kozlowski, 1983); E: Wide backed points from Riparo Biarzo; F: Crescents from the recent phase of Riparo Tagliente (layer 10). G: Curved backed points from Badanj (Boric et al., 2021).

similar frequencies. However, backed points are shorter (< 37 mm) due to minor exploitation of bladelets and elongated flakes. This aspect must be connected to the size of flint cobbles available in the surrounded area (Fasser et al., 2020). Backed points width (Interquartile range: 5-7 mm) and thickness (Interquartile range: 2-4 mm) remain stable.

The backing process is applied by deep and abrupt retouches both direct and crossed aimed at delineating a rectilinear ("elongated backed points" Type A) or curved back ("wide backed points"). The use of a crossed retouch is strictly connected to a back with a thickness ≥ 3 mm and inverse detachments are generally located in the mesial or basal portion when the back is positioned over the point of maximum transverse thickness. The aim is to regulate the back delineation and to reduce thickness. Backed points orientation follows the morphological axis of the blank. The use of complementary retouches is less intense compared to Riparo Tagliente probably due to the smaller size of the blanks selected. They are marginal, direct and semi-abrupt or inverse and flat and equally used to thin the apex or the base. Occasionally, in wide backed points the back removes the proximal extremity through a sort of convex truncation. The appearance of two new morphologies in North-Eastern Italy during the Younger Dryas (e.g., Riparo Soman, Riparo la Cogola, Bus de la Lum), namely bi-truncations (n=2) an "elongated backed points" (cf. Microgravettes) with a basal oblique or transverse truncation (n=2) (Fig. 2.4 d) should also be noted. Two double backed points are also attested.

The main difference with the previous period concerns the production of backed truncated bladelets. Those from Riparo Biarzo represent a further evolutionary step within the process of standardisation of this type of gear throughout the interstadial:

- they become the most produced type of item among armatures
- they are manufactured exclusively on full debitage and regular microbladelets with a profile almost systematically rectilinear, a calibrate thickness and a width than does not overpass 12 mm
- their size (length; width; thickness) decreases compared to the previous phase
- their morphology becomes strongly normalised, the back is rectilinear as well as the cutting edge, which is frequently modified by marginal complementary retouches, and truncations are double forming an obtuse angle with respect to the back (c.f. segmenti trapezoidali/trapezoidal segments, sensu Bagolini and Guerreschi 1978).

On the other hand, backed bladelets almost disappear.

The retouch sequences adopted still vary depending on blank morphology. Narrow blanks are modified by one single sequence of removals, whereas wider blanks (selected for backed points production) are transformed by several unidirectional or bidirectional sequences. As far as retouch techniques are concerned, soft stone percussion on an organic anvil remains the most applied, reaching a percentage of around 65%. The pressure technique is applied almost exclusively using a stone retoucher.

Riparo Soman records several changes compared to both the recent phase of Riparo Tagliente and Riparo Biarzo. The most evident one concerns backed points production. Wide backed points Type B produced on irregular and thick elongated flakes or wide bladelets are nearly absent as well as backs with a curved delineation. Blank selection focuses on thin (1-3 mm) and regular full debitage microbladelets with variable width (7-15 mm) and a relatively plain cross-section and bladelets with an elongated shape (width varies between 9 mm and 16 mm and thick between 2 mm and 4 mm). The former is mainly used to produce "wide backed points" Type A and "elongated backed points" Type A, and the latter to manufacture "elongated backed points" Type B. This latter achieves 20% of the assemblage. A similar percentage is documented only during the ancient phase of Riparo Tagliente. Back delineation returns to be rectilinear or at least slightly convex. The backed retouch is deep, direct and abrupt or deep, crossed and abrupt according to blank thickness and generally it stops before or in correspondence with the mid portion of the original blank. Butts are removed by the backing process, basal inverse and flat complementary retouches or truncations. The latter can be rectilinear and transverse or oblique forming an obtuse angle with respect to the back. Backed truncated points are 1/3 of the entire complete backed points assemblage reaching the higher percentage of the entire Late Epigravettian sequence analysed. At a general level, there is a return to a higher investment in blanks standardisation resulting in low values of Standard Deviation of backed points dimension and a lower retouch intensity.

Backed truncated bladelets do not change particularly compared to Riparo Biarzo. They are almost exclusively manufactured on regular, thin and narrow microbladelets and the reduction process has the clear purpose of normalising their size. However, truncations can be both obtuse like those of Riparo Biarzo or more variable. As to Riparo Biarzo backed bladelets are almost absent and geometrics and microburins are probably the result of mixing processes with the uppermost Sauveterrian layers. Five bi-truncations (trapezoids) are documented.

The exploitation of narrow and thin blanks and a backing process not particularly invasive influences both the number of retouch sequences and the retouch techniques adopted: backs are more frequently delineated by one single retouch sequence applied using pressure with an organic tool. Percussion technique is mainly used for shaping backed points because of their higher thickness.

Most of the studies conducted on sites of North-Eastern Italy dated to the ER3 seem to comply with variations in armatures production observed between Riparo Biarzo (end of GI-1) and Riparo Soman (GS-2). For example Layers 26c, 26b/14b and 15/65 of Riparo Dalmeri (TN) dated between 13,400 and 12,900 cal BP (Dalmeri et al., 2006) document the presence of three main backed point categories (bp1, bp2 and bp3). These morpho-types recall those proposed for the recent phase of Riparo Tagliente and Riparo Biarzo: bp1 and bp2 have strong similarities with "elongated backed points" type A and B respectively, whereas bp3 could be correlated to the "wide backed points", attesting a certain homogeneity in backed points production over the B-A interstadial (Duches et al., 2018). The same goes for the backed truncated bladelets that are perfectly comparable with those from Riparo Biarzo (strong standardisation, generally double obtuse truncations, rectilinear back, use of complementary retouch to regularise the delineation of the cutting edge) confirming the important diffusion of this type of gear (c.f. *segmento trapezoidale*) in North-Eastern Italy starting from the second half of GI-1. Even the backing technique adopted is consistent with results obtained at Riparo Biarzo: according to R. Duches and colleagues (2018) stone percussion on anvil was chosen more frequently than pressure.

By contrast, among sites dated to the Younger Dryas, such as Bus de la Lum (Peresani et al., 2000), Riparo Cogola SU 19 (Cusitano et al., 2004), Palù Echen (Duches et al., 2014) and Le Regole 1 and 2 (Basetti et al., 2009) wide and thick backed points manufactured on less standardised and thicker bladelets or elongated flakes ("wide backed point" type B) are not documented as observed at Riparo Soman. Backed points tend to be short (20-30 mm) and narrow, attesting a progressive backed points microlithization (Bassetti et al., 2009). Furthermore, a good amount of backed truncated points similar to those of Riparo Soman is attested (Fig. 2.3). Also in these sites normalised backed bi-truncated bladelets with a double obtuse or transverse truncations replace backed bladelets (Bassetti et al 2009; Cusinato et al., 2004; Peresani et al., 2000; Ziggiotti and Dalmeri, 2008).

A similar armatures assemblage can be detected in two sites from the Marche region: Cava Romita and Grotta del Prete. The former is dated to the Younger Dryas while the latter is undated, but the higher number of backed truncated bladelets compared to backed points tilts towards a chronology encompassing the end of Allerød and/or the Younger Dryas. In Cava Romita armatures are produced on standardised microbladelets. D. Esu and colleagues (2006) describe backed points as narrow (3-5 mm) and short (15-25 mm) with a rectilinear or slightly convex back. Proximal portions sometimes have a basal truncation (Fig. 2.3 f). Backed bi-truncated bladelets are perfectly comparable with those of the Veneto-Trentino-Friulan area from a dimensional and morphological perspective (double symmetric truncation; Fig. 2.2). As in Riparo Soman few pieces have both extremities modified by an inverse and flat retouch (Fig. 2.2 the third one from the left). In Grotta del Prete A. Broglio and colleagues (Broglio et al., 2005) mentioned 3 trapezoids drawing another important connection between the North-Eastern Italy and the Marche region.

Since the Late Gravettian and until the beginning of the Late Epigravettian this two areas appear directly linked as it is attested by the discovery in several Venetian sites (Grotta Paina, Grotta Trene and Riparo Tagliente ancient phase) of chert from the Umbria-Marches Apennines (Bertola et al., 2018). This raw material exchange seems to stop at the beginning of the Bølling-Allerød Interstadial (Bertola et al., 2018). The rapid diffusion of the forest in the Po Plain documented after 14.500 cal BP has been interpreted as the main cause of the reduction of cherts circulation and therefore of the mobility/exchange system between these areas (Bertola et al., 2018). Nevertheless, the sharing of the same hunting equipment and therefore of the same design of arrowhead during the Allerød and the Younger Dryas demonstrates that the change in vegetation cover did not prevent intense social networks and interactions between groups.

As regards armatures from the sites dated to the transition between the end of the Allerød phase and the Younger Dryas in North-Western Italy and South-Eastern France, a completely different situation can be highlighted compared to North-Eastern Italy:

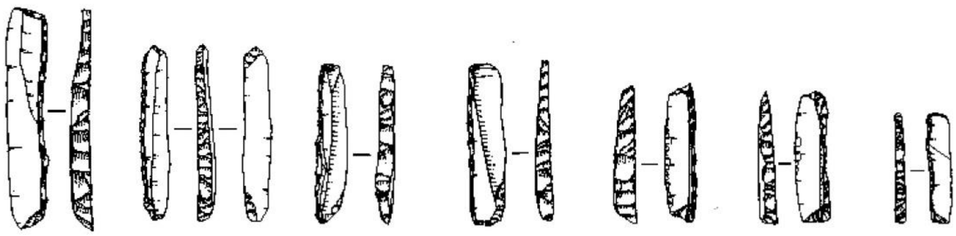


Figure 2.2 – Backed truncated bladelets from Cava Romina (Marche). From Esu et al., (2006) modified.

- Backed points are entirely referred to *Microgravettes* and produced on regular elongated blanks through a rectilinear back applied by direct and abrupt retouches. Curved or slightly curved backed points manufactured on irregular and thick blanks are absent, attesting their disappearance before the end of the Allerød (Montoya, 2002; Tomasso, 2016). Backed truncated points are rarely mentioned (Bartolomei et al., 1979).
- The important spread of backed bi-truncated bladelets attested in North-Eastern Italy is not reflected in the western sites (Montoya 2004; Tomasso 2014, 2016; Mevel et al. 2014; Fornage-Bontemps 2013), although some specimens are reported in Arma dello Sefanin (V-IV), Arma di Nasino (XIII-XI) and Arene Candide (CIII-I) in Liguria or in Greppi Cupi II, La Greppia, Riparo del Fredian and Riparo delle Campane in Northern Tuscany (Tozzi and Dini, 2007).
- Backed bladelets present a discontinuous distribution. They are highly attested in Saint-Antoine-Vitrolles locus 1 and 2 (Montoya, 2002) and Rochedane layer A4 (Fornage-Bontemps, 2013), whereas they are rare in the hunting equipment of the sites located on the coast of the Ligure Provençal Arc (Palma di Cesnola 1983 ; Tomasso, 2014) and in Northern Tuscany (Tozzi and Dini, 2007).
- Geometrics (manly isosceles triangles) produced using the microburin blow technique reached high percentages at the end of the Allerød in the Ligure-Provençal arc (e.g. 36% in Grotta dei Fanciulli layer 1 and in 21% Riparo Mochi layer A) (Tomasso, 2014, 2016), while they are extremely rare in Northern Tuscany (Dini and Sagramoni, 2006; Dini and Tozzi, 2005; Tomasso, 2014; Tozzi and Dini, 2007) and absent north of Durance River (Saint-Antoine-Vitrolles, Mannlefelsen I layer R and Rochedane layer A4).
- Trapezoids are only rarely recorded (Bartolomei et al., 1979; Palma di Cesnola; 1983; Tozzi and Dini, 2007).

This variability was generally interpreted as a different adaptation to the local environment (Palma di Cesnola, 1993). Since the faunal spectrum (Sala, 2007 in martini 2007) and environmental data (Finsinger et al., 2011; Ravazzi et al., 2007; Vescovi et al., 2007) indicate a similar trend south of the Alps, this regionalization process during Late Epigravettian of Northern Italy and South-Eastern France may be ascribed to a more cultural factor and thus to different regional identities within the same cultural facies, confirming the role of armatures as indicators of ethnic groups (Cattelain, 2004, 1997, 1994; Churchill, 1993; Ellis, 1997; Gendel, 1988; Lemonnier, 1987; Pétrequin and Pétrequin, 1990; Wiessner, 1983).

This morpho-typological variability across space does not reflect a difference in backing techniques. Actually the latter seem to vary in the same way and with the same rhythm in Northern Italy and South-Eastern France. As a matter of fact, at all western sites referred to the end of the GI-1 (Riparo Mochi layer A, Grotta dei Fanciulli layer 1, Pié Lombard Unit A and Monte Frignone II) soft stone percussion on anvil was the main backing technique applied (Tomasso, 2014, 2016), whereas the beginning of the Younger Dryas (Saint Antoine-Vitrolles and Isola Santa layer 5) coincides with a major exploitation of pressure technique. Unfortunately, any information concerning the nature of the compressor is mentioned (Montoya, 2002; Tomasso, 2016).

In Southern Italy this process of regionalization is even more marked (Martini et al., 2007; Palma di Cesnola, 1993; Palma di Cesnola, 2007). Along the southern Tyrrhenian coast during the Allerød period F. Martini et al. (2007) pointed out a more diffused presence of backed truncated bladelets, although never overpassing 10%-20% of the entire armatures assemblage (the only exception is Grotta della Serratura Layer 8E). Geometrics are rare and backed points are shorter than 30 mm. Several double backed points are mentioned. Backed truncated bladelets continue to assume an important role in the Southern Adriatic coast (e.g., Grotta Romanelli layer E, D and C; Palma di Cesnola, 2007).

2.4. Terminal Epigravettian

Any of the armatures assemblages analysed in this Ph.D. covers the span of time between the end of the Younger Dryas and the beginning of the Preboreal. Thus, we briefly re-propose the main traits of the Terminal Epigravettian that were presented in Chapter 2 Part 1.

Concerning Northern Italy and South-Eastern France, backed points decrease in number and undergo a clear process of microlitization already started during the previous phase. The back retouch is rectilinear, poorly invasive and applied by direct and abrupt retouches (Basetti et al., 2009; Binder, 1980; Cusinato et al., 2004; Peresani et al., 2011; Tomasso, 2014). Backed truncated bladelets and bi-truncations continue to be attested in North-Eastern Italy (e.g. La Cogola layer 18 and Palughetto), whereas they are missing in the Western area where backed bladelets were highly produced (e.g., Abri Martin). During this transitional phase all along the Italian peninsula and in the South-Eastern France several sites (e.g., La Cogola layer 18, Palughetto, Andalo, Greppi Cupi I, Grotta Continenza layer 34-30, Grotta Romanelli layer A-B, Abri Martin layer 2-3, etc.) know an increase of both geometrics (crescents and isosceles triangles) and microburins (Bassetti et al., 2009; Binder, 1980; Broglio, 1994; Boschian et al., 2017; Peresani et al., 2011) anticipating one of the main feature of the Sauveterrian hunting equipment. Also the augmentation of double backed points reported by Martini (Martini et al., 2007) in the Southern Tyrrhenian sites during the final Late Epigravettian goes towards this

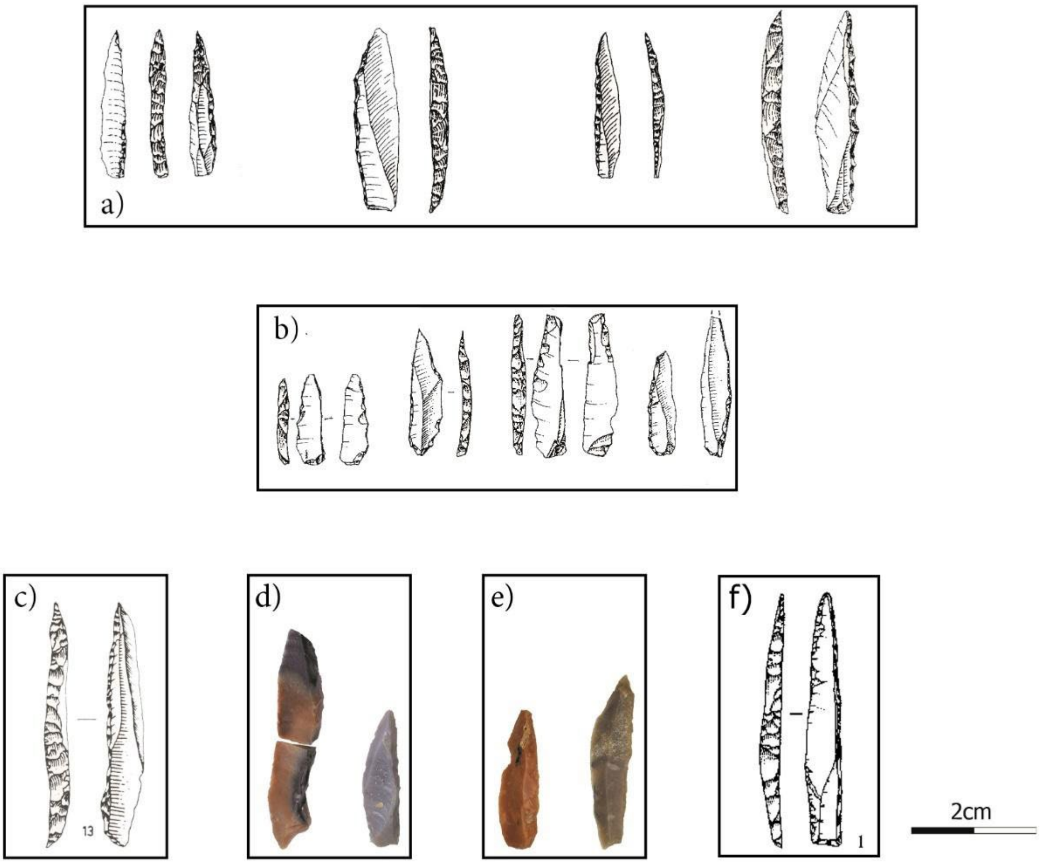


Figure 2.3 – Backed truncated points in North-Eastern Italy between the end of the Allerød and the Younger Dryas. a: La Cogola layer 19 (Cusinato et al., 2004); b: Bus de la Lum (Peresani et al., 2000); c: Villabruna layer 5-6 (Aimar et al., 1994); d: Riparo Biarzo; e: Riparo Soman; f: Cava Romita (Esu et al., 2006).

direction.

The presence of microburins within Late Epigravettian assemblages deserves a brief discussion. Ordinary microburins are attested all along the Late Glacial, but generally in low numbers, especially if compared to Krukowski ones. During the GS-2 and the Bølling-Allerød Interstadial microburins (both ordinary and Krukowski) are normally considered as the result of an accidental breakage. The Clusantin cave is the only site dated to the Interstadial with an important amount of ordinary microburins (n=17). Nevertheless, even in this case, R. Duches and M. Peresani (2010) have questioned their intentionality and degree of predetermination. As far as we known, the microburin blow technique seems to become an intentional choice exclusively from the Younger Dryas (e.g. Palu Echen) and especially during this final Late Epigravettian phase (Bassetti et al., 2009; Broglio, 1994)

2.5. Sauveterrian

The analysis of layer 8 of Mondeval de Sora allowed the recognition of two main armature types: geometrics and backed points. The former are manufactured on thin triangular cross-section microbladelets shorter than 25 mm. The lateralization of the microburins notch (proximal microburin-right notch and distal microburin-left notch) and length of blanks selected reveal a microburin blow applied only for removing one blank extremity (rarely both) while the other was mainly reduced by retouching (direct and semi-abrupt). A third and extremely marginal retouch is often attested on the functional edge. The microburin fracture is systematically reached by a pressure technique applied by an organic (pheraps antler) compressor. Also the backing process is carried out with an organic retoucher as confirmed by a combined low- and high-power analysis. In some cases, after the microburin blow retouching can occur by pressure with a soft stone. The geometrics assemblages were divided into seven morpho-types attesting to a great morphological variability:

- Short scalene triangle
- Elongated scalene triangle
- Short isosceles triangle
- Elongated isosceles triangle
- Symmetric crescent
- Asymmetric crescent
- Large crescent

Among them the most attested one is the short scalene triangle. At a general level geometrics size is extremely small. The interquartile range varies between 8-11 mm for the length, 3-4 mm for the width and 1-2 mm for the thickness.

On the other hand, backed points are manufactured on a wider array of products, in particular microbladelets and laminar flakes shorter than 25 mm with a trapezoidal cross-section (the thickness is slightly higher compared to blanks used for geometrics) and flakes obtained from a dedicated *chaîne opératoire* Their reduction process involves the delineation of one or two backs by applying deep, direct and abrupt retouches. The low thickness values of blanks (mainly < 4 mm) do not require the use of a crossed retouch. They were shaped transversally on flakes or longitudinally on elongated blanks. Three different morpho-types were identified according to the length-width ratio and the number of backs:

- Narrow Sauveterrian points have a length-width ratio of 5:1 or higher and a double rectilinear back. Their size (interquartile range) varies from 14-17 in length, 2-3 in width and 1-2 in thickness.
- Wide Sauveterrian points are shorter (interquartile range: 8-15 mm) and wider (interquartile range 3-4 mm). The length-width ratio is lower than 5:1. The two backs are slightly convex
- Curved backed points are characterised by a single back with a curved delineation and an unretouched base. They are short (interquartile range: 10-15 mm), wide (interquartile range: 3,5-4,5 mm) and thin (interquartile range: 2-2 mm).

The backing technique mainly used is pressure applied with either an organic or less frequently a stone compressor. The use of soft stone percussion on anvil is rare and limited to the accomplishment of specific tasks (e.g., the beginning of the reduction process of transverse baked points or longitudinal backed points produced on wide elongated blanks).

Within the armatures assemblage a good amount of backed truncated bladelets were also analysed. The majority of them belong to the B type (see Chapter 6 Part 2) and they present a highly standardised morphology and size. They are produced on regular and thin (1-2 mm) microbladelets by a rectilinear back applied by a direct and abrupt retouch. The back invasiveness (deep or marginal) is strongly related to the achievement of a standardised width of 3-4 mm. Truncations are single or double with a transverse orientation. The cutting edge has a rectilinear delineation achieved by applying a single sequence of complementary retouches all along the entire morphological axis.

The Sauveterrian occupations at Mondeval de Sora are chronologically referred to the Middle Sauveterrian (*sensu* Broglio, 1980; Broglio and Kozlowski, 1984). As a matter of fact, the main traits of this phase concerning armatures production i.e., higher percentage of long and narrow crescents rather than short and wide and lower number of isosceles triangles in favour of scalene ones, are well documented, although elongated scalene types with a short and small base are not so abundant.

In a more technological perspective a certain homogeneity can be verified between Mondeval de Sora and the other North-Eastern Italian sites dated to the Preboreal and to the beginning of the Boreal. Blanks selected are extremely variable and the thickness seems to be the only controlled parameter (Fontana and Guerreschi, 2009; Wierer, 2008). The difference in thickness of blanks selected according to type of armature is also attested at Romagnano Loc III and Riparo La Cogola SU 16 (Flor et al., 2011; Bassetti et al., 2009) where geometrics are thinner than backed points. The backing process occurs exclusively by direct retouch, while a crossed backed retouch is hardly ever documented (Bassetti et al., 2009; Cusinato et al., 2004; Visentin, 2017; Wierer, 2008).

In those sites in which the notch lateralization of microburins is reported (e.g., Le Mose, Grottina dei Covoloni, Cassera Lissandri 17 and La Cogola layer 16) a trend similar to Mondeval de Sora is reported: proximal microburins mainly have a right notch, whereas distal microburins a left one (Visentin, 2017; Cusinato et al., 2004). This opposite notch lateralization between distal and proximal microburins, adding to the length of full lamino/lamellar products, which are generally shorter than 30 mm like in Mondeval de Sora, allows to propose the production of a single geometric per blank by a distal or proximal microburin blow also in these sites (1st modality; Figure 3.30 Part 1).

The only detailed study focused on notch lateralization was performed by Peresani and Miolo (2012). Authors analysed proximal microburins from 13 North-Eastern Italian sites attesting to a decrease in lateralization along the Sauveterrian sequence: from proximal microburins with a right notch to a more variable notch lateralization. Unfortunately, the lack of data concerning distal microburins (intentionally excluded from the analysis) does not allow us to fully understand the significance of this trend. Is this variation in lateralization related to a change in number of geometrics obtained per blank or is it merely related to a different holding modality while applying the microburin blow? This might be an interesting aspect to better investigate in the future.

As far as the backing technique is concerned, the only data are those collected by L. Chesnaux (2014) through the analysis of armatures from the site of Paris-15e « 62 rue Henry-Farman », La Grande Rivoire (Isère) and collection 1 and 3 of Saint-Lizier à Creysse. The Author proposed the use of pressure technique applied with an organic tool confirming the diffusion of this technique throughout the Sauveterrian techno-complexes.

2.5.2. Late Epigravettian and Sauveterrian: a cultural continuum ?

In North-Eastern Italy the transition between the Late Epigravettian and the Sauveterrian has always been considered as continuous. In fact several features of the Sauveterrian armatures production first appear during the final phases of the Late Epigravettian, such as:

- geometrics produced by the microburin blow technique
- double backed points
- small size of armatures
- morphological standardisation of types
- almost exclusively selection of thin (1-2 mm) blanks
- disappearance of a crossed backed retouch

Furthermore, the same notch lateralization was observed between sites dated to the Terminal Epigravettian (Palughetto, Peresani et al., 2011; La Cogola US 18, Cusinato et al., 2004). and those referred to the Sauveterrian (e.g. Mondeval de Sora layer 8, this dissertation; Le Mose, Grottina dei Covoloni, Cassera Lissandri 17, Visentin, 2017; La Cogola layer 16, Cusinato et al., 2004). This convergence may attest to the transmission of the technical procedure for geometrics production (1st modality; Figure 3.30 Part 1) between the Epigravettian and the Sauveterrian. Furthermore, more traditional Epigravettian traits, such as the production of well normalised backed bi-truncated bladelets characterised by a marginal complementary retouch all along the cutting edge continue during the first part of the Sauveterrian.

The cultural continuity between these two facies is even more evident considering the retouch techniques. The dominating use of pressure technique applied with an organic compressor during the Younger Dryas seems to continue throughout the Preboreal. The reason for the success of this technique is probably to be researched in three main factors:

- the low thickness values of blank selected (< 3 mm)
- the reduced size of armatures
- the brief retouching process required.

This latter point depends on the use of narrow and thin blanks with a predetermined size during the Younger Dryas, and on the systematic use of the microburin blow technique during the Early Holocene.

The similarities between the end of the Epigravettian and the Sauveterrian is reflected also in some aspects of reduction schemes (Bassetti et al., 2009; Cusinato et al., 2004; Fontana et al., 2009; Peresani et al., 2011; Tomasso, 2014; Tomasso et al., 2014; Visentin, 2017):

- the increase of flakes exploited as cores

- the core reorientations once the debitage surface is exhausted
- the high cores reduction before their abandonment
- an independent small flakes production
- a general decrease of products size

On the contrary, the most typical feature of the Sauveterrian armatures missing during Late Epigravettian is the strong normalisation of armatures morphology and size starting from a high array of blanks (microbladelets, elongated flakes and flakes). This attests to a complete independence from any constraints in blanks size and morphology. The only exception is thickness. This technical behaviour is part of the well-known "pragmatic" aspect of Sauveterrian technical systems (Flor et al., 2011; Fontana and Visentin 2016; Visentin, 2017; Walczak, 1998). In this sense the best example is the Sauveterrian point shaped transversally on flakes in which the difference between the original blank and the finished armatures is huge. The disappearance of inverse and flat complementary retouches, together with the disappearance of *Microgravettes* and trapezoids are other important changes that occurred at the onset of the Sauveterrian.

Table 2.3 **-** Main trends of backed points analysed.

		RT Ancient phase (final part of GS-2)		**RT Recent phase (first half of GI-1)**		**Riparo Biarzo (second half of GI-1)**	**Riparo Soman (GS-1)**	**Mondeval de Sora (Pre-boreal)**
		1st group	*2nd group*	*3rd group*	*4th group*			
Blank selection	*Blank category*	Microbladelets		Microbladelets, bladelets and elongated flakes		Microbladelets, bladelets and elongated flakes	Microbladelets, bladelets	Microbladelets, elongated flakes, flakes
	Blank morphometric features	Narrow and thin		From narrow and thin to wide and thick		From narrow and thin to wide and thick	Narrow and both thin and thick	Thin
	Regularity	Regular		Regular and irregular		Regular and irregular	Regular	irregular
Backing	*Relation between back and main dorsal ridge*	Over the main dorsal ridge		Variable		Variable	Variable	Over the main dorsal ridge
	Invasiveness	Low		High		High	Low	High
	Back delineation	Rectilinear		Rectilinear, slightly convex, convex		Rectilinear, slightly convex, convex	Rectilinear and slightly convex	Rectilinear and slightly convex
	Backed retouch extent, position and angle	Deep direct abrupt or marginal direct abrupt		Deep direct or crossed abrupt		Deep direct or crossed abrupt	Deep direct or crossed abrupt	From deep, direct and abrupt or semi-abrupt
	Apex orientation	Distal			Distal and proximal	Distal	Distal	Distal and proximal
Finalisation	*Complementary retouches localization*	Apical		Apical and basal		Apical and basal	Apical and basal	-
	Complementary retouches extent and position	Marginal direct semi-abrupt and inverse flat				Marginal direct semi-abrupt and inverse flat	Marginal direct semi-abrupt and inverse flat	-
	Basal Truncation	Occasionally used to resume fractures		Convex		Rare	Rectilinear transverse or oblique	-
Main objectives		Elongated backed points Type A and B		Elongated backed points Type A and Wide backed points Type A and B		Elongated backed points Type A and Wide backed points Type A and B	Elongated backed points Type B and Wide backed points Type A	Sauveterrian Points and Curved backed points
Size in mm (interquartile range)		22-34x4-6x1-2	22-30x4-7x1-3	25-35x4.5-7x2-3	25-34x5-7.5x2-4	16-24x5-7x2-4	20-32x5-7x2-3	8-17x2-4x1-2
Resumed pieces		Low frequency		High frequency due to fractures originate by the backing process		High frequency due to fractures originate by the backing process	Low frequency	Low frequency

Table 2.4 - Main trends of backed truncated bladelets analysed.

		Riparo Tagliente		**Riparo Biarzo (second half of GI-1)**	**Riparo Soman (GS-1)**	**Mondeval de Sora (Preboreal)**
		Layer 17-7	*Layer 6-4*			
Blank selection	*Blank category*	Microbladelets and bladelets	Microbladelets and bladelets	Microbladelets	Microbladelets	Microbladelets
	Blank morphometric features	Wide and thin		Narrow and thin		
	Regularity	Regular				
Backing	*Back delineation*	Variable	Rectilinear			
	Backed retouch extent, position and angle	Deep direct or crossed abrupt			Deep direct abrupt	Deep or marginal direct abrupt
Finalisation	*Complementary retouches localization*	Almost absent		Frequently all along the functional edge		
	Number of truncations	Single	Double, rarely single			
	Truncations orientation	Variable	Asymmetric	Symmetric and obtuse	Symmetric and obtuse (sometimes asymmetric)	Symmetric and transverse
	Resumed fracture	High frequency (unintentional fractures)	High frequency (intentional fractures)	Low frequency	Low frequency	Low frequency
Size in mm (interquartile range)		-	18-28x6-7x2-3	13-19x4-5x2-3	15-22x4-6x2-2	9-14x3-4x1-2

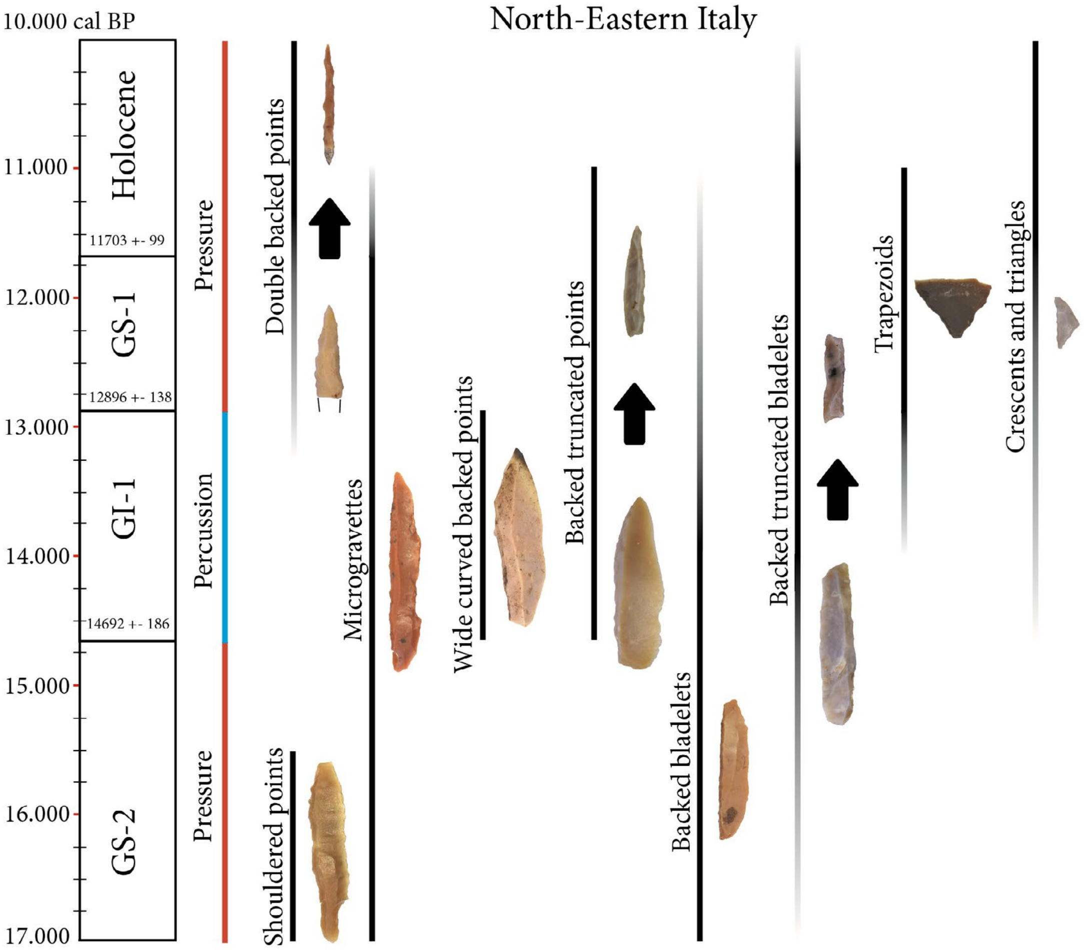


Figure 2.4 – Armatures development and backing techniques variations in North-Eastern Italy throughout the Late Glacial and the Early Holocene.

Chapter 3 – Conclusion: an attempt of comparison between the Late Epigravettian and Western societies

3.1 Behind armatures morphology

Comparing armatures production of these two chrono-cultural sequences is not an easy task. Differences that can be considered of "stylistic" nature are evident all along the sequence confirming the validity of microliths as primary *fossiles directeurs* in the definition of specific cultural "techno-complexes" or "cultural facies" and thus the existence of a clear "cultural" separation between the Western-Atlantic area and the Mediterranean one. This diversification is mostly visible when evaluating armatures shapes and dimensions as well as hafting modalities and thereby the way arrows and javelins are conceived. Sometimes divergences can be observed also within the same cultural tradition allowing to emphasise regional trends in both the Late Epigravettian and Western-Atlantic sequence. They can be the result of a mere adaptation of hunting techniques in relation to the local environment (e.g., between Pyrenees and Aquitaine Basin during the Upper Magdalenian and Early and Late Azilian?) or be influenced by more cultural reasons (e.g., between North-Eastern Italy and North-Western Italy during ER3 or between the Western and Eastern France during the Late Azilian?). Moving to a different level of analysis that considers more technological aspects, next to some specificities for each cultural facies, several interesting similarities can be highlighted across time between these two sequences (Fig. 3.1).

Focusing on the last part of the GS-2, in both the Upper Magdalenian and Late Epigravettian, armatures are produced from regular, narrow and thin full debitage bladelets and microbladelets and shaped by a brief backing process mainly applied with a direct retouch using a pressure backing technique. The high degree of normalisation of armatures morphology is due to the high investment in blank standardisation rather than in retouching. The main technological difference between these two assemblages is represented by the number of retouch sequences applied to shape deep backs. During the Upper Magdalenian backs are produced by a first and total marginal retouch and then by a second and deeper sequence, while during the Late Epigravettian they are directly shaped by a single sequence of removals generally from the distal portion to the proximal one. Although also from a morpho-typological viewpoint some similarities can be detected (e.g. backed bladelets and Gravette-like backed points), the way projectile implements are designed is clearly different, especially if we consider the more frequent occurrence of osseous projectile points during Upper Magdalenian (Pétillon, 2015). This type of gear is rarely attested during the entire Italian Late Epigravettian (Martini, 2007). A major use of a stone compressor during the ER1 and an organic one during Upper Magdalenian is perfectly consistent with the different degree of bone and antler exploitation between these two cultural facies. Lithic retouchers are easily collectable and do not require a high investment in their shaping compared to organic compressors; thus the first highlight a more "opportunistic" behaviour within the Epigravettian groups. This higher pragmatism is reflected also in production schemes where next to a certain regularity in blanks production, they do not show a great investment in the shaping-out phase which is limited at most to a frontal crest (Montoya 2008, 2004). On the contrary, during Upper Magdalenian the core preparation involved also flanks and sometimes even the back (Langlais, 2010; Langlais et al., 2016, 2014c, 2012).

In Northern Eastern Italy, the B-A Interstadial coincides with the manufacture (next to traditional *Microgravettes*) of more robust and wide backed points shaped by a curved back. They are produced on less standardised and thicker blanks by a greater technical investment in their *façonnage* phase performed by soft stone percussion on anvil and involving a crossed backed retouch and often a modified base. Inverse backed retouches are employed exclusively on blanks thicker of 3 mm once the back overpasses the point of maximum transverse thickness. Their aim is to regularise the back delineation or to thin specific portions of the blank. From a wider perspective it may be suggested that the appearance of this new type of backed point may be related to the phenomenon defined as "azilianisation" (Fasser et al., 2022) that coincides with the diffusion during the Bølling-Allerød Interstadial of a wide array of curved backed points within different European techno-complexes together with a progressive reduction in blanks standardisation. Such a trend seems to firstly begin in the Late Epigravettian sites of Balkans around 17000-15000 cal BP (e.g. Kopacina cave, Badanj; Vukosavljević et al., 2011; Boric et al 2021) and then progressively spread towards the North of Italy (c.f. "wide backed points") and South-Eastern France (*Pointes d'Istres*) during the Interstadial. Actually, the possibility of an earliest beginning of the Late Epigravettian in the eastern side of the Adriatic basin was taken into account also by Ruiz-Redondo et al. (2022). Moreover, population movements from Balkan/Anatolian to Northern Italy are confirmed by genomic data from Riparo Tagliente even though dated before the beginning of the Interstadial (Bortolini et al., 2021)

In the Western-Atlantic area some of these changes in armatures production are attested during the Early Azilian, e.g. spread of backed points with a curved back, increase of deep and crossed backed retouches and the use of soft stone percussion on anvil. However, the analysis of the Early Azilian layer 3B of Pont d'Ambon allowed to verify also important divergences: blanks remain strongly normalised and the accuracy dedicated to the shaping phase still remarkably high. In fact, technological and morphological similarities between the "wide backed points" detected in the upper layers of Riparo Tagliente and in Riparo Biarzo can be identified exclusively with Late Azilian assemblages (Fig. 3.1) (Valentin 2006; Naudinot 2008; Fat-Cheung 2014; Fat-Cheung et al. 2014; Naudinot et al. 2019).

As confirmed by the studies of layer 3A of Pont d'Ambon and layer 6 of Troubat, in contrast to the Early Azilian, Late Azilian curved backed monopoints are generally obtained by heterogeneous and thick blanks normalised by an invasive backing process (Naudinot et al. 2017b, 2019; Valentin 2008). Such a pattern is perfectly consistent with changes recorded at

Riparo Tagliente reinforcing the hypothesis of the diffusion of common traditions throughout the interstadial.

The earlier beginning of the "Azilianization process" within the Late Epigravettian societies was recently emphasised by N. Naudinot et al. (2017b) considering other aspects than armatures, such as: the development of schematic mobile art, the decrease of blades production, the progressive simplification of lithic production methods, the absence of shaping out phase, the disappearance of an organic hammer and the decrease of raw material circulation. In the Western Atlantic sequence, except for knapping techniques, all these aspects tend to emerge during the Late Azilian rather than the Early Azilian (Naudinot et al., 2019, 2017b). Thus, would it not be more appropriate to talk about an "Epigravettianization" of western societies instead of an Azialinization? Similarly, the diffusion of backed bladelets and backed truncated bladelets - which are completely absent during Early Azilian (Fat Cheung et., 2014; Mevel, 2013; Naudinot et al., 2017a; Valentin, 2008) - within the Eastern Late Azilian groups (Bodu and Valentin, 1997; Coudret and Fagnart, 1997, 2004, 2012, 2015; De Bie and Caspar, 1996; Crotti et al., 2016; Mevel et al., 2014; Naudinot et al., 2019; Valentin et al., 2004), may be attributable to the diffusion of Epigravettian traits towards North-West. A parallelism between the Azilianization process and transformations in the Late Epigravettian has been previously stressed also by other Authors (Broglio,1997; Thévenin, 1997). Obviously, further research is needed, along with more reliable radiocarbon dates, especially for the Balkans region, before trying to fully understand this widespread European process.

After this period in which these two macro regions seem to follow a similar evolution - not only within lithic armatures production - the Western Atlantic area and Northern Italy know a clear cultural separation during the Younger Dryas, according Naudinot et al. (2017b). The return to a highly sophisticated blades production on exotic flint during the Laborian (Langlais et al., 2014a), and at a general level in the Flat Blade Techno-complexes (Naudinot et al., 2019), is missing during the Late Epigravettian where the production was aimed at manufacturing microbladelets and bladelets thought simplify methods on local raw material (Bassetti et al., 2009; Cusinato et al., 2004; Tomasso, 2014; Peresani et al., 2011). Anyway, it is important to highlight that studies focusing on sites dated to the Younger Dryas-Preboreal transition of Northern Italy are far from being exhaustive.

Such a difference in product size partially affected armatures manufacture. If during the Younger Dryas, Late Epigravettian armatures are generally thin (1-3 mm), narrow (< 7 mm), shorter than 30 mm and produced on microbladelets, during the Early Laborian *Malaurie* points and backed bi-truncated bladelets are generally thicker (> 3 mm), larger (> 8 mm) and produced on small blades and bladelets. Moreover, the strong recycling process observed among Laborian groups seems to be absent in the Late Epigravettian of the Younger Dryas. Nevertheless, it is interesting to note that from a morphological/typological viewpoint several innovations documented in Southern France during the Early or Late Laborian appeared before in Northern-Eastern Italy between the end of GI-1 and the beginning of GS-1, such as:

- rectilinear backed points with a transverse or oblique basal truncation

- symmetric backed bi-truncated bladelets highly standardised that dominate the armatures assemblages
- trapezoids hafted as transverse projectile tips

For the time being a diffusion from East to West of such items is difficult to be supported, even if it is the most likely, mainly due to the lack of geographic continuity: these types of armatures are in fact less abundant (e.g., backed bi-truncated bladelets) or rarely mentioned (e.g., backed truncated points and trapezoids) in the Late Epigravettian sites of North-Western Italy and South-Eastern France. However, this absence can be related to a hiatus in the archaeological evidence. Even *Blanchères* points which are typical of the Late Laborian are morphologically comparable to the Late Epigravettian *Microgravettes*, although they present three main differences: *Blanchères* points have a systematic proximal apex, an unretouched cutting edge and a lateral position along the shaft (i.e., barbs).

Nevertheless, a projectile weapon conceived with a composite tip, the return of a certain regularity and predetermination of blanks morphology, the disappearance of wide and thick curved backed points produced on irregular blanks and the diffusion of pressure applied by an organic tool as main backing technique allow to confirm a certain degree of interactions between these two cultural facies.

A further important difference between these two regions that must be highlighted occurs between the end of the Younger Dryas and the Preboreal. While the Late Epigravettian in Northern Italy and South-Eastern France experienced a gradual mesolithization of technical systems (e.g., diffusion of geometrics and microburins), the Late Laborian of South-Western France keeps showing a clear Palaeolithic lithic industry with no signs of Mesolithisation (Naudinot et al., 2017b, 2019). Although radiocarbon dates do not allow to confirm a diffusion of the Sauveterrian technical systems from East to West (Langlais et al., 2015; Visentin 2017), divergences between Late Laborian and the Sauveterrian, added to a significant date overlap of these two facies (around 500 years) make it difficult to believe to a local origin of the Sauveterrian from the Laborian as proposed for Northern Italy.

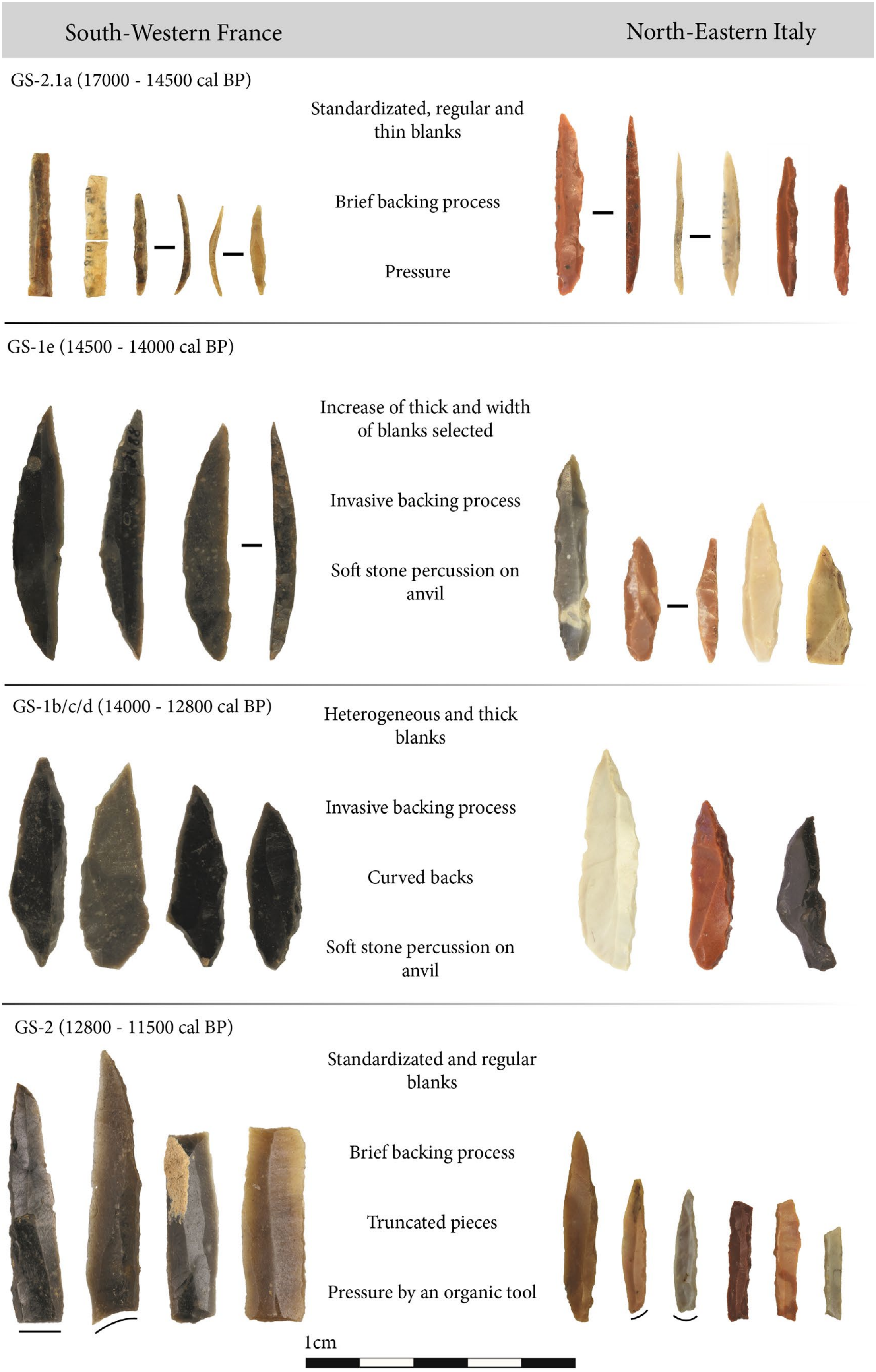


Figure 3.1 – Common features between the two analysed sequences during the Late Glacial.

3.2 Arrowhead design and environmental changes, is there a connection?

The Late Glacial, in addition to being a period characterised by important cultural transformations, is marked by significant climatic and environmental changes. The relationship between cultural and climatic variations has been highly discussed over the years and often interpreted as the former being the consequence of the latter (e.g., Bignon, 2003; Guillien and Laplace 1978; Naudinot et al. 2017b; Ruiz-Redondo et al., 2022; Thévenin, 1997; Valentin, 2008). This is particularly true concerning armatures production. In fact, according to several Authors (e.g., Churchill, 1993; Pelegrin, 1997), the hunting environment and the available games can significantly influence both the hunting techniques adopted and the weapon equipment. As a matter of fact, in both sequences analysed innovations in armatures production often coincided with specific climatic oscillations.

Focusing on the western Atlantic sequence, the reason behind the disappearance of osseous projectile points at the transition between the Upper Magdalenian and the Early Azilian in favour of an exclusive use of lithic backed points is still difficult to address. J. Pelegrin pointed to the environmental changes (vegetation and hunted preys) occurring during the interstadial as the main cause of this transformation (Pelegrin, 1997). However, environmental data shows an important renovation only since the Allerød, thus, after the onset of Early Azilian (Andrieu et al., 1993; Bertran et al., 2009; Jalut and Turu, 2009; Leroyer, 2018, 2006; Penalba, 1989; Peyron et al., 2005; Reille and Andrieu, 1995). At a general level, the only significant change coinciding with the beginning of the Early Azilian seems to be the disappearance of reindeer which was replaced in the faunistic spectrum by red deer (Costamagno et al., 2016). Is the disappearance of the reindeer enough to justify such a radical change in hunting equipment?

On the other hand, the shift in backed points production occurred at the transition between Older Dryas and the interstadial at Riparo Tagliente coincides with the transition from open to forested environments (Ravazzi et al., 2007) and the associated change in pursued preys (from *Bos*, *Bison* and *Capra ibex* to *Cervus elaphus*, *Capreoulus capreoulus* and *Sus scrofa*; Capuzzi and Sala, 1980; Bartolomei et al., 1982; Rocci Ris et al., 2007). Similarly, the turnover in backed points production between the Early and Late Azilian occurs during the second half of the GI-1 (c/b/a) when an expansion of tree species configuring a mixed forest composed of *Pinus* and *Betula* (Bertran et al., 2009; Cupillard et al., 2015; David, 2001; Leroyer, 2018, 2006, 1997; Litt et al., 2001; Ortu et al., 2010; Wick, 2000) together with an increase of woodland animals (Costamagno et al., 2009, 2008) are recorded.

In the Late Epigravettian the Allerød period records after 13500 cal BP an increase of thermophilous plants and forest density. Such an event overlaps with the important diffusion of backed bi-truncated bladelets in Northern-Eastern Italy more or less at the beginning of ER3 (13300 cal BP) according to A. Tomasso (2014).

The onset of the Early Laborian and the shift to the Late Laborian seems to correspond to two main climatic variations: the GS-1 climate oscillation and the beginning of the Early Holocene. Both these events deeply impact environments. In South-Western France, during the Early Laborian aurochs, horses and red deer were mainly hunted, while during Late Laborian red deer is accompanied by wild boar (Langlais et al., 2020). This faunistic change is not noticed in Northern France (Bémilli et al., 2014; Verjux et al., 2013) where the Early Laborian is almost absent.

The GS-1 climate oscillation in the southern side of the Alps, even though it is well documented, had a minor impact on the environment. Compared to Northern Europe, the forest did not disappear, the treeline was still above 1400 m a.s.l. (Gobet et al., 2005; Vescovi et al., 2007) and the hunted preys do not significantly change (Fiore and Tagliacozzo, 2004; Tagliacozzo and Cassou, 1994). In fact, armatures variability, excluding few aforementioned changes (diffusion of trapezoids, disappearance of wide curved backed points), remained fairly similar (microgravettes associated with backed truncated bladelets or backed bladelets) at least until the beginning of the Early Holocene where an important diffusion of geometrics is attested.

Thus, although it is always difficult to chronologically link cultural and climatic changes precisely, the hypothesis of environmental transformations as a driving force for armatures changes during the Late Glacial seem to be most of the time a reliable explanation.

3.3 A globalisation of back retouch modalities?

Applying a detailed analysis focused on armatures production at a large scale allowed observing the variability of Late Glacial armatures in a new light. Northern Italy and France give the impression to follow a similar evolution across this period (Fig. 3.1). Most similarities can be identified from a technological viewpoint and they seem to be the result of a shared "technical package" or "set of common technical behaviours". This mainly includes a similar way of applying backing techniques and retouch methods and acting in response to changes in blanks morphology, that most of the time show a similar trend. In this regard it should be considered that this "technical package" does not reflect a specificity of each cultural facies but spread transversally within them.

Armature divergences between the two regions are thus the result of the different sought-after morphologies likely related to specific hafting modalities in association with different environments and pursued prey and/or precise cultural needs, but often they do not depend on the use of different methods and techniques. Actually, starting from the second half of the GI-1 several similarities can be observed also from a morpho-typological perspective, especially between Late Epigravettian and Late Azilian and Late Epigravettian and Laborian.

The question to ponder over is the origin of this common technical behaviour: is it the result of a mere convergence related to the fact that being the same human species we respond similarly to the same external stimulus (e.g. analogous environmental changes at certain times?) or, as I would like to propose here, the occurrence of the same technical practices over a large territory should be interpreted as the confirmation of an important social network between European Late Glacial groups ? Thus, it is possible that the demographic increase occurred in the Late Glacial enhanced processes of regionalisation accompanied by the development of intense connections between neighbouring groups. Furthermore, a transmission from Est to West of certain technological and morphological traits throughout the Late Glacial, not only in armatures production, is more than just a suggestion and it deserves further investigations. Interpreting changes in the lithic industry of Western-Atlantic societies as the result of influences from the East becomes even more intriguing considering the origin and development of the Sauveterrian. In the future, it will be interesting to verify the role played by the Iberian Peninsula and the Easternmost Epigravettian regions concerning these common transformations and to extend our reflection (modalities of production vs. morphologies) to other categories of objects and raw materials characteristics of the Final Palaeolithic and Mesolithic techno-complexes.

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Résumé

PREMIÈRE PARTIE

1. Objectifs de l’étude

Cette thèse de doctorat porte sur les modalités de fabrication des armatures lithiques au Tardiglaciaire et au cours de la première partie de l’Holocène dans deux régions spécifiques : le nord-est de l’Italie et le sud-ouest de la France. En raison de leur grande variabilité dans le temps et l’espace, les armatures lithiques ont été largement utilisées comme des fossiles directeurs pour identifier les différentes traditions techniques. Cette variabilité typologique, ainsi que d’autres caractéristiques spécifiques, ont permis depuis les premières études (Breuil, 1913) de mettre en évidence une séparation culturelle entre les régions ouest-atlantiquées et méditerranéennes-balcaniquées. L’objectif de ce projet est de contribuer à la définition du cadre culturel de ces deux séquences et de comprendre s’il existe une correspondance entre les spécificités typologiques des armatures lithiques et les méthodes ainsi que les techniques de fabrication. En outre, cette analyse permettra d’identifier les variations d’un point de vue diachronique et les éventuelles tendances communes entre ces deux séquences. En effet, malgré le développement des études technologiques appliquées aux assemblages lithiques (Tixier et al., 1980 ; Boëda, 1986, 1994 ; Inizan et al., 1999, Arzarello et al., 2011), l’analyse des supports retouchés, et donc des armatures aussi, a été rarement intégrée dans la reconstruction des chaînes opératoires et une méthodologie commune est encore absente car pendant plusieurs décennies, cette catégorie d’outils a été analysée par une simple approche typologique.

2. Le cadre climatique

Les changements climatiques observés au niveau global (Rasmussen et al., 2014, 2007, 2006) entre le Tardiglaciaire et le début de l’Holocène se reflètent dans l’environnement avec des rythmes différents au nord-est de l’Italie et au sud-ouest de la France. La fin de Dryas ancien (GS-2a) dessine un environnement steppique similaire dans les deux régions, alors que le réchauffement climatique du GI-1e a eu des effets différents (Jalut et al., 1998 ; Leroyer, 2018 ; Ravazzi et al., 2007 ; Vescovi et al., 2007). Le versant sud des Alpes et la grande plaine du Pô enregistrent une expansion rapide de la forêt mixte (conifères et bouleaux) jusqu’à 1700 m d’altitude au début de l’GI-1 (Bølling) ainsi qu’une augmentation importante des plantes thermophiles pendant la fin de l’GI-1 (Allerød). En revanche, la végétation du sud-ouest de la France (bassin d’Aquitaine et le versant nord des Pyrénées) reste assez ouverte et dominée par des d’espèces steppiques jusqu’au début de l’Allerød, où une augmentation de *Betula* et de *Pinus* est constatée. Après un déclin du pollen arboricole au cours du Dryas récent plus marqué vers la coté Atlantique de la France par rapport à l’Italie du Nord, la réponse de la végétation à l’amélioration climatique de l’Holocène semble, encore une fois, beaucoup plus lente au nord des alpes que dans la zone méridionale (Aubert et al., 2004 ; Jalut et al., 1992 ; Jalut and Turu, 2009 ; Leroyer, 2018 ; Ravazzi and Vescovi, 2009 ; Ravazzi et al., 2007 ; Vescovi et al., 2007).

En ce qui concerne les territoires voisins, les Alpes françaises et le Plateau suisse enregistrent à l'interstadial une première reforestation de basse et moyenne altitude par la *Betula* (Bølling) et ensuite par le *Pinus* (Allerød) (Cupillard et al., 2015 ; David, 2001 ; Ortu et al., 2010 ; Wick, 2000). Par rapport au versant sud, les plantes thermophiles sont rarement documentées. En Europe centrale et occidentale, le réchauffement climatique au cours du Bølling est marqué par l'apparition d'une forêt ouverte de bouleaux dominée par des taxons herbacés, puis d'une forêt mixte de bouleaux et de pins au cours de la période Allerød (Leroyer, 1997 ; Litt et al., 2001).

Bien que les changements climatiques aient affecté toute l'Europe, l'adaptation de la végétation a été généralement différente autour des côtes atlantiques et du nord de l'Europe par rapport au territoire situé au sud des Alpes. Comme certains auteurs ont proposé (Naudinot et al., 2017b), les températures estivales plus élevées du sud de l'Europe (Heiri et al., 2014 ; Larocque et Finsinger, 2008) et la présence de refuges d'espèces mésophiles dans la plaine du Pô avant le GI-1 (Kaltenrieder et al., 2009 ; Ravazzi et al., 2004) ont probablement permis, depuis l'interstadial, une expansion plus rapide des forêts d'arbres tempérés.

3. Le cadre culturel

Le Dernier Maximum Glaciaire porte après le Gravettien à une séparation culturelle de l'Europe entre une région ouest-atlantique et une méditerranéenne-balcanique. Cette division a été initialement définie (Breuil, 1913) sur la base de la variabilité typologique des outils lithiques et osseux. A l'état actuel de nos connaissances, la première est caractérisée par la séquence Solutréen-Badegoulien-Magdalénien-Azilien-Laborien (Langlais et al., 2014a ; Langlais et al., 2014b ; Naudinot et al., 2019), tandis que la seconde atteste le développement de l'Épigravettien ancien et récent (Broglio et Improta, 1995 ; Martini, 2007 ; Palma di Cesnola, 1983, 1993). Ensuite, le développement d'approches méthodologiques différentes entre les communautés académiques de ces régions ont accentué cette division : l'Italie a été fortement influencé par la «typologie analytique» de George Laplace (Laplace, 1964a), au moins jusqu'à la fin des années 90, tandis que la France a d'abord suivi la méthode de Sonneville-Bordes et Bordes (Sonneville-Bordes et Perrot, 1956 ; Sonneville-Bordes, 1966, 1959) et ensuite le concept de chaîne opératoire de Leroi-Gourhan (1965, 1964, 1945, 1943). Ce n'est que dans les 20 dernières années que les deux régions ont commencé à adopter la même approche technologique pour l'analyse des séries lithiques (Arzarello et al., 2011 ; Inizan et al., 1999).

3.1. La séquence française de l'ouest-atlantique

Entre la fin du GS-2 et la transition Pléistocène-Holocène, quatre traditions culturelles différentes se sont développées dans la zone ouest-atlantique française : le Magdalénien supérieur, l'Azilien ancien et récent, puis les techno-complexes post-aziliens (*Flat-Blades-techno-complexes*) qui comprennent ce qu'on appelle le Laborien dans le sud et l'ouest de la France. Le passage d'un techno-complexe à l'autre est systématiquement marqué par des changements importants dans l'industries lithique et osseuse ainsi que dans l'art et les modèles de mobilité

(Naudinot et al., 2019).

La transition entre le Magdalénien supérieur et l'Azilien ancien (GI-1e) est aujourd'hui perçue comme assez graduelle (Naudinot et al., 2019). Certaines caractéristiques de l'industrie lithique de l'Azilien ancien rappellent celles des groupes du Magdalénien, notamment une production régulière intégrée de lames et lamelles et un investissement technique assez important dans la phase de mise en forme des nucleus (Fat Cheung et a., 2014 ; Langlais et al., 2016). Dans les deux périodes, la circulation des matières premières allochtones diminue par rapport au Magdalénien moyen et l'art reste figuratif. En revanche, plusieurs différences existent : la percussion directe organique disparaît au profit de la pierre tendre, le débitage unidirectionnel du Magdalénien supérieur devient bidirectionnel au cours de l'Azilien ancien et l'équipement de chasse change complètement. Les pointes en bois de cervidé ainsi qu'un large éventail d'armatures lithiques (pointes, lamelles à dos, lamelles à dos tronquées, triangles scalènes) laissent la place à un type unique de pointe à dos courbe avec un ou deux apex.

L'Azilien récent (GI-1c/b/a - début du GS-1) coïncide avec une transformation plus évidente des systèmes techniques (Fat Cheung 2015; Fat Cheung et al., 2014; Naudinot et al., 2019); si d'une part les schémas de réduction sont extrêmement simplifiés et visent à obtenir des éclats laminaires peu standardisés et des lames/lamelles larges et épaisses par une séquence unidirectionnelle, d'autre part les produits sont extraits par percussion directe à la pierre dure et l'impact du percuteur est porté à l'intérieur du plan de frappe. En outre, une énorme variabilité de monopointes à dos courbe prend la place des bipointes. Pour finir, La matière première atteste une évidente restriction de la zone d'approvisionnement.

Au cours du Laborien (GS-1/première partie du Préboreal), les modalités de production extrêmement opportunistes et simplifiées des groupes de l'Azilien récent cèdent la place à une production plus sophistiquée de lames et de lamelles régulières au profil rectiligne à partir de matières premières souvent exogènes. Le retour d'une mise en forme importante des nucleus est aussi attesté (crêtes postérieure, antérieure ou postéro-latérale). A cela s'ajoute que les supports de plain débitage sont extraits à la percussion directe tangentielle à la pierre tendre en alternant deux plans de frappe opposées. Des nouvelles armatures apparaissent : d'abord des rectangles et des pointes de la Malaurie dans le Laborien ancien, puis des Blanchères et des trapèzes au Laborian récent.

Tout au long du Tardiglaciaire, le bassin d'Aquitaine et la zone pyrénéenne, bien qu'ils aient été systématiquement attribués à la même tradition culturelle, montrent plusieurs différences dans la morphologie des armatures et dans les schémas de la production lithique. La discussion sur la signification de ces divergences est encore ouverte (Barbaza, 2011 ; Fat-Cheung, 2020 ; Fat Cheung et al., 2014 ; Langlais et al., 2016). Sont-ils simplement le résultat d'une exploitation de matières premières différentes par les mêmes groupes humains ou bien d'une différence fonctionnelle des sites ou plutôt d'une véritable démarcation culturelle ?

3.2 Épigravettien récent

Au cours de la même période, la péninsule italienne et le sud-est de la France témoignent le développement de l'Épigravettien récent. Ce faciès est en continuité culturelle avec l'Épigravettien ancien et en général avec le Gravettien, par rapport aux faciès culturelles d'Europe occidentale. Les éléments caractéristiques de l'Épigravettien ont été identifiés sur un large territoire : du sud-est de la France à la Russie et l'Anatolie (Fornage-Bontemps, 2013 ; Gavrilov, 2021 ; Mevel et al., 2014 ; Montoya, 2004 ; Montoya et al., 2013 ; Tomasso, 2014).

Des processus de régionalisation et des divergences d'un point de vue diachronique ont été mis en évidence et ces variations ont été généralement interprétées comme une adaptation à différents environnements (Fontana et al., 2020 ; Martini, 2007 ; Palma di Cesnola, 1983, 1993). Les divisions chronologiques ont été proposées sur la base des variations typologiques (Broglio 1997, 1998 ; Guerreschi 1984b; Laplace, 1964b; Palma di Cesnola, 1993 ; Broglio 1997, 1998) et technologiques (Montoya 2004, 2008; Tomasso 2014) des assemblages lithiques. En se concentrant sur ces dernières, L'Épigravettien récent d'Italie du nord et du sud-est de la France connaît à partir de l'interstadial une simplification progressive des méthodes de production ainsi qu'un changement dans les objectifs de débitage : de lames, lamelles et microlamelles normalisées à un ensemble de lamelles et microlamelles plutôt irrégulières. La préparation des nucleus perd rapidement d'importance et l'utilisation d'un percuteur organiques cède la place à la pierre tendre (Montoya 2004, 2008). En outre, la circulation de matières premières se réduit (Bertola et l., 2018 ; Tomasso, 2015). L'Italie du nord et le sud-est de la France semblent partager toutes ces tendances. D'autre part, si nous considérons les armatures lithiques, une situation complètement différente apparaît (Fasser et al., 2022 ; Tomasso 2014, 2016). Leur forte variabilité ne suit pas la même évolution sur l'ensemble de ce territoire, ce qui confirme le fort caractère régional des armatures. Il est intéressant de noter qu'au cours de la fin de l'Épigravettien récent plusieurs innovations dans l'industrie lithique anticipent des aspects centraux de la production sauveterrienne (triangles et segments produit avec la technique du microburin ; Bassetti, 2009 ; Cusinato et al., 2004 ; Guerreschi, 1984a; Peresani et al., 2011; Tomasso, 2014).

3.3. Le Sauveterre

Après cette longue période au cours de laquelle ces deux macro-régions semblent suivre une évolution indépendante, le sud de la France et partiellement l'Italie présentent une production lithique similaire faisant référence à la tradition sauveterrienne (Broglio, 1971 ; Valdeyron, 2008 ; Visentin, 2017). La production porte sur des petites lamelles, microlamelles, éclats laminaires et éclats par de brèves séquences d'enlèvements unidirectionnels ainsi que des réorientations fréquentes du nucleus. La phase de mise en forme est inexistante, ainsi que les procédures de gestion. De plus, la matière première lithique est locale et extrêmement variable. Les armatures suivent également une tendance similaire dans toutes les principales régions sauveterriennes, avec des segments, des triangles isocèles et des triangles scalènes courts qui se transforment progressivement en triangles scalènes allongés (Bintz, 1995 ; Broglio and

Kozlowski, 1984 ; Guilbert, 2003 ; Valdeyron et al., 2008). Néanmoins, comme l'affirment plusieurs auteurs (Valdeyron et al., 2008 ; Visentin, 2017), il existe de nombreuses différences « stylistiques » concernant les outils et les armatures. A cela s'ajoute que dans le sud de la France, la technique du microburin disparaît pendant le Boréale, alors qu'en Italie du nord elle continue à être très utilisée et que la forte microlithisation des armatures dans le sud-est de la France et dans le nord de l'Italie n'est pas attestée dans le sud-ouest de la France.

Généralement, en Italie le Sauveterrien est considéré comme le résultat d'un processus de transformation directement lié à l'Épigravettien récent (Broglio, 1973 ; Guerreschi, 1984a; Martini et Tozzi, 1996). Au contraire, dans le sud de la France les modes de transition entre les dernières communautés paléolithiques et les premières communautés mésolithiques sont moins clairs, en particulier dans le Sud-Ouest où le Laborien ne présente aucun signe de « mésolithisation » (Langlais et al., 2015 ; Naudinot et al., 2019).

4. La méthodologie

La méthodologie appliquée pour l'analyse des armatures lithiques est basée sur deux approches complémentaires : une expérimentale et une technologique. Les deux ont comme objectif la reconstruction de l'ensemble des chaînes opératoires pour la production des armatures, depuis la sélection des supports jusqu'aux méthodes et techniques de retouche. L'approche expérimentale a été consacrée à l'étude de trois axes de recherche principales :

- L'étude des techniques de retouche efficaces pour la production des armatures à dos à travers la combinaison de différentes retouchoirs (lithiques vs. organiques) et de modes d'application de la force (percussion vs. pression vs. égrisage) pour un total de quatre techniques de retouche : percussion sur enclume, pression par retouchoir en pierre, pression par retouchoir organique (os et bois de cervidé) et égrisage à la pierre.
- l'identification de critères utiles pour la reconnaissance des techniques de retouche sur les armatures archéologiques, en adoptant une analyse qualitative (approche à haut et bas grossissement) et quantitative.
- L'analyse de la variabilité des schémas de production utilisés pour la fabrication des armatures au cours du Tardiglaciaire et au premier Mésolithique, ainsi qu'une meilleure compréhension de certains expédients techniques, comme la technique du microburin et d'autres techniques de fracturation.

L'approche technologique appliquée aux armatures archéologiques a été réalisée à l'œil nu et à l'aide d'un binoculaire. Pour reconstituer les modalités de production, plusieurs paramètres quantitatifs et qualitatifs ont été pris en compte.

D'un côté, des données concernant les supports :

- Type de produit (plain débitage, etc.).
- Section
- Profil
- Catégorie dimensionnelle (lames, lamelles et microlamelles)

D'un autre côté, les éléments du façonnage et des outils finis :

- Intégrité
- Taille
- Localisation, position, inclinaison et profondeur du dos
- Délinéation du dos et du bord opposé
- Relation entre le dos et les nervures dorsales du support
- Orientation de l'apex
- Présence et position du piquant-trièdre
- Localisation des retouches complémentaires et des troncatures ainsi que leur position et inclinaison
- Identification des catégories morphologiques
- Identification des techniques de retouches appliquées pendant toute la phase de façonnage.

Afin de mieux comprendre l'ordre des principales étapes opérationnelles adoptées pendant le façonnage, les pièces abandonnées en cours de construction et les pièces cassées pendant la retouche ont été aussi analysées. Une attention particulière a également été accordée aux pièces reprises et donc aux processus de recyclage d'armatures.

Une analyse préliminaire pour l'identification des fractures diagnostiques d'impact a été aussi réalisée dans le but d'avancer des hypothèses sur les modes de montage des armatures lithiques en suivant les résultats des études précédentes (Fischer, Vemming Hansen et Rasmussen, 1984 ; Plisson, 2005 ; Yaroshevich et al., 2010 ; Duches, 2011 ; Chesnaux, 2014 ; Roux et al., 2020).

5. La méthodologie dans la pratique

5.1. Activité expérimentale et analyse des matériaux expérimentaux

L'activité expérimentale a été réalisée par l'Auteur et par deux autres tailleurs (Davide Visentin et Alessandro Potì). Les matières premières sélectionnées étaient représentées par des nodules de la Formation Maiolica qui se trouvent largement dans la région de Lessini (VR, Italie), quelques blocs de radiolarite du plateau de Cariadeghe (BS, Italie) ainsi que de la Scaglia Rossa et de la Scaglia Variegata de la Vallée de Non (TN, Italie). Deux chaines opératoires indépendantes ont été adoptées dans deux buts différents : la première vise à produire des lames et des lamelles à partir de gros nodules et la deuxième des microlamelles à partir de petits blocs. Deux techniques de taille ont été utilisées : la percussion directe à la pierre tendre et la percussion directe organique (bois de cervidé). Ensuite, des produits lamino/lamellaires caractérisés par des bords parallèles ou subparallèles ont été sélectionnés et divisés en plusieurs classes dimensionnelles afin de tester les méthodes et les techniques de retouche sur des pièces présentant des valeurs morphométriques différentes. L'activité de retouche visait à obtenir quatre catégories principales d'armatures : les pointes à dos, les lamelles à dos, les lamelles à dos tronquées et les géométriques. Les retouches ont été appliquées en utilisant différents galets de calcaire, de grès et de serpentinite de même que des retouchoirs en bois de cervidé et en os.

5.1.1. Analyse qualitative pour l'identification des techniques de retouche

Une analyse à la binoculaire et une au microscope ont été effectuées afin d'identifier un large éventail de critères diagnostics utiles à la reconstruction des techniques de retouche. Une telle approche combinée est souvent utilisée dans l'analyse fonctionnelle mais elle est rarement appliquée à la production des outils lithiques (Rots 2010). La première a été menée sur un échantillon de 140 armatures expérimentales et elle a permis d'identifier plusieurs variables descriptives significatives à l'identification des techniques de retouche, en particulier : (a) la distribution des élèvements du dos, (b) la morphologie du bord retouché, (c) la délinéation du dos vue par la face dorsale, (d) la morphologie des négatives, (e) la terminaison ainsi que l'initiation des négatives, (f) l'inclinaison du dos, (g) la délinéation du dos vue en section transversale, (h) la localisation et la morphologie des cônes incipient. La validité de ces paramètres a été vérifiée par une série de *blind tests* réalisés par l›auteur et quatre lithiciens qui ont atteint un taux de réussite d'environ 70-75% (Fasser et al. 2019).

Les fractures liées au façonnage ont été observées en essayant d'identifier des morphologies spécifiques de chaque technique de retouche. Il est intéressant de noter que la morphologie des fragments change en fonction du mode de retouche appliqué et donc qu'il peut être utilisés comme élément diagnostic de séquences de réduction spécifiques.

L'application de l'approche à haut grossissement sur un échantillon de 50 armatures expérimentales a permis de mettre en évidence la formation, au cours de la retouche, de plusieurs microtraces ainsi que d'établir une corrélation entre certaines d'entre elles et la matière première (organique or minéral) de retouchoirs

5.1.2. Analyse quantitative pour l'identification des techniques de retouche

L'un des problèmes les plus fréquents concernant l'identification des techniques de retouche ainsi que de celles de débitage est représenté par l'interprétation subjective que différents chercheurs donnent des paramètres évalués comme diagnostiques de chaque technique. Afin d'éliminer cette problématique qui peut porter à l'application de façon parfois arbitraire de ces paramètres, nous avons essayé de les quantifiés, en examinant 80 négatifs de retouches (20 par technique). Les paramètres considérés pour chaque négatif étant :

- - la largeur de l'initiation et de la terminaison des négatives
- - angles de diffusion des négatives
- - la profondeur des négatives.

Les deux premiers paramètres ont été mesurés au microscope numérique, tandis que la profondeur par l'emploie du logiciel Mountains Lab.

En testant la signification statistique des différences métriques entre les négatifs produits par les quatre techniques à travers le logiciel RStudio, des résultats intéressants ont été obtenus : la pression par retouchoir organique et la percussion sur enclume sont statistiquement différenciables, au contraire, selon les paramètres enregistrés, entre la pression par retouchoir à la pierre et l'égrisage à la pierre il n'existe aucune différence statistique.

5.1.3. La technique du microburin

Une ultérieure section expérimentale a eu pour but d'examiner la technique du microburin. Cette procédure est sporadiquement attestée au Paléolithique supérieur pour devenir ensuite un élément clé dans la production des géométriques sauveterriens. Deux modes d'application de la force ont été proposés pour obtenir un piquant-trièdre : la percussion sur enclume et la pression (Tixier et al 1980 ; Inizian et al 1999). Cependant personne n'a essayé d'identifier des paramètres diagnostiques pour les distinguer. Pour cette raison une collection expérimentale de 95 microburins a été produite et ensuite examinée à la binoculaire et au microscope. Les résultats ont révélé que la variabilité morphologique de plusieurs éléments observables sur les microburins (la morphologie des encoches, des pointes d'impact, des bulbes tout comme l'inclinaison et le profil de la fracture) ainsi que les microtraces liées au type de retouchoir (organique vs lithique) sont efficaces pour discerner les différentes techniques de fracturation.

5.2. Analyse des séries archéologiques

La méthodologie développée pour l›analyse des matériaux expérimentaux a été adoptée également pour l›étude des séries archéologiques. Un total d›environ 2250 pièces a été pris en compte. Pour la zone italienne, nous avons sélectionné des sites de l›Épigravettien récent et du Sauveterrien qui s'étendant du GS-2a au début de l'Holocène (17.000-9.000 B.P.) : Riparo Tagliente, (VR ; couches 17 à 4), Riparo Soman (VR; phase d'occupation I et II), Riparo Biarzo (UD; couche 5), Mondeval de Sora, (BL ; couche 8). Pour la zone française, nous avons choisi le site de Troubat (Hautes Pyrènes ; layer 13-6) et de Pont d'Ambon (Périgord ; couches 3B-2). Ces sites sont datés approximativement à la même période chronologique que les sites italiens et se réfèrent au Magdalénien moyen et supérieur, à l'Azilien ancien et récent ainsi qu'au Laborien ancien. Pour reconstruire les méthodes et les techniques de production, une approche à faible grossissement (0,63x - 3x) au binoculaire a été appliqué systématiquement sur toutes les pièces analysées. L'approche à haut grossissement au microscope (50x-500x) a été appliquée à un échantillon d'armatures provenant de Riparo Tagliente et Mondeval de Sore, tandis que l'analyse quantitative seulement à des armatures de Riparo Tagliente .

DEUXIÈME PARTIE

1. Les résultats de l'analyse des séries archéologiques

1.1. Troubat (Hautes-Pyrénées, France)

1.1.1. Le Magdalénien supérieur : les couches 10-7

Le Magdalénien supérieur de Troubat est datée entre la fin du Dryas ancien (couche 10-8) et l'Allerød (couche 7). Les dates qui se réfèrent à cette dernière période ne sont pas acceptées par tous les académiciens car probablement trop récentes. L'analyse technologique de 280 armatures porte à affirmer qu'il n'y a pas de changements significatifs le long de la séquence stratigraphique du Magdalénien supérieur et que la sélection des supports, les méthodes et les techniques de retouche restent similaires, révélant une certaine homogénéité à la transition entre le Magdalénien supérieur ancien et le Magdalénien supérieur récent. L'assemblage des armatures est composé exclusivement d'éléments latéraux bien standardisés et les principaux types attestés sont des lamelles à dos tronquées, trois morphologies différentes de lamelles à dos (lamelles à dos étroites et appointées, lamelles à dos appointées et lamelles à dos simple) et une petite collection de triangles scalènes fabriqués sans l'emploie de la technique du microburin. La seule variation remarquable le long de la séquence est la quasi disparition des triangles dans la couche 7. Aucune pointe lithique a été attestée.

Toutes les armatures sont produites sur des microlamelles (longueur < 36 mm) de plein débitage plutôt réguliers, étroites (< 10 mm), fines (1-2 mm) et parfois obtenus par un débitage sur tranche. Le façonnage est peu invasif et se fait par une seule séquence de retouches marginales et directes ou tout au plus par l'ajout d'une seconde séquence de retouches légèrement plus profondes. La pièce n'est pratiquement jamais retournée afin d'appliquer une retouche croisée. Par ailleurs afin de modifier le bord opposé au dos, une retouche complémentaire marginale directe et semi-abrupte est parfois appliquée sur les lamelles à dos et les lamellas à dos tronquées. L'ensemble du processus de façonnage a été réalisé à travers une pression par retouchoir organique. Plus rarement, les traces observées sur les dos indiquent l›utilisation d›un retouchoir en pierre. L›application d›une ou deux troncatures marginales et directes semble être une solution occasionnelle. Leur orientation est transversale ou oblique. Le fait que seulement trois lamelles à dos tronquées ont été trouvées complètes ne nous permet pas de comprendre pleinement leur morphologie. Les triangles scalènes sont systématiquement orientés avec l'apex en position distale.

1.1.2. L'Azilien récent : la couche 6

Un total de 87 pointes à dos prévenant de la couche 6 a été examiné. Ces pièces sont datées au Dryas récent. Les supports sélectionnés sont des microlamelles épaisses et des éclats laminaires extrêmement irréguliers. Le façonnage est mal contrôlé, ce qui entraîne une grande variabilité morphologique. Cette variabilité peut être regroupé en deux morphotypes principaux

: les pointes à dos courbe et les pointes fusiformes. Les premières sont produites sur des microlamelles à travers un dos courbe opposé à un bord rectiligne et une portion proximale non retouchée. Au contraire, les pointes fusiformes sont le plus souvent produites sur des éclats laminaires ayant une forme symétrique par rapport à l'axe morphologique du support. Cette symétrie est parfois obtenue par une retouche partiale opposée au dos courbe ou même par un deuxième dos total. D'une manière générale, les pointes à dos courbe et les pointes à dos fusiformes doivent être considérées comme des variantes de la même idée de pointes de projectile, ces dernières étant produites sur des supports plus larges et plus courts tandis que les premières sur des supports plus allongées. La retouche du dos est systématiquement profonde et croisée au niveau de la pointe sur les pièces les plus épaisses. La percussion sur enclume est la technique de retouche la plus utilisée. De petits cônes incipient sur la face dorsale diagnostiques d'une enclume en pierre ont été parfois identifié. Une retouche à pression appliquée par retouchoir en pierre est visible sur les apex et sur les rares pièces fines.

1.2. Pont d'Ambon (Dordogne, France)

1.2.1. Azilien ancien : couche 3B

La couche 3B de Pont d'Ambon est datée autour de 14000-13500 cal BP. Deux morphologies bien standardisées de pointes à dos courbe ont été identifiés sur un total de 146 pièces provenant de la couche nommée : les bipointes et les monopointes. Les supports sélectionnés sont des lames et lamelles de plein débitage plutôt régulières au profile rectiligne ou légèrement courbe présentant une section transversale assez plate. Si l'épaisseur est bien calibrée (3-4 mm) et la longueur est standardisée (50-70 mm), au contraire la largeur est plus variable (8-20 mm). Les méthodes de retouche sont aussi assez normalisées : le dos est marginal et direct en cas de supports étroits (< 12 mm) et fins (< 3 mm) tandis qu'il est profond et crossé quand les supports sont plus larges et épais. Les retouches inversées du dos sont utilisées pour affiner les pointes. Le façonnage du dos commence à partir de l'apex distal en avançant progressivement vers la partie mésiale. Il peut ensuite continuer par une seule séquence d'enlèvements jusqu'à atteindre le deuxième apex ou la base ou bien par une seconde séquence de retouche à partir de l'extrémité proximale. Le côté opposé au dos est naturellement rectiligne et donc rarement modifié par des retouches complémentaires. Les techniques de retouche identifiées sont la percussion sur enclume et plus rarement la pression par retouchoir en pierre ; cette dernière n'est employée que pour modifier les pièces les plus fines par une retouche plus marginale et pour façonner les apex. Le retouchoir organique n'est plus employé et l'analyse des fractures diagnostiques d'impact confirme un montage des pointes dans une position latéro-distale.

1.2.2. L'Azilien récent : la couche 3A et 3

la couche 3A de Pont d'Ambon confirme un changement important dans les armatures autour de 13300-13100 cal BP. En effet, les pointes à dos (n=146) sont obtenues à partir de supports hétérogènes (éclats laminaires et lames/lamelles larges et épaisses) et façonnées par une retouche plus invasive par rapport à la phase azilienne ancienne. Si la sélection d'un large éventail de supports cause une diminution du degré de standardisation de la taille des pointes, la morphologie est assez homogène. Effectivement, un seul type est quasi systématiquement attesté : la pointe à base rétrécie (sensu Célérier 1993b). Le processus de façonnage se déroule à travers deux séquences de retouche opposées profondes et directes : la première de l'apex vers la partie mésiale, la seconde au contraire part de la base. Une dernière séquence de retouches inverses est ensuite occasionnellement appliquée pour amincir l'apex des pièces les plus épaisses. La technique de retouche employée est la percussion sur enclume en pierre. Comme dans la couche 6 de Troubat, de petits cônes incipient sur la face dorsale diagnostiques d'une enclume en pierre ont été identifiés sur les pointes à dos plus épais (4-5 mm). Enfin, les modes de montage sont assez variables : axial ou plus désaxé selon la courbature du dos.

L'analyse des armatures de niveau 3, datées au Dryas récent (n=56), a donné des résultats plutôt inattendus. En effet les supports deviennent plus réguliers et allongés, tandis que les éclats laminaires sont quasiment absents. D'un côté les pointes à base rétrécie deviennent plus étroites et allongées et elles présentent un dos mois courbe, d'un autre coté deux nouveaux types de pointes à dos apparaissent : des bipointes et une sorte de Microgravette. Cette dernière a un dos rectiligne ou légèrement convexe sur la pointe et elle peut avoir des retouches marginales opposées au dos sur la base ou sur l'apex. Les fractures d'impact diagnostiques observées dans ce dernier type suggèrent une modalité de montage axiale. En outre, la percussion sur enclume reste la technique la plus utilisée pour façonner le dos, sauf pour les retouches complémentaires où une pression par retouchoir organique et en pierre est attesté.

1.2.3. Laborien ancien : la couche 2 de Pont d'Ambon

Les armatures analysées (n=226) de la couche 2 de Pont d'Ambon, datée entre le Dryas récent et le début de l'Holocène, sont représentés par des pointes de la Maluarie et des rectangles. Ces armatures sont fabriquées à partir de lames et de lamelles de plein débitage très régulières et caractérisées par un profil droit, une épaisseur calibrée (3-5 mm) ainsi qu'une largeur assez variable. La profondeur de dos est liée à l'obtention d'une classe de largeur spécifique (9-10 mm), donc le dos peut être marginal, direct et semi-abrupt ou profond, direct et abrupt selon la largeur du support. Une retouche croisée est utilisée exclusivement dans les pointes de la Malaurie plus épais. La délinéation du dos des pointes de la Malaurie peut être rectiligne ou légèrement convexe. La pointe est également proximale ou distale et la troncature basale peut avoir une orientation transversale ou plus rarement oblique. Au contraire, les rectangles ont un dos systématiquement rectiligne et deux troncatures transversales. Le bord fonctionnel n'est jamais modifié par des retouches complémentaires.

Les techniques de retouche changent radicalement par rapport à la phase précédente : la pression par retouchoir organique devient la technique la plus utilisée.

Les points de la Maluarie et les rectangles ont une longueur très variable qui s'explique, au moins partiellement, par un fort processus de recyclage selon trois modalités différentes :

- remise en forme des rectangles fracturées.

- remise en forme des pointes de la Malaurie fracturées
- transformation de fragments basaux de pointes de Malaurie en rectangles.

L'analyse des fractures d'impact a permis de proposer une arme de chasse conçue comme composite et donc formée par l'association d'une pointe apicale (pointe de Malaurie) et plusieurs lamelles à dos bi-tronquées (rectangles) montées latéralement par rapport à la hampe.

1.3. Riparo Tagliente (VR, Italie)

1.3.1. la phase ancienne (17-11)

À la fin du Dryas anicien l'objectif de la production se concentre sur des pointes à dos allongées, étroites, fines et plutôt standardisées (pointes à dos allongé, type A et B ; cf. Microgravettes), associées à de rares pointes à cran et quelques lamelles à dos. Ces projectiles sont fabriqués sur des microlamelles homogènes au profile rectilignes et aux bords réguliers. Le dos est systématiquement rectiligne et réalisé par des retouches directes et abruptes. En plus, étant donné les faibles valeurs d'épaisseur des supports choisies, les armatures sont rarement façonnées par une retouche croisée. Le façonnage du dos s'effectue d'abord par l'extrémité distale (avec un apex dans le cas des pointes à dos), puis par une retouche progressive le long de l'axe longitudinal de la pièce par une seule séquence de retouches. Le bord opposé au dos est légèrement convexe et il est parfois modifié par des retouches complémentaires directes et semi abruptes ou inverses et plates afin de mieux délimiter l'apex ou plus rarement la base.

Les lamelles à dos tronquées sont très sporadiques et elles semblent être une morphologie occasionnelle et souvent le résultat d'un processus de recyclage comme le suggère le haut pourcentage de fractures reprises. Les troncatures sont simples, rarement doubles, avec une orientation variable. Ces éléments peuvent également être le résultat d'une pratique circonstancielle au moment du montage ayant pour but d'adapter la longueur d'une lamelle à dos à l'espace restreint dans lequel elle doit être insérée.

La technique de retouche la plus utilisée est la pression, qu'elle soit appliquée par un retouchoir organique (moins fréquente) ou en pierre (plus fréquente) pendant tout le processus de fabrication. L'analyse à haut grossissement effectuée plaide en faveur d'un compresseur organique fabriqué en bois de cervidé. Une percussion en pierre tendre sur une enclume organique est aussi documentée.

1.3.2. La phase récente (10-4)

Les couches supérieures du Riparo Tagliente marquent une transformation importante des armatures lithiques à la transition entre le GS-2 et la première moitié de GI-1. En ce qui concerne les pointes à dos, l'analyse technologique a mis en évidence d'importants changements dans la sélection des supports et dans les méthodes et techniques de retouche. Un «nouveau» type de pointe à dos (pointes à dos large, type A et B) se développe à côté des Microgravettes plus traditionnelle. Non seulement les pointes à dos large sont plus robustes et épaisses, mais elles présentent aussi un rapport largeur-longueur inférieur à 1 : 5. Le type B (le plus attesté) est généralement obtenu sur des lamelles larges et épaisses ou des éclats laminaires irrégulières, alors que les pointes à cran ne sont plus fabriquées. En général les pointes à dos commencent à être normalisées par un investissement technique plus important dans leur phase de façonnage. En outre, le dos devient plus souvent courbe et croisé et la partie basale est modifiée par des retouches complémentaires ou des troncatures convexes.

Les séquences de retouche deviennent aussi plus variables : la retouche du dos ne se produit plus seulement par une seule séquence d'enlèvement (comme dans la couche 17-11), mais aussi par deux séquences indépendantes opposées ou même par plusieurs séquences chaotiques.

Les couches les plus récentes de Riparo Tagliente (couches 6 à 4) montrent le début d'un processus de standardisation des lamelles à dos tronquées. Ce type d'armature devient plus normalisé tant du point de vue dimensionnel (épaisseur et largeur) que morphologique (profil rectiligne et double troncature). Cependant, la longueur reste variable, tandis que l'orientation de la troncature dessine plus fréquemment une morphologie asymétrique.

Le changement dans la sélection des supports et dans l'intensité de la retouche provoque une adaptation des techniques de retouche : la pression diminue de manière significative, tandis que la percussion sur un enclume organique augmente.

1.4. Riparo Biarzo (UD, Italie)

La couche 5 de Riparo Biarzo, datée à la fin de l'Allerød et dont nous avons examiné 339 armatures, révèle la situation suivante. Les pointes à dos montrent les mêmes morphotypes identifiés dans la phase récente de Riparo Tagliente : des Microgravettes (pointes à dos allongé) et des pointes à dos large présentant une délinéation du dos courbe. Les dos sont profonds, abrupts et directs ou croisés et l'utilisation d'une retouche croisée est strictement liée à un dos d'une épaisseur supérieure à 3 mm. Les détachements inverses sont généralement situés dans la partie mésiale ou basale. L'utilisation d'une retouche complémentaire est moins intense par rapport au Riparo Tagliente, probablement en raison de la taille plus réduite des supports sélectionnées. Elles sont marginales, directes et semi-abruptes ou inverses et plates. Ces dernières sont utilisées indifféremment pour amincir l'apex ou la base. Parfois, dans le cas de pointes à dos large, l'extrémité basale est modifiée par une sorte de troncature convexe. Il est intéressant de noter l'apparition de deux morphologies généralement répandues dans le nord-est de l›Italie au cours du Dryas récent, les trapèzes (n=2) et les Microgravettes montrant une troncature basale rectiligne avec une orientation oblique ou transversale (n=2). Deux pointes à dos double sont également attestées.

Les lamelles à dos tronquées de Riparo Biarzo représentent une nouvelle étape dans le processus de standardisation de ce type d'outil au Tardiglaciaire :

- elles deviennent le type le plus produite parmi les armatures
- elles sont fabriquées exclusivement à partir de microlamelles régulières de plein débitage au profil rectiligne ayant une épaisseur calibrée et une largeur qui ne dépasse pas 12 mm
- leur taille (longueur ; largeur ; épaisseur) diminue par rapport à la phase précédente

- leur morphologie se normalise fortement. Le dos est rectiligne ainsi que le bord opposé, qui est fréquemment modifié par des retouches très marginales, les troncatures sont doubles et symétrique les unes aux autres

En revanche, les lamelles à dos simple disparaissent presque totalement.

Les séquences de retouches adoptées varient en fonction de la morphologie des supports ; en effet, les supports étroits sont modifiés par une seule séquence d'enlèvements, tandis que les plus larges sont transformées par plusieurs séquences chaotiques. En ce qui concerne les techniques de retouche, la percussion sur une enclume reste la plus employée. La pression n'est utilisée que sur les pièces les plus fines par retouchoir en pierre et pour les retouches complémentaires.

1.5. Riparo Soman (VR, Italie)

La séquence stratigraphique épigravetienne de Riparo Soman est traditionnellement divisé en deux phases : la première datée de la transition Bølling-Allerød par une seule date, la seconde du Dryas récent par quatre dates. Cependant, différents aspects font penser que les occupations humaines sont entièrement référables au Dryas récent ou tout au plus à la fine de l'Allerød. Notamment : l'absence de différences typologiques et technologiques entre les deux phases, les fortes divergences de la première phase de Riparo Soman par rapport à la phase récente de Riparo Tagliente (théoriquement contemporaines) et la présence de plusieurs types d'armatures plus fréquemment attestés à la fin du Allerød ou au Dryas récent plutôt que dans la première partie de l'interstadial. En outre, aucune variation importante des restes fauniques a été enregistrée le long de la séquence (Tagliacozzo et Cassou, 1994) et le dépôt archéologique était principalement composé de brèches détachées de la voûte de l'abri en raison des phénomènes thermoélastiques suggérant une formation sous l'influence d'un climat plutôt froid (Dryas Récent ?) (Battaglia et al., 1994).

Les armatures examinées (n=212) enregistrent plusieurs changements par rapport au Riparo Biarzo et la phase récente du Riparo Tagliente. Le plus évident concerne la production de pointes à dos. D'abord les pointes à dos large de type B produites sur des lamelles irrégulières et épaisses ou sur des éclats laminaires sont presque absentes, tout comme les dos à délinéation courbe. Puis la sélection des supports se concentre sur des microlamelles fines (1-3 mm), régulières et de largeur variable (7-15 mm) présentant une section relativement plate et sur des lamelles de forme allongée (largeur variante entre 9 mm et 16 mm et épaisseur entre 2 mm et 4 mm). La première catégorie de supports est principalement utilisée pour produire des pointes à dos large de type A et des pointes à dos allongé de type A, tandis que la seconde sert à fabriquer des pointes à dos allongé de type B. Ensuite la délinéation du dos revient à être plutôt rectiligne ; la retouche du dos est profonde, directe et abrupte ou profonde, croisée et abrupte, selon l›épaisseur du support. Des troncatures rectilignes transversales ou obliques formant un angle obtus par rapport au dos sont bien attestées. Ces pointes à dos tronquées représentent 1/3 de l'assemblage des pointes à dos entières. D'une manière générale, nous constatons un retour à un investissement plus important dans la standardisation des supports plutôt que dans le façonnage.

Les lamelles à dos tronquées sont très similaires à celles de Riparo Biarzo. Elles sont presque exclusivement fabriquées sur des microlamelles régulières, fines et étroites et le façonnage a clairement pour but de normaliser leur taille. Cependant, la double troncature peut être soit oblique que transversale. Comme à Riparo Biarzo, les lamelles à dos sont presque absentes tandis que les géométriques et les microburins sont probablement le résultat des mélanges avec les couches Sauveterriennes. Cinq trapèzes sont documentés.

Un façonnage peu invasif influence les techniques de retouches adoptées : les dos sont plus fréquemment retouchés par pression organique. La percussion sur une enclume organique est principalement utilisée pour les pointes à dos en raison de leur plus grande épaisseur.

1.6. Mondeval de Sora (BL, Italie)

Un échantillon de 208 armatures et de 421 microburins provenant de la couche 8 du Mondeval de Sora (10583-10407 cal BP 10716-10556 cal BP) a été analysé. Trois types d'armatures ont été identifié : les géométriques, les pointes à dos (principalement des Sauveterres) et les lamelles à dos tronquées. Les premières sont fabriquées sur des microlamelles à section triangulaire de moins de 25 mm de longueur. La latéralisation des encoches de microburins (microburin proximale - encoche droit et microburin distal- encoche gauche) et la longueur des supports sélectionnées révèlent l'emploie d'un seul coup de microburin pour chaque géométriques afin d'enlever une extrémité de support, alors que l'autre est principalement réduite par la retouche (directe et semi-abrupte). Une troisième retouche extrêmement marginale est souvent attestée sur le bord opposé au dos. La fracture du microburin est systématiquement atteinte par pression appliquée par retouchoir organique (peut-être bois de cervidé) ainsi que la retouche. Parfois, après le coup de microburin, la retouche peut se faire par pression à la pierre tendre. Les assemblages géométriques ont été divisés en 7 morphotypes différentes attestant une grande variabilité morphologique :

- Triangle scalène court
- Triangle scalène allongé
- Triangle isocèle court
- Triangle isocèle allongé
- Segment symétrique
- Segment asymétrique
- Segment large

Parmi eux, le plus attesté est le triangle scalène court. En général, la taille des géométries est extrêmement réduite. L'écart interquartile varie entre 8-11 mm pour la longueur, 3-4 mm pour la largeur et 1-2 mm pour l'épaisseur.

En revanche, les pointes à dos sont fabriquées sur un plus large éventail de produits, notamment les microlamelles et les éclats laminaires de moins de 25 mm de longueur à section trapézoïdale (l'épaisseur est légèrement supérieure par rapport aux supports utilisées pour les géométriques) et des éclats obtenus à partir d'une chaîne opératoire dédiée. Leur processus de réduction implique la mise en forme d'un ou deux dos par retouches profondes, directes et abruptes. Les faibles valeurs d'épaisseur (< 4 mm) ne nécessitent d'aucune utilisation de retouche croisée. Elles ont été façonnées transversalement sur les éclats ou longitudinalement sur les microlamelles et les éclats laminaire. Trois morphotypes ont été identifiés en fonction du rapport longueur-largeur et du nombre de dos : Les Sauveterre étroites, les Sauveterrien larges et les petites pointes à dos courbe. La technique de retouche principalement utilisée est la pression par retouchoir organique, moins fréquemment en pierre. par contre l›exploitation de la percussion sur enclume est rare.

Au sein de l'assemblage d'armatures, une bonne quantité de lamelles à dos tronquées a également été analysée. La majorité d'entre elles présentent une morphologie et une taille très standardisées. En effet elles sont produites sur des microlamelles régulières et fines (1-2 mm) par un dos rectiligne appliqué par une retouche directe et abrupte. La profondeur du dos (profond ou marginal) est fortement liée à l'obtention d'une largeur standardisée de 3-4 mm. et les troncatures sont simples ou doubles avec une orientation transversale. Le bord opposé au dos a une délinéation rectiligne obtenue en appliquant une séquence très marginale de retouches.

TROISIÈME PARTIE

1. Discussion et conclusion

1.1. Encadrement des résultats dans la séquence atlantique-occidentale française

1.1.1. Le Magdalénien supérieur

La variabilité des armatures attestée à Troubat reflète parfaitement celle d'autres sites pyrénéens. Belvis (Sacchi, 1994), Parco (Langlais, 2010), La Vache (Schmider, 2003) et Rhodes II (Fat Cheung, 2015) confirment un équipement de chasse principalement composé par des lamelles à dos appointées, des lamelles à dos simple, des lamelles à dos tronquées et des triangles scalènes. Leurs modalités de production aussi sont conformes à ce que nous avons observé à Troubat. Les supports sont des microlamelles fines et étroites parfois obtenues par un débitage sur tranche, la retouche est marginale et directe, montrant une certaine homogénéité dans toute la région pyrénéenne. Le seul type manquant à Troubat est celui de lamelle à dos denticulé.

L'absence de pointes lithiques à Troubat, comme dans les autres sites pyrénéens, a confirmé l'existence de deux régions distinctes dans le sud-ouest de la France (Langlais, 2018) : d'un côté le bassin d'Aquitaine et le Quercy présentant des pointes lithiques et d'un autre côté les Pyrénées et le Languedoc dépourvus de pointes lithiques. Cette différence, plutôt que le résultat d'une réelle démarcation culturelle, semble être influencée par les contraintes liées aux matières premières disponibles localement qui sont de faible qualité et sous forme de petits blocs (Fat-Cheung, 2015 ; Lacombe, 2005 ; Simonnet, 2007, 2003, 1999). En effet, dans les sites pyrénéens les lames sont souvent importées alors que la production locale est de plus petite taille (Langlais et al., 2016). Etant donné que les pointes lithiques sont produites sur des supports de plus grandes dimensions par rapport aux lamelles à dos (Langlais, 2007 ; Langlais et al., 2016) et qu'elles sont très sensibles aux fractures d'impacts (e.g., Duches, 2011 ; Borgia, 2006), il s'agirait d'une stratégie peu fonctionnelle en termes économiques d'utiliser une ressource aussi «précieuse» que les lames pour un objet à court terme comme les pointes de projectiles.

Pour ce qui concerne les techniques de retouche, les seules données datées à cette période viennent de l'unité d'habitation Q31 du site en plein air d'Étiolles. J. Pelegrin (2004) a proposé pour la production de 10 armatures l'utilisation à la fois de la pression par retouchoir organique et de la percussion sur enclume. Si d'une part, cette étude confirme l'emploie d'un retouchoir organique au Magdalénien supérieur, d'autre part la petite taille de l'échantillon ne permet pas de vérifier quelle technique était la plus répandue.

1.1.2. L’Azilien ancien

La couche 3B de Pont d’Ambon a attestée une rénovation complète de l’équipement de chasse par rapport au Magdalénien supérieur suivie par un changement drastique tant dans la sélection des supports que dans les méthodes et techniques de retouche. Le seul aspect en continuité avec le Magdalénien supérieur est une certaine normalisation des supports sélectionnées. Cependant, leur taille augmente fortement, ce qui oblige les tailleurs a façonné les armatures par une retouche plus invasive à la percussion sur enclume quelquefois associée à la pression à la pierre.

L’Azilien ancien semble être l’un des rares faciès culturels européens du Tardiglaciaire pendant lequel les armatures ne sont pas des indicateurs de tendances régionales En effet, les traits observés dans la couche 3B de Pont d’Ambon sont les mêmes enregistrés sur l’ensemble du territoire Azilien ancien (Bodu et Mevel, 2008 ; Bodu et Valentin, 1997 ; Naudinot et al., 2018, 2017a ; Valentin, 2006 ; Fat Cheung et al., 2014 ; Mevel, 2013), à l’exception de la partie centrale et orientale des Pyrénées (Fat Cheung, 2015, 2020 ; Fat Cheung et al., 2014). N. Naudinot et L. Mevel ont observé l’utilisation de la percussion sur enclume pour la production d’armatures au Rocher de l’Impératrice (Naudinot et al., 2017a) et à La Fru couche 2 aire 1 (Mevel et al., 2014), confirmant la disparition des retouchoirs en os ou en bois de cervidé au cours de l’Azilien ancien. Ce changement est parfaitement cohérent avec la diminution de la production de l’industrie osseuse entre le Magdalénien supérieur et l’Azilien ancien. Même les techniques de taille témoignent du passage d’une percussion directe organique à une percussion directe à la pierre tendre, laissant donc la place à une production lithique entièrement gérée par des outils en pierre.

Cette diffusion de normes standardisées dans la production d’armatures est-elle représentative d’une plus grande homogénéité culturelle de l’Azilien ancien par rapport à d’autres périodes ? Ou les différentes identités ethniques doivent-elles être recherchées dans d’autres aspects de la vie quotidienne des groupes humains ? Il s’agit d’une ligne de recherche intéressante qui doit être mieux examinée à l’avenir, surtout si on la compare à l’Azilien récent pendant lequel, comme nous avons pu l’observer, la variabilité morphologique des armatures lithiques à travers l’espace augmente de manière significative.

1.1.3. L’Azilien récent

L’analyse des niveaux aziliens récent de Pont d’Ambon et Troubat ont permis de mettre en évidence quatre grandes tendances dans la production d’armatures au cours de l’Azilien récent.

En général les Pyrénées et le bassin d’Aquitaine semblent répondre à un même schéma conceptuel pour la production de monopointes à dos courbe : supports peu standardisés et un façonnage très invasif par percussion sur une enclume en pierre. Certaines de ces caractéristiques sont bien connues dans toute la région Atlantique comme l’ont déjà souligné plusieurs auteurs (Fat Cheung 2014 ; Fat Cheung et al. 2014 ; Naudinot, 2008 ; Naudinot et al., 2017b, 2019 ; Valentin 2006).

La deuxième tendance est un certain degré de spécificité de la région pyrénéenne par rapport à la plaine aquitaine. En effet, la variabilité des pointes attestée à Troubat (pointes à dos courbe et pointes fusiformes) a été observée uniquement dans les autres sites pyrénéens (Fat Cheung 2020, 2015, 2014 ; Barbaza 1996, 2009). Au contraire, les pointes à base rétrécie témoignés à Pont d'Ambon couche 3A sont observées dans plusieurs sites voisins, comme Abri Murat, Rochereil, Pégourié, Morin et Pagès (Fat Cheung, 2014 ; Fat Cheung et al., 2014), mais elles sont absentes dans les Pyrénées. Cette typologie de pointes semble diminuer en s'éloignant du bassin d'Aquitaine (Bodu et Valentin, 1997 ; Naudinot, 2008 ; Valentin 2006), voir disparaître (Mevel et al., 2014 ; De Bie et Caspar, 1996), en soulignant une forte diversité morphologique de pointes à dos courbe au cours de l'Azilien récent.

En autre, une différente distribution des lamelles à dos et/ou des lamelles à dos tronquées a été observée entre la France occidental (Pyrénées, Aquitaine, Bretagne et Pays de la Loire), où elles sont absentes (Fat-Cheung et al., 2014 ; Marchand et al., 2009 ; Naudinot, 2008, 2013) et les territoires plus orientaux (Normandie, Bassin parisien, vallée de la Somme, Alpes occidentales, Rhénanie) où les lamelles à dos ou les lamelles à dos tronquées sont bien documentées (Baales and Street, 1996 ; Bodu et Valentin, 1997 ; Coudret et Fagnart, 2015, 2012, 2004, 1997 ; De Bie et Caspar, 1996 ; Mevel et al., 2014 ; Naudinot et al, 2019 ; Valentin et al., 2004). La signification de cette différence dans l'armement de chasse n'a jamais été vraiment discutée. Pourrait-elle être liée à des interactions plus intenses entre les groupes humains aziliens plus orientaux et ceux de l'Épigravettien récent où les lamelles à dos et lamelles à dos tronquées sont très communes ?

Enfin, l'étude de la couche 3 de Pont d'Ambon a permis d'identifier une phase azilienne anecdotique probablement référée à la première partie du Dryas récent. Elle est caractérisée par un assemblage de pointes à dos qui semble anticiper partiellement des caractéristiques observées à partir du Laborien ancien, comme la diffusion de pointes produites sur des supports plus réguliers et allongés par des dos plus rectilignes et l'emploie, bien que marginalement, de la pression par un retouchoir organique. Ce changement dans l'arme de chasse doit-il être considéré comme une étape intermédiaire vers la «Laborianisation» des armatures lithiques ? Ou bien peut-il représenter une phase azilienne indépendante actuellement mal connue dans le Sud-Ouest au début du Dryas récent ? Ce qui est le plus intriguant de ces pointes à dos rectiligne est la présence sur quelques unes d'entre elles de retouches complémentaires inverses et plates faites à pression par retouchoir organique. Cette pratique n'a jamais été mentionnée à l'Azilien récent, alors qu'elle constitue un élément clé des armatures épigravettiennes (Fasser et al., 2022).

1.1.4. Le Laborian ancien

Le début du Laborien ancien représente une forte rupture dans la séquence Tardiglaciaire du sud-ouest de la France. L'arme de chasse est conçue comme composite et formée par l'association d'une pointe apicale (pointe de Malaurie) et plusieurs lamelles à dos bi-tronquées (rectangles) montées latéralement. Par rapport à l'Azilien récent, où le comportement technique visait essentiellement à simplifier et à accélérer la production, les armatures du Laborien ancien témoignent d'un effort plus remarquable en termes de temps et de régularité, tant dans la production des supports que dans leur façonnage. Grace à l'analyse de la couche 2 de Pont d'Ambon nous avons pu souligner un changement drastique dans les techniques de retouche aussi reposant sur l'emploi quasi exclusif de la pression par retouchoir organique.

Bien qu'il n'y ait pas de publications présentant des données détaillées sur les modalités de fabrication des armatures du Laborien ancien, les rectangles et les pointes de la Maluarie ont toujours été décrites comme produites sur des lames régulières ou des petites lames à travers un dos rectiligne ou légèrement courbe, sans latéralisation préférentielle du dos ni orientation de l'apex. En plus, les troncatures sont presque systématiquement transversales (Langlais et al., 2014a, 2014b, 2015 ; Naudinot, 2013, 2010, 2008 ; Naudinot et Jacquier, 2014). Toutes ces caractéristiques sont parfaitement cohérentes avec les armatures du Laborien ancien de Pont d'Ambon. Par ailleurs, même si M. Langlais et al. (2020) ont souligné des différences dans les dimensions des supports et dans la précision du façonnage d'un site à l'autre, la variabilité de l'épaisseur et de la largeur d'au moins trois sites du Sud-Ouest (La Borie del Rey, Camping-du-Saut et Peyrazet) a donné les mêmes valeurs que celles de Pont d'Ambon. A noter que la longueur est toujours très variable.

Une réutilisation des pointes de Malaurie fracturées sous forme de rectangles a déjà été proposée par M. Langlais (Langlais, 2007 p. 393 ; Langlais et al., 2015, 2014b, 2014a), mais à la suite de notre analyse, nous avons démontré que ce processus de recyclage était en réalité considérablement plus complexe. Ce comportement technique est probablement lié à la façon dont sont conçues les armatures et leur mode de montage. Les pointes de Malaurie et les rectangles se caractérisent par une morphologie et une taille similaire qui ne permettent pas seulement de remettre en forme facilement les pièces après une cassure, mais aussi d'interchanger leur rôle sur l'arme de chasse. Il s'agit d'une stratégie très efficace en termes économiques permettant de ne point recommencer le processus de production après peu d'utilisations, ce qui est un énorme avantage compte tenu de l'effort technique élevé requis pour la production des supports ainsi que des armatures elles-mêmes. Cet aspect devient encore plus intéressant s'il est mis en relation avec un important système de réutilisations et recyclages des outils domestiques (Langlais et al., 2020 ; Naudinot et Jacquier, 2014, 2015), une augmentation des chasses sur longues distances ainsi qu' un changement des modèles de mobilité basé sur une intense circulation des matières premières et une segmentation spatio-temporelle très marquée des activités (Naudinot, 2013, 2010 ; Naudinot et Jacquier, 2014, 2015 ; Naudinot et al., 2019 ; Valentin, 2008).

1.2. Encadrement des résultats dans la séquence de l'Épigravettien récent

1.2.1. Le début de l'Épigravettien récent (ER 1)

En Italie du Nord, cette première phase de l'Épigravettien récent est peu documentée en dehors des couches les plus anciennes de Riparo Tagliente. Des sites archéologiques documentant des vestiges épigravettiens datés à la même période se trouvent dans les Balkans et en Italie centrale et méridionale. Au cours de cette période, d'une part la côte adriatique orientale présente une situation complètement différente caractérisée par la transition d'un Épigravettien à pointes à cran (Épigravettien ancien) à un Épigravettien à pointes à dos courbe (Épigravettien récent) (Kozlowski, 1999 ; Montet-White et Kozlowski, 1983 ; Vukosavljević et al., 2011) d'autre part la péninsule italienne subit un phénomène de régionalisation (Martini, 2007 ; Palma di Cesnola, 1983). Les sites du sud de l'Italie datés de cette période sont souvent fouillés à l'ancienne et seules des données typologiques sont disponibles. Une brève comparaison a permis quand même de mettre en évidence une certaine affinité avec Riparo Tagliente pour ce qui concerne la production des pointes à dos et des lamelles à dos (Martini et al., 2007, 2002 ; Palma di Cesnola, 2007 ; Palma di Cesnola et al., 1983 ; Ricci et al., 2019), comme par exemple, une plus grande quantité des premières par rapport aux secondes, la faible épaisseur du supports sélectionnés, la standardisation morphologique et les dos rectilignes. Les lamelles à dos tronquées, parfois même à double troncature symétrique, sont attestées quasi exclusivement dans les Pouilles (couche 7-5 de Paglicci, couche F-D de Le Mura ; Palma di Cesnola, 1993). En effet, dans le reste de l'Italie, comme à Riparo Tagliente, elles sont presque absentes (Mussi et al., 2008 ; Martini et al., 2007 ; Tozzi and Dini, 2007 ; Peresani et al., 2005 ; Ucelli Gnesutta et al., 2006). Les seules informations concernant les techniques de retouche pour cette période proviennent du site de Grotta del Pozzo (Aquila, Italie). Les Auteurs (Mussi et al., 2008) confirment l'emploi d'une technique par pression.

1.2.2. L'Épigravettien récent de la première partie de l'interstadial (ER 2)

Les variations identifiées le long de la séquence de Riparo Tagliente semblent être partiellement confirmées par les autres sites du nord-est de l'Italie. Dans la Grotta del Clusantin, datée au Bølling, les pointes à dos sont encore produites à partir de supports régulières et fines (Duches et Peresani 2010), tandis qu'à Val Lastari (Allerød) et Villabruna A (fin du Bølling-début d'Allerød), les pointes à dos sont fabriquées à partir d'un ensemble de supports plus variés, qui comporte des valeurs d'épaisseur plus élevées, suivant la tendance enregistrée à Riparo Tagliente (Montoya, 2004). Les sites mentionnés ont livré des lamelles à dos et des lamelles à dos tronquées, mais ces dernières présentent une double troncature symétrique et une morphologie assez normalisée uniquement dans les couches supérieures de Villabruna A (qui ne sont pas datées) et à Val Lastari, ce qui confirme la standardisation progressive de ce type d'objet au cours de l'interstadial. Cette tendance se vérifie également dans les Marches, où le seul site daté du début de l'Allerød (Grotta della Ferrovia) présente un important assemblage de lamelles à dos tronquées avec troncatures simples ou doubles (Broglio et Lollini, 1981 ; Peresani et Silvestrini, 2007). Ce type d'armature joue un rôle important également dans le reste de la côte adriatique, par exemple dans la couche 4-2 de Paglicci (Pouilles) (Palma di Cesnola et al., 1983 ; Palma di Cesnola, 2007) et dans la Grotta della Continenza (bassin de Fucin) où il apparait à partir de la couche 38, donc après 14000 cal BP (unités EP2 40-35) (Boschian et al., 2017). Sur la côte tyrrhénienne, les lamelles à dos tronquées sont peu documentées (Martini et al. 2007 ; Tozzi et Dini, 2007).

Les études typologiques menées sur les sites du centre et du sud de l'Italie ne permettent pas d'évaluer les éventuels changements dans la production de pointes à dos par rapport à la phase précédente, hormis l'apparition de quelques pointes à dos double sur la côte tyrrhénienne (Tozzi et Dini, 2007) et de Microgravettes à troncature basale oblique dans les Marches (Peresani et Silvestrini 2007). Le passage d'une technique de retouche par pression à une technique par percussion à la transition entre la fin du GS-2 et le GI-1 observé à Riparo Tagliente, est confirmé par les études de C. Montoya sur les sites vénitiens de Villabruna A et Val Lastari (Montoya, 2004).

Les Balkans attestent à partir de la dernière partie du GS-2 (vers 17000-15000 cal BP) la diffusion, à côté des Microgravettes et des lamelles à dos, de grands segments et de pointes à dos courbe (Montet-White et Kozlowski, 1983, Kowlowski, 1999 ; Vukosavljević et al., 2011). Certaines pièces présentent des similitudes morphologiques et technologiques avec celles de la phase récente de Riparo Tagliente. Dans ce cas également, la grande variabilité de la production de pointes à dos semble être liée à une augmentation de la variabilité des supports sélectionnés. Cette évidence pourrait suggérer une diffusion des dos courbes des Balkans vers l'ouest.

Une tendance similaire peut être détectée dans des sites du Sud-Ouest de la France datés de l'Allerød et initialement référencés au «Valorguien» par Escalon de Fonton (1972) mais successivement attribués à l'Épigravettien récent (Montoya, 2002, 2004). Comme à Riparo Tagliente, ces assemblages présentent en association avec les Microgravettes (pointes à dos allongé à Riparo Tagliente) un type plus large et plus épais (Pointe d'Istres) caractérisé par un dos plus courbé et une forme plus symétrique (Escalon de Fonton 1972 ; Onoratini, 1982). D'un point de vue morphologique, certaines Pointes d'Istres ressemblent à des pointes à dos large (type A et B) de Riparo Tagliente. Même la variante appelée par Escalon de Fonton (1972) « Pointe d'Istres à base arrondie » est très similaire aux pointes à dos tronquées large de type B avec une troncature basale convexe. Selon C. Montoya (2002), les Microgravettes et les Pointes d'Istres correspondent à la même idée de pointe à dos, mais ces dernières étant produites sur des supports moins standardisées et irrégulières.

1.2.3. L'Épigravettien récent entre la fin de l'interstadial et le Dryas récent (ER 3)

La plupart des études menées sur des sites du nord-est de l'Italie datés entre la fin de l'interstadial et le Dryas récent semblent concorder avec les différences et les similarités que nous avons pu observer entre la phase récente de Riparo Tagliente (première moite de GI-1), Riparo Biarzo (fin de GI-1) et Riparo Soman (GS-2). Par exemple, les couches 26c, 26b/14b et 15/65 de Riparo Dalmeri (TN), datées entre 13 400 et 12 900 cal. BP (Dalmeri et al., 2006), documentent une variabilité de pointes à dos qui rappelle encore celle proposée pour la phase récente de Riparo Tagliente et Riparo Biarzo (Duches et al., 2018) confirmant une certaine continuité au cours de l'interstadial. Au contraire, les lamelles à dos tronquées ont une morphologie (double troncature symétrique) parfaitement comparables exclusivement à celles de Riparo Biarzo et Riparo Soman. Cette évidence confirme la diffusion de ce type de lamelles à dos tronquées dans le nord-est de l'Italie à partir de la seconde moitié du GI-1. Même la technique de retouche est cohérente avec les résultats obtenus à Riparo Biarzo et dans la phase récente de Riparo Tagliente. Selon R. Duches et ses collègues (2018) la percussion sur enclume a été choisie plus fréquemment que la pression.

Parmi les sites datés du Dryas récent nous avons identifiés de nombreuses affinités avec Riparo Soman. Bus de la Lum (Peresani et al., 2000), Riparo Cogola couche 19 (Cusitano et al., 2004), Palù Echen (Duches et al., 2014) et Le Regole 1 et 2 (Basetti et al., 2009), montrent une disparition des pointes à dos larges type B et en général des dos courbes. En outre, une bonne quantité de pointes à dos tronquées et des trapèzes est attestée confirmant la propagation de ces types d'armature en particulier au Dryas récent. Les lamelles à dos tronquées sont bien normalisées avec une double troncature obtuse ou transversale et elles remplacent les lamelles à dos simple (Bassetti et al 2009 ; Cusinato et al, 2004 ; Peresani et al, 2000 ; Ziggiotti et Dalmeri, 2008). Une analyse morpho-scopique inédite d'un petit échantillon d'armatures (n=20) du le site de Arco (Mottes et al., 2018), menée par l'auteur, a certifié le passage d'une percussion sur enclume à une pression par retouchoir organique come principale technique de retouche au cours du Dryas récent.

Le même équipement de chasse est documenté dans la région des Marches soulignant de fortes interactions sociales entre les deux territoires. Le site de Cava Romita, daté au Dryas récent, présente des armatures produites sur des microlamelles bien standardisées. D. Esu et ses collègues (2006) décrivent les pointes à dos comme étroites (3-5 mm) et courtes (15-25 mm) avec un dos rectiligne ou légèrement convexe. Les parties proximales proposent parfois une troncature rectiligne basale. Les lamelles à dos bi-tronquées sont parfaitement comparables, d'un point de vue dimensionnel et morphologique (double troncature symétrique), à celles du Nord-Est. A. Broglio et al. (2005) mentionnent 3 trapèzes à la Grotta del Prete,

En ce qui concerne les armatures provenant des sites datés de la transition entre la fin de la phase Allerød et le Dryas récent dans le nord-ouest de l›Italie et le sud-est de la France, nous pouvons mettre en évidence une situation complètement différente par rapport au nord-est de l'Italie. Les pointes à dos sont des Microgravettes produites sur des supports allongées et régulières par un dos rectiligne à retouche directe et abrupte. Les pointes à dos courbes ou légèrement courbes fabriquées sur des supports irréguliers et épais semblent absentes, ce qui atteste leur disparition peut-être avant la fin de l'Allerød (Montoya, 2002 ; Tomasso, 2016). En outre, les pointes à dos tronquées sont rarement mentionnées (Bartolomei et al., 1979).

L'importante diffusion des lamelles à dos bi-tronquées attestée dans le nord-est de l'Italie est absente dans les sites occidentaux (Montoya 2004 ; Tomasso 2014, 2016 ; Mevel et al. 2014 ; Fornage-Bontemps 2013), bien que quelques exemplaires soient également signalés (Palma di Cesnola 1983 ; Bartolomei et al., 1979; Tozzi et Dini, 2007). Les lamelles à dos ne disparaissent pas, mais leur distribution est discontinue ; en effet elles sont fortement attestées à Saint-Antoine-Vitrolles (Montoya, 2002) et dans la couche A4 de Rochedane (Fornage-Bontemps, 2013), alors qu'elles ne font pas partie de l'équipement de chasse dans plusieurs sites situés sur la côte de l'Arc Ligure Provençal (Tomasso, 2014) et en Toscane du Nord (Tozzi et Dini, 2007). Les géométriques (triangles isocèles) produites par la technique du microburin, quasiment absentes dans le nord-est de l'Italie, atteignent des pourcentages plutôt élevés déjà à la fin de l'Allerød (36% dans la couche 1 de Grotta dei Fanciulli et 21% de la couche A de Riparo Mochi ; Tomasso, 2014, 2016). Les trapèzes sont rarement enregistrés (Bartolomei et al., 1979 ; Palma di Cesnola, 1983 ; Tozzi et Dini, 2007).

Cette grande variabilité des armatures dans l'espace est généralement interprétée comme une adaptation aux différents environnements (Palma di Cesnola, 1993). Puisque le spectre faunistique (Sala, 2007 in Martini 2007) et les données environnementales (Finsinger et al., 2011 ; Ravazzi et al., 2007 ; Vescovi et al, 2007) indiquent des tendances similaires au sud des Alpes, ce processus de régionalisation pourrait être attribué à une composante plus culturelle et donc à différentes identités régionales au sein d'un même faciès culturel, confirmant le rôle des armatures comme indicateurs de groupes ethniques (Cattelain, 2004, 1997, 1994 ; Churchill, 1993 ; Ellis, 1997 ; Gendel, 1988 ; Lemonnier, 1987 ; Pétrequin et Pétrequin, 1990 ; Wiessner, 1983).

Cependant, ces divergences morpho-typologiques au Nord de l'Italie et au sud-est de la France ne reflètent pas une différence dans les techniques de retouche qui semblent varier de la même manière et avec le même rythme le long du Tardiglaciaire. En effet, dans les sites occidentaux du GI-1 (Riparo Mochi couche A, Grotta dei Fanciulli couche 1, Pié Lombard Unité A et Monte Frignone II), la percussion sur enclume est la technique de retouche la plus employée (Tomasso, 2014, 2016), tandis que le début du Dryas récent (Saint Antoine-Vitrolles et Isola Santa couche 5) coïncide avec une exploitation majeure d'une technique par pression. Malheureusement, aucune information concernant la nature du compresseur est mentionnée (Montoya, 2002 ; Tomasso, 2016).

En Italie du Sud, ce processus de régionalisation est aussi très marqué (Martini et al., 2007 ; Palma di Cesnola, 1993 ; Palma di Cesnola, 2007). Le long de la côte sud tyrrhénienne, au cours du Allerød, F. Martini et al. (2007) ont signalé une augmentation de lamelles à dos tronquées qui toutefois dépassent rarement 10-20 % de l'ensemble des armatures. Les géométriques sont rares et les pointes à dos sont courtes. Plusieurs pointes à dos double sont mentionnées. A noter que les lamelles à dos tronquées continuent à jouer un rôle important sur la côte adriatique méridionale (par exemple, Grotta Romanelli couche E, D et C ; Palma di Cesnola, 2007).

1.2.4. L'Épigravettien récent et le Sauveterrien : une transition culturelle progressive ?

En Italie la transition entre l'Épigravettien récent et le Sauveterrien a toujours été considérée comme continue (Broglio, 1973; Guerreschi, 1984a; Martini and Tozzi, 1996). En fait, plusieurs caractéristiques de la production sauveterriennes apparaissent d'abord pendant les phases finales de l'Épigravettien. Tout le long de la péninsule italienne et au sud-est de la France plusieurs sites caractérisés par une industrie lithique encore clairement épigravettienne (par exemple, la couche 18 de La Cogola, Palughetto, Andalo, Greppi Cupi I, la couche 34-30 de Grotta Continenza, la couche A-B de Grotta Romanelli, la couche 2-3 d'Abri Martin, etc.) connaissent une forte augmentation des géométriques (segments et triangles isocèles) et des microburins (Bassetti et al, 2009 ; Binder, 1980 ; Broglio, 1994 ; Boschian et al., 2017 ; Peresani et al., 2011). Même la petite taille des armatures, la sélection presque exclusive de supports minces (1-2 mm), la disparition de la retouche croisée du dos, ainsi que l'augmentation des pointes à dos double signalée par F. Martini (Martini et al., 2007) dans les sites du Tyrrhénien méridional vont dans ce sens.

En outre, la latéralisation des encoches des microburins observée à Mondeval de Sora et dans d'autres sites Sauveterriens (Le Mose, Grottina dei Covoloni, Cassera Lissandri 17, Visentin, 2017 ; La Cogola couche 16, Cusinato et al., 2004) a été remarquée aussi dans plusieurs sites datés de l'Épigravettien terminal (Palughetto, Peresani et al., 2011 ; La Cogola US 18, Cusinato et al., 2004). Cette convergence peut attester la transmission de la même modalité de production des géométriques (1ère modalité ; Figure 3.34 Partie 1) entre l'Épigravettien et le Sauveterrien.

La continuité culturelle entre ces deux faciès est encore plus évidente si l'on considère les techniques de retouche. L'emploi de la pression par compresseur organique documenté au cours du Dryas récent semble se poursuivre au Sauveterrien comme attesté à Mondeval de Sora. L. Chesnaux (2014) a proposé une technique à pression aussi en trois sites sauveterriens français (Paris-15e «62 rue Henry-Farman», La Grande Rivoire et des collections 1 et 3 de Saint-Lizier à Creysse). La raison du succès de cette technique est probablement à rechercher dans deux facteurs principaux :

- les faibles valeurs d'épaisseur des ébauches choisies (< 3 mm)
- la taille réduite des armatures

Au contraire, une des caractéristiques les plus typiques des armatures sauveterriennes absentes au cours de l'Épigravettien récent est la forte normalisation des armatures à partir d'un large éventail de supports. Ceci atteste d'une indépendance totale des contraintes liés à la taille et à la morphologie de ces derniers. La seule exception concerne l'épaisseur. Ce comportement technique s'aligne parfaitement avec le pragmatisme des systèmes techniques sauveterriens (Flor et al., 2011 ; Fontana et Visentin 2016 ; Visentin, 2017 ; Walczak, 1998). La disparition des retouches complémentaires inverses et plates, ainsi que la diminution des Microgravettes et la disparition des trapèzes sont d›autres changements qui différencient l'Épigravettien récent du Sauveterrien.

1.3 Comparaison entre l'Épigravettien du nord de l'Italie et la séquence tardiglaciaire du sud-ouest de la France.

Comparer la production d'armatures de ces deux séquences chrono-culturelles n'est pas facile. Les différences que l'on peut considérer de nature «stylistique» sont évidentes tout au long de la séquence tardiglaciaire, confirmant la validité des armatures en tant que fossiles directeurs dans la définition de «techno-complexes» et donc l'existence d'une séparation culturelle plutôt claire entre la zone ouest-atlantique et la zone méditerranéenne. Cette diversification est surtout visible dans les formes et les dimensions des armatures, ainsi que dans le mode de montage. Parfois, des divergences peuvent être observées au sein d'une même tradition culturelle, ce qui permet de mettre en évidence des tendances régionales. Cependant, en passant à un niveau d'analyse plus technologique, à côté de certaines spécificités de chaque faciès culturel, plusieurs similitudes peuvent être soulignées.

Si nous nous concentrons sur la dernière partie du GS-2, les armatures du Magdalénien supérieur et de l'Épigravettien sont produites à partir de microlamelles de plein debitage régulières et minces et retouchées par une technique à pression. La forte normalisation des armatures est due à un investissement élevé dans la standardisation des supports plutôt que dans le façonnage. Bien que, d›un point de vue morpho-typologique, certaines analogies puissent également être détectées (fabrication de lamelles à dos dans Épigravettien et des pointes à dos de type Gravette/Microgravette dans certains sites du Magdalénien supérieur), la manière de concevoir l'arme de chasse est clairement différente, surtout si l'on considère l'exploitation majeure des pointes osseuses au cours du Magdalénien supérieur (Pétillon, 2015). Ce type de projectile est rarement attesté ou cours de l'Épigravettien italien (Martini, 2007). L'emploi d'un retouchoir en pierre pendant l'ER 1 et d'un compresseur organique au Magdalénien supérieur est parfaitement cohérente avec le diffèrent niveau d'intérêt dans l'industrie osseuse entre ces deux faciès. Les retoucheurs lithiques sont facilement collectables et ne nécessitent pas d'un investissement élevé dans leur façonnage, mettant en évidence un comportement plus «opportuniste « au sein des groupes épigravettiens. Ce plus grand pragmatisme se reflète également dans les modalités de réduction des nucleus où, à côté d'une certaine régularité dans la production de supports, elles ne montrent pas de grands investissements dans la phase de mise en forme qui est limitée tout au plus à une crête frontale (Montoya 2008, 2004). Au contraire, au Magdalénien supérieur, la préparation des nucleus concerne les flancs et parfois même le dos (Langlais, 2010 ; Langlais et al., 2016, 2014c, 2012).

Au nord-est de l'Italie, l'interstade B-A coïncide avec la diffusion de pointes plus robustes et larges à dos souvent courbe. Elles sont produites sur des supports moins standardisés par un façonnage plus invasif réalisé par percussion sur enclume. La retouche du dos est profonde et souvent croisée et la base modifiée par des retouches complémentaires directes ou inverses. L'apparition de ce nouveau type de pointes à dos à l'Épigravettien récent est peut-être liée au phénomène d'Azilianisation (Fasser et al., 2022), qui coïncide avec la diffusion, au cours de l'interstadial, d'un large éventail de pointes à dos courbe au sein de différents techno-complexes européens, ainsi qu'une réduction progressive de la standardisation des supports. Cette tendance semble d'abord se manifester dans les sites de l'Épigravettien récent des Balkans vers 17000-15000 cal. BP (Vukosavljević et al., 2011), puis s'étendre progressivement vers le nord-est de l'Italie (c.f. Pointes à dos large) et le sud-est de la France (c.f. Pointes d'Istres). La possibilité d'un début précoce de l'Épigravettien récent sur la côte orientale adriatique a également été prise en compte par Ruiz-Redondo et al. (2022). Des mouvements de populations des Balkans/Anatolie vers l'Italie du nord sont confirmés par les données génomiques, même s'ils sont antérieurs au début de l'interstadial (Bortolini et al., 2021).

Dans la zone ouest-atlantique, certains de ces changements sont attestés déjà au cours de l'Azilien ancien et au début de l'interstadial, comme la diffusion des pointes à dos courbe, l'augmentation des retouches à dos profonds et croisés et l'utilisation de la percussion sur l'enclume. Cependant, l'analyse de la couche 3B de Pont d'Ambon a permis de vérifier également des divergences importantes : les supports sont fortement normalisés et la précision destinée à la phase de façonnage reste remarquable. En fait, les affinités technologiques et morphologiques entre les pointes à dos large provenant des couches supérieures de Riparo Tagliente et de Riparo Biarzo peuvent être identifiées exclusivement dans les assemblages de l'Azilien récent (Valentin 2006 ; Naudinot 2008 ; Fat-Cheung 2014 ; Fat-Cheung et al. 2014 ; Naudinot et al. 2019). En effet, comme le confirment les études de la couche 3A de Pont d'Ambon et de la couche 6 de Troubat, contrairement à l'Azilien ancien, les pointes à dos courbe de l'Azilien récent sont obtenues à partir de supports hétérogènes et épais qui ont été normalisés par un façonnage invasif (Naudinot et al. 2017b, 2019 ; Valentin 2008). Une telle tendance est parfaitement cohérente avec les changements enregistrés être la phase ancienne et la phase récente de Riparo Tagliente, renforçant l'hypothèse de la diffusion de pratiques communes entre le deux séquences culturelles ou cours de l'interstadial.

|Un processus d'azilianisation plus précoce au sein des sociétés épigravettiennes a été récemment souligné par N. Naudinot et al. (2017b) en considérant d'autres aspects que les armatures, comme le développement de l'art mobile schématique, la diminution de la production de lames, la simplification progressive des méthodes de production lithique, l'absence de la misse en forme de nucleus, la disparition de la percussion directe au percuteur tendre organique ou encore la diminution de la circulation des matières premières. En effet, dans la séquence tardiglaciaire française une grande partie de ces aspects émergent au cours de l'Azilien récent plutôt que de l'Azilien ancien (Naudinot et al., 2019, 2017b). Donc, ne serait-il pas plus approprié de parler d'une «épigravettianisation « des sociétés occidentales ? De même, la diffusion des lamelles à dos et des lamelles à dos tronquées au sein des groupes de l'Azilien récent oriental (Bodu et Valentin, 1997 ; Coudret et Fagnart, 1997, 2004, 2012, 2015 ; De Bie et Caspar, 1996 ; Crotti et al., 2016 ; Mevel et al, 2014 ; Naudinot et al., 2019 ; Valentin et al., 2004), totalement absentes parmi ceux de l'Azilien ancien (Fat Cheung et., 2014 ; Mevel, 2013 ; Naudinot et al., 2017a ; Valentin, 2008), pourrait être attribué à ce phénomène de diffusion de concepts épigravettiens vers le nord-ouest. En effet, un parallélisme entre l'azilianisation et les transformations de l'Épigravettien récent a été souligné aussi par d'autres auteurs (Broglio, 1997 ; Thévenin, 1997). Il est évident que des recherches supplémentaires sont nécessaires, ainsi que des dates radiocarbones plus fiables, surtout dans la région des Balkans, avant d'essayer de comprendre pleinement ces phénomènes à échelle européenne.

Après cette période où ces deux macro-régions semblent suivre une évolution similaire, non seulement en ce qui concerne la production d'armatures lithiques, selon Naudinot et al. (2017b) la zone atlantique occidentale et l'Italie du nord connaissent au cours du Dryas récent une nette séparation culturelle. En effet, le retour à une production très sophistiquée de lames sur silex exotique au Laborien (Langlais et al., 2014a), n'est pas présent ou cours de l'Épigravettien récent dont la production est destinée à la fabrication de microlamelles et de lamelles à travers des méthodes simples sur des silex locaux (Bassetti et al., 2009 ; Cusinato et al., 2004 ; Tomasso, 2014 ; Peresani et al., 2011). Il est quand même important de souligner comme notre connaissance de la transition Dryas récent-Préboréal en Italie du nord est loin d'être exhaustive.

Une telle différence dans la taille des produits a affecté la fabrication des armatures. Si pendant le Dryas récent, les armatures de l›Épigravettien sont généralement fines (1-3 mm), étroites (< 7 mm), courtes (< 30 mm) et produites sur des microlamelles, au Laborien ancien, les pointes de Malaurie et les rectangles sont généralement plus épaisses (> 3 mm), larges (> 8 mm) et fabriquées à partir de lames et de lamelles. En outre, le très fort processus de recyclage observé entre les groupes laboriens semble absente dans l'Epigravettian du Dryas récent. Néanmoins, il est intéressant de noter que d'un point de vue morpho-typologique plusieurs innovations documentées au sud-ouest de la France au cours du Laborien apparaissent avant au nord-est de l'Italie entre la fin de GI-1 et le début de GS-1. En particulier :

- les pointes à dos rectilignes avec une troncature basale transversale ou oblique
- les lamelles à dos bi-tronquées symétrique, bien standardisées et qui dominent les assemblages lithiques
- les trapèzes

Pour l'instant, une diffusion de ces éléments de l'est vers le ouest, même si elle est la plus probable, elle est toutefois difficile à soutenir, principalement en raison de l'absence de continuité géographique : ces typologies d'armatures sont présentes de façon sporadique seulement dans certains sites de l'Italie du nord-ouest et du sud-est de la France. Cela peut-il être lié à un hiatus dans les évidences archéologiques ?

Même les pointes de Blanchères, typiques du Laborien récent, sont morphologiquement comparables aux Microgravettes de l'Épigravettien récent, bien qu'elles présentent trois différences principales : d'une part les pointes de Blanchères ont un apex systématiquement proximal, d'autre part elles attestent un bord fonctionnel non retouché et un montage latéral sur la hampe. Cependant, une arme de chasse conçue comme composite, le retour d'une certaine régularité et d'une préméditation plus stricte de la morphologie des supports en fonction des armatures recherchées, ainsi que la disparition des pointes à dos courbe et la diffusion d'une pression par retouchoir organique comme principale technique de retouche ont permis de confirmer un certain degré d'interactions entre ces deux faciès culturels.

Pour ce qui concerne le début de l'Holocène, si l'Épigravettien récent de l'Italie du nord et de la France du sud-est voit une progressive mésolithisation des systèmes techniques, le Laborian du sud-ouest français présente encore des caractéristiques très paléolithiques et aucun signe de mésolithisation est visible (Naudinot et al., 2019). Bien que les dates radiocarbones ne permettent pas de confirmer une diffusion des systèmes techniques sauveterriens d'Est en Ouest (Langlais et al., 2015 ; Visentin 2017), les divergences entre le Laborien récent et le Sauveterrien, ajoutées à un recouvrement important des dates entre ces deux faciès (environ 500 ans), rendent difficile de croire à une origine locale du Sauveterrien comme proposé pour l'Italie.

1.4 Conclusion

En conclusion, l'application d'une analyse détaillée sur la production d'armatures à grande échelle a permis d'observer la variabilité des armatures de la fin du Tardiglaciaire sous un jour nouveau. L'Italie du Nord et la France donnent l'impression de suivre une évolution similaire. La plupart des analogies peuvent être identifiées d'un point de vue technologique et semblent être le résultat d'un «ensemble de comportements techniques communs». Il s'agit principalement de la même façon d'interpréter les techniques et les méthodes de retouche et d'agir en réponse aux changements de la morphologie des supports sélectionnés qui souvent changent d'une manière similaire. A cet égard, il faut considérer qu'un tel « paquet technique « commun ne reflète pas une spécificité de chaque faciès culturel mais se diffuse transversalement.

Les divergences d'armatures entre les deux régions sont donc le résultat des différentes morphologies recherchées, probablement liées à des modes de montage spécifiques en association avec les différents environnements et les proies recherchées ainsi qu'à des besoins culturels précis, mais elles ne dépendent pas de l'utilisation de méthodes et techniques différentes. En réalité, à partir de la seconde moitié du GI-1 d'importantes affinités d'un point de vue morpho-typologique peuvent également être observées, en particulier entre l'Épigravettien récent daté à l'interstadial et l'Azilien récent ainsi qu'entre l'Épigravettien récent daté au Dryas récent et le Laborien.

La question à laquelle il faudrait réfléchir concerne l'origine de ce comportement technique commun : est-ce le résultat d'une simple convergence liée au fait qu'étant la même espèce humaine, nous répondons de manière similaire au même stimulus externe (par exemple des changements environnementaux analogues dans certaines periods) ? Ou bien, comme je voudrais proposer ici, l'occurrence des mêmes pratiques techniques sur un large territoire devrait être interprétée comme la confirmation d'un important réseau social entre les groupes européens ? En outre, la transmission d'est en ouest de certains traits technologiques et même morphologiques dans la production d'armatures est plus qu'une simple suggestion et mérite d'être approfondie. Voir les changements dans l'industrie lithique des sociétés atlantiques-occidentales au cours du Tardiglaciaire comme la conséquence d'influences orientales devient encore plus intriguent si nous considérons l›origine et le développement du Sauveterrien. Dans le futur, il faudrait vérifier également le rôle joué par la péninsule ibérique et les régions épigravettiennes les plus orientales concernant ces transformations communes et étendre cette problématique (modalités de production vs. morphologies) à d'autres types d'objets et de matières premières caractéristiques des techno-complexes du Paléolithique final et du premier Mésolithique.

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