Journal Pre-proof

The use of blades and pointed tools during Middle Palaeolithic, the example of Riparo Tagliente (VR)

Gabriele L.F. Berruti, Elisa Bianchi, Sara Daffara, Monica Gomes, Allison J. Ceresa, Federica Fontana, Marta Arzarello, Carlo Peretto

PII: S1040-6182(20)30394-3

DOI: https://doi.org/10.1016/j.quaint.2020.07.016

Reference: JQI 8402

To appear in: *Quaternary International*

Received Date: 23 March 2020

Revised Date: 11 July 2020

Accepted Date: 15 July 2020

Please cite this article as: Berruti, G.L.F., Bianchi, E., Daffara, S., Gomes, M., Ceresa, A.J., Fontana, F., Arzarello, M., Peretto, C., The use of blades and pointed tools during Middle Palaeolithic, the example of Riparo Tagliente (VR), *Quaternary International* (2020), doi: https://doi.org/10.1016/j.quaint.2020.07.016.

THE USE OF BLADES AND POINTED TOOLS DURING MIDDLE PALAEOLITHIC, THE EXAMPLE OF RIPARO TAGLIENTE (VR)

Gabriele L.F. Berruti[1-2-*], Elisa Bianchi[3], Sara Daffara[1], Monica Gomes[1], Allison J. Ceresa[1], Federica Fontana[1], Marta Arzarello[1], Carlo Peretto[1].

1- Università degli studi di Ferrara, Dipartimento di Studi Umanistici Sezione di scienze preistoriche ed antropologiche.
2- Museo di Paleontologia ed Archeologia C. Conti di Borgosesia.
3- Museo Archeologico del Finale.

* Corresponding author.
Gabriele Luigi Francesco Berruti
phone: +393491061501
e-mail: brrgrl@unife.it
ORCID: 0000-0002-8637-4585

Abstract

The aim of this study is to understand Neanderthals' techno-functional behavior at Riparo Tagliente (VR). To this purpose, the use-wear analysis on the lithic artefacts from the upper levels of the Mousterian sequences was carried out. In particular, two main features of the Mousterian lithic assemblage of Riparo Tagliente are considered: how the laminar component and the pointed tools were differently used. The use of blades in the Mousterian period represents a debated issue: many scholars interpret the Mousterian blades as specific tools used as butchering knives, while others underline their use as undifferentiated tools. The use of pointed tools is also an interesting topic: if different scholars stress their undifferentiated use, others propose their use as spear points. The use-wear analysis completed on the Riparo Tagliente's Mousterian lithic assemblage highlights a general opportunistic behavior in the use of knapping products. Concerning the relation between the artefacts' use and their typology, the data collected suggests a relation between blades and butchering activities and an undifferentiated use of pointed tools. Our study also underlines the identification of wear traces on flakes that are usually considered as waste products (i.e.

management-flakes of Levallois cores and reshaping flakes), suggesting that we should reconsider the definition of waste products in the light of the use-wear analysis results.

Keywords: Middle Paleolithic, Neanderthals' techno-functional behavior, Mousterian, blade, pointed tool, Use-wear analysis.

1. Introduction

Riparo Tagliente is a well-known archaeological site located in a rock-shelter in north-eastern Italy. The site has been known and excavated since 1958 and thousands of lithic artefacts and faunal remains have since then been found, together with some human remains (Arnaud et al., 2016; Bartolomei et al., 1982). The archaeological deposit of the site contains lithic and faunal remains belonging to different human occupations referable to: Mousterian, Aurignacian and Epigravettian (Bartolomei et al., 1982; Arzarello, 2003; Thun Hohenstein and Peretto, 2005; Peresani, 2010; Bianchi, 2011; Arnaud et al., 2016). The excavation of the Mousterian levels allowed the recovery of lithic artefacts and faunal remains referable to many different occupations; in the upper layers of the Mousterian sequence (layers 34 to 37), the human occupations seem to be more intense (Bartolomei et al., 1982). This hypothesis is supported by lithic technology (Arzarello, 2003; Arzarello and Peretto, 2005; Carmignani, 2017), archaeozoology and palaeontology studies (Thun Hohenstein and Peretto, 2005; Thun Hohenstein, 2006). The aim of this research is to understand Neanderthals' behaviour during the phases documented in the upper levels of the Mousterian sequences of Riparo Tagliente through the use-wear analysis of the lithic assemblage, in order to obtain results comparable to the ones obtained in similar published studies (e.g. Shoumacker, 1993; Lemorini, 2000; Martínez and Rando, 2001; Lemorini et al., 2003; 2016; Claud, 2012; Lazuén, 2012; Lazuén and Delagnes, 2014; Lazuén and González-Urquijo, 2014; Berruti, 2017; Picin et al., 2020a; 2020b). In this paper, two main features of the Mousterian lithic assemblage of Riparo Tagliente were considered for use-wear analysis: the way in which the laminar component was used (Bianchi, 2011; Carmignani, 2017) and that of pointed tools (i.e. Mousterian points, Levallois points and triangular flakes *sensu*: Sisk and Shea, 2003). The use of blades in the Mousterian period is quite well documented, but it also represents a debated issue (Lemorini, 1992; 2000; Ameloot-Van der Heijden, 1993; Beyries, 1993; Arrighi et al., 2009). In some of these studies, blades are interpreted as specific tools used as butchering knives (Ameloot-Van der Heijden, 1993; Beyries, 1993; Lemorini, 2000), while others underline their use as undifferentiated tools (Arrighi et al., 2009). The use of pointed tools during Mousterian is also an interesting topic: if different scholars stressed their undifferentiated use (Beyries and Plisson, 1998; Moncel et al., 2009; Goval et al., 2016), others have proposed their use as spear points (Boeda et al., 1996; Shea, 1997; Shea et al., 2001; Bonilauri, 2010; Lazuén, 2012; Lazuén and González-Urquijo, 2014). Some scholars linked these tools to the exploitation of vegetal resources (Groman-Yaroslavski et al., 2016). The use-wear study of blades and pointed tools was carried out on a sample of artefacts coming from the different layers of the Mousterian sequence. Moreover, a use-wear analysis was conducted on the whole lithic assemblage from layer 36 of the internal survey pit, which is the most abundant and most well preserved of the sequence (Arzarello, 2003; Arzarello and Peretto, 2005). This study was carried out in order to understand if there were correlations between the typology of tools, the knapping method applied, and the materials being manipulated. Concerning scrapers, for example, despite their definition that suggests their functional homogeneity, different functional studies show that these tools were used for several tasks (Texier et al., 1998; Lemorini, 2000; Hardy, 2004; Claud, 2012): a study on the Quina and demi-Quina scrapers from the Yabrudian levels at Qesem Cave (Israel), highlights that these were used in a great variety of activities, from woodworking to butchering and other various activities (Lemorini et al., 2016; Zupancich et al., 2016b). Even more interesting, for our purpose, are two studies conducted on the discoid lithic products of Fumane cave, level A8 and A9. (Italy, MIS 3) (Lemorini et al., 2003) and on the particular lithic industry of the second occupation phase of Le Pucheuil (France, MIS 6) (Lazuén and Delagnes, 2014). In the case of Le Pucheuil the flakes produced through a reduction sequence, called Le Pucheuil-type, were analyzed. Also, in these cases the functional analysis confirms that products coming from the same kind of reduction sequence and with similar morphometric features, were used to process a wide range of materials, like hide, wood and non-woody materials and for butchering activities (Lazuén and Delagnes 2014). In other cases, the functional analysis applied on Middle Palaeolithic lithic industries identified a link between a particular kind of tool and the material on which it was being used, for example denticulates used for wood working activities. As in the study conducted by Martínez and Randoon level Ja of Abric Romaní, on 6 different refitting sequences made with 31 different products, 11 of which were retouched elements (Martínez and Rando, 2001). The purpose of this research is to investigate whether there is, in the Mousterian levels of Riparo Tagliente, an unambiguous relationship between the typology and/or the knapping method of the lithic artefacts and their use.

2. Description of the site

The Tagliente rock-shelter is located in the Venetian Prealps (Stallavena di Grezzana, Verona, northeastern Italy) on the west side of Valpantena. It is situated in the bottom of one of the main valleys of the Monti Lessini which are part of the pre-Alpine range, at an altitude of 250 m a.s.l. (Fig. 1). The shelter opens a few meters above the valley floor, at the base of the western slope of the Tregnago mount. From an ecologic point of view, the rock-shelter occupies a strategic position at the intersection of different topographic features: the plain, the valley-bottom, the rocky slopes and the top of the massif. This location offered the inhabitants of the site the possibility of exploiting different landscapes, rich in faunal and vegetal resources, which varied in distribution over time (Bartolomei et al., 1982; Bertola, 2001; Arzarello, 2003; Bianchi, 2011; Berto et al., 2018). The stratigraphic sequence of Riparo Tagliente is the result of different phases of human presence corresponding to Mousterian, Aurignacian and Epigravettian occupations (Arzarello, 2003; Thun Hohenstein and Peretto, 2005; Bianchi, 2011; Bartolomei et al., 1982; Bartolomei et al., 1984; Arnaud et al., 2016; Berto et al., 2018; Fontana et al., 2009; 2018).

Figure 1: Riparo Tagliente. Site position; Map of the excavation area: in light blue the two trenches where the Mousterian levels were explored, the dotted line represents the extension of the Medieval excavations and the purple line represents the actual rain line of the shelter (modified from Bartolomei et al, 1982 and Carmignani 2017).

2.1 Stratigraphy and chronology

The lower part of the stratigraphic sequence, containing the Mousterian lithic industries, has been identified in two survey pits, one placed in the internal part of the shelter and the other in the external part. The two areas were correlated on the basis of the lithic assemblages (Arzarello, 2003) (Fig.1). The lower part of the stratigraphic sequence of the internal survey pit begins with "*terre rosse*" of colluvial origin, resulting from soil erosion outside the shelter and corresponding to the initial phase of the Würm (isotopic stage 3) (units 1a, layers 52 to 44). During this depositional event, the climate was characterized by cold, damp winters and dry summers (Bartolomei et al., 1982; 1984). The

overlying layers of the lower series (layers 43 to 25) constitute unit 1b: layers 43 to 40 are characterized by a massive rockfall and clasts deriving from the degradation of the wall. The top of the Mousterian sequence (layers 39 to 31) is formed by loess, intercalated with thin levels of shatter stones. The presence of loess attests an arid periglacial environment, while shattered stones are characteristic of a more humid glacial environment (Bartolomei et al., 1984).
Layers from 30 to 25 recall the above-mentioned features but at the top an interruption of the loess sedimentation is visible. Layer 25, that seems to be in stratigraphic continuity with the sequence below, is characterized by the presence of an important pedogenetic phenomenon found in association to an Aurignacian lithic industry containing *Dufour* bladelets (Bartolomei et al. 1982; Arzarello 2003). This first part of the sequence was interrupted by an erosive episode, due to Progno of Valpantena, the creek that at present flows at the bottom of the valley. Sediments referable to the end of isotopic stage 2 (Late Glacial) lay on this erosive surface forming a thick sequence with rich evidence dated to the late Epigravettian (Bartolomei et al., 1982, Fontana et al 2009, 2016). No radiometric dates are available for the Mousterian sequence of Riparo Tagliente. However, layer 25 containing an Aurignacian industry with *Dufour* bladelets provides a good *terminus ante quem* (Bartolomei et al., 1982; Arzarello, 2003). Moreover data of faunal, sedimentological and archaeological studies, suggests a chronology spanning between MIS 4 and MIS 3 (Bartolomei et al., 1982; 1984; Arnaud et al., 2016).

<u>2.2 Faunal remains and archeozoological analysis</u>

The faunal remains are more abundant in the upper Mousterian layers (from 41 to 35) than in the lower ones. The majority of the large mammal remains from the Mousterian layers consists of teeth, mandible fragments, limb elements, vertebrae and sesamoids belonging to adult and sub-adult ungulates (Thun Hohenstein, 2006). The most represented species is *Capreolus capreolus* followed by *Cervus elaphus*, *Capra ibex* and *Rupicapra rupicapra*. The carnivore assemblage is dominated by *Canis lupus* and *Ursus arctos* followed by *Vulpes vulpes.* Among rodents, *Marmota marmota* is the most frequent. In the lower layers (44-52), the composition of the faunal assemblage remains unchanged among artiodactyls, while carnivores increase in number and variety of represented taxa (*Canis lupus*, *Vulpes vulpes*, *Ursus arctos*, *Panthera pardus*, *Meles meles* and *Martes martes*) (Bartolomei et al., 1982; Thun Hohenstein and Peretto, 2005; Thun Hohenstein, 2006). The abundant presence of neonatal or fetal cervids remains, suggests that Neanderthals occupied the rock shelter mainly during spring. Cut-marks and intentional bone fracturing are mostly on artiodactyls and on some *Marmota marmota* diaphysis (Thun Hohenstein, 2006). The human activities recorded on bones are well documented along the whole sequence, but are more abundant in its upper part (layers 41 to 35) (Thun Hohenstein, 2006).

2.3 The Mousterian lithic assemblage

The Mousterian lithic assemblage is characterized by the use of different knapping methods, all carried out on local raw materials (i.e. different kinds of local cherts) collected in the surroundings of the site, usually from the bed of the Progno river (Arzarello, 2003; Arzarello and Peretto, 2005). The proportion of each flint type in the Mousterian levels reflects those that can currently be found close to the river: the Biancone flint and the organogenic one are extremely frequent in the form of pebbles with sizes ranging from a few centimeters up to tens of centimeters. Similarly to what is observed in the archeological levels, the flint pebbles of Scaglia Variegata and Scaglia Rossa are less frequent and generally of smaller dimension (Arzarello, 2003; Arzarello and Peretto, 2005). The opportunistic knapping method is the most represented (c.f. S.S.D.A, Forestier, 1993) but the Levallois method (Boëda et al., 1990a; Boëda, 1993) is also present, applied with lineal and recurrent modalities. In the lower levels, centripetal recurrent Levallois is the most frequent while in the upper part of the sequence unipolar recurrent Levallois becomes dominant (Arzarello, 2003; Arzarello and Peretto, 2005). Although the discoid method (Boëda, 1993; Peresani, 2003) is not one of the predominant reduction strategies in the considered lithic assemblage, its application reflects a good knowledge of this method by the human groups that occupied the site (Arzarello, 2003; Arzarello and Peretto, 2005; Carmignani, 2017). The discoid method is attested both as an independent reduction strategy and as a final stage of exploitation of Levallois cores (Arzarello, 2003; Arzarello and Peretto, 2005). One of the main peculiarities of the lithic assemblage is the presence of a volumetric laminar *débitage* that increases in importance along the sequences starting from level 36 (Arzarello, 2003; Arzarello and Peretto, 2005; Bianchi, 2011; Carmignani, 2017). The exploitation of the volume develops from a single striking platform or, more rarely, from two opposite striking platforms, generally following a recurrent and *semi-tournant* approach. The laminar products obtained, are often thick; the butts are smooth and a few mm thick. The edges of the blades are often irregular and more frequently convergent than straight, and the ribs are generally sub-parallel (Arzarello, 2003; Arzarello and Peretto, 2005; Bianchi, 2011) (Fig. 2 and Fig. 3). The formal tools mainly consist in side-scrapers and denticulates made on opportunistic products and, more rarely, on Levallois flakes (Arzarello and Peretto, 2005; Carmignani, 2017). Mousterian points, Levallois points, pseudo-Levallois points and triangular flakes are also sporadically represented (Arzarello, 2003).

Figure 2: General scheme of debitage methods and products (modified from Arzarello 2003).

Figure 3: Layer 36: a) 1,2: blades; 3,5,7: Levallois flakes; 4,6: scrapers; b) 634/2 36 646 discoid core c) Q 634-1 36 644 blade core (modified from Arzarello 2003).

3. Materials

3.1 Blades and pointed tools

Different categories of items were analysed: blades, Levallois points, Mousterian points and triangular flakes coming from squares 635, 634, 614 and 615 and from layers 34 to 37 of the internal survey pit (Tab.1). The artefacts selected for the analysis include 214 blades and 15 pointed tools. The blades presenting marked post-depositional alterations, such as white patina and pseudo-retouches were excluded. The low number of pointed tools here considered, is due to their low representation in the sequence. Additionally, the functional study, using both a Low and High magnification approach, was not possible on artefacts showing marked post-depositional alterations. Three of the selected pointed tools are pseudo Levallois points, five are Mousterian points, one is a Levallois point and six are triangular flakes coming from an opportunistic debitage.

Table 1: Number and type of the lithic industry analyzed from squares: 635;634;614;615 layers 34 to 37

Number of lithics analyzed		
Type	**Total**	**Selected**
Blades	326	214
Levallois point	9	1
Pseudo Levallois point	15	3
Mousterian points	11	5
Triangular flakes	25	6

3.2 The lithic assemblage of layer 36

The study of the whole lithic assemblage from layer 36 which was the best preserved of the entire sequence, began with a preliminary observation, with naked eye and with a stereomicroscope, in order to identify the artefacts with suitable characteristics for use-wear analysis (according to the criteria developed by Terradillos-Bernal and Rodríguez-Álvarez, 2017). In this preliminary phase, the considered sample was composed of all the *débitage* products (simple flakes and formal tools) with the exclusion of the lithics less than 2 cm long, that had been stored all together in paper bags, causing several conservation problems (i.e. marked and continuous edge removals that impede use-wear analysis). A total of 619 artefacts have been evaluated through the application of four criteria: completeness, presence of at least one functional edge, a suitable morphology for prehension or hafting and surface preservation (absence of marked post-depositional alterations). After this preliminary evaluation, the sample was composed of 60 *débitage* products from level 36, corresponding to about 10% of the entire sample (Tab.2).

Table 2: lithic assemblage from layer 36.

Lithic industry of the layer 36		
Tools	**Total**	
Notches	3	
Blades	11	
Mousterian points	2	
Side-scrapers	34	
Cores	**Total**	
Centripetal recurrent Levallois	1	
Blades core	2	
S.S.D.A.	2	
Discoid	1	
Debitage	**Total**	**Selected**
Levallois	83	16
Discoid	21	4
Opportunistic/S.S.D.A.	515	40
Total	**619**	**60**

3.3 Taphonomy and conservation

The taphonomic analysis of the sample confirms that the lithic assemblage is in good state of preservation, although some products have thermal alterations and small amounts of white patina. However, it suffers from some conservation problems: all the Mousterian lithic artefacts come from excavations carried out in the 80s and they were stored for many years in large groups in wooden boxes or paper bags, except for some that were individually stored in little paper bags.

The storage in large groups favored the formation of pseudo-retouches on the edges, preventing a proper analysis of edge removals. Edge removals due to post-depositional phenomena were easily recognizable because they were randomly distributed on the surfaces of the artefacts (even in the areas distant from the edges) (Shea and Klenck, 1993; Asryan et al., 2014; Lemorini et al., 2014a; Asryan, 2015).
Sometimes, this type of preservation can produce the complete (or partial) destruction of the original edges of the lithic tools. The storage in single paper bags favored the deposition, on the edges, of micro residues of the glue sealing the bottom of the bags (Fig. 4). Glue residues is extremely durable and can prevent the use-wear study of polishes. Another problem, affecting especially the formal tools, is the presence of graphite on the edges, probably due to the tools being drawn (Fig. 4). These factors contributed to the reduced number of the sample analyzed.

Figure 4: RT 36 534; Levallois flake RT 36 534 with pseudo-retouches (dotted line) and graphite signs (circle); residues of glue on the edge.

4. Methods

4.1 Use-wear analysis method

Each selected artefact was gently washed with warm water and soap, then soaked in an ultrasonic tank containing a mixture of demineralized water (75%) and alcohol (25%) for 3 minutes and finally dried in the open air. The use-wear analysis was carried out with an integrated approach that uses the low power approach (Odell and Cowan, 1986) in combination with the high power approach (Keeley, 1980). Several studies (e.g. Lemorini et al., 2014; Wilkins et al., 2015; Moss, 1983; Beyries, 1987; Ziggioti, 2011; Van Gijn, 2014; Berruti and Daffara, 2014; Cruz and Berruti, 2015) show that the use of both the methodologies is more effective and productive. This kind of study was conducted to provide a more detailed understanding of the activities carried out with the lithic artefacts and to support the diagnosis of the processed materials (e.g. Keeley, 1980; Ziggioti, 2005; Lemorini et al., 2006; 2014a; Rots, 2010; Van Gijn, 2014). The diagnostic impact fractures, from now on referred to as DIFs, which are useful for the study of pointed elements (Lombard et al., 2004), concern especially the macro-fractures of stone-tipped weapons. These macro-traces are usually interpreted as indicating penetrative action (Iovita et al., 2014). Evidence of DIFs is crucial in the identification of the use of a tool as a projectile. Experiments on this matter were developed in the 1980s (e.g. Odell, 1981; Fischer et al., 1984). More recently, other authors (Dockall, 1997; Iovita et al., 2014) described a combination of the major DIF categories. These

scholars worked on the establishment of a set of DIFs combining experimental research, and studies of equifinality in order to differentiate impact fractures that occur in hunting contexts. Also, by comparison, the aim was to eliminate from the 'diagnostic' category fractures that are related to other actions (Dockall, 1997; Iovita et al., 2014; Lombard, 2005a; Odell, 1981; Odell and Cowan, 1986; Pargeter, 2013).
During the present analysis different microscopes were used: a stereomicroscope Seben Incognita III with magnification from 20x to 80x, a stereomicroscope Leica Ez4 HD with magnification from 8x to 35x, a metallographic microscope Optika B 600 Met with oculars 10x, 5 objectives PLAN IOS MET (5-10-20-50-100x), polarizing filters and bright and dark field equipped with a digital camera Optika B5 and a metallographic microscope AmScope ME300T-M (40X-640X) equipped with AmScope MD600 camera.

4.2 The experimental collection

An experimental reference collection of 50 lithic artefacts (20 blades, 6 points and 24 simple flakes) was built in order to have a basis for comparison of the traces detected on the archaeological artefacts, and for the data issued from the bibliography (e.g. Lemorini et al., 2014a; 2014b; Wilkins et al., 2015; Moss, 1983; Beyries, 1987; Ziggioti, 2011; Van Gijn, 2014; Berruti and Daffara, 2014; Cruz and Berruti, 2015). The reference collection is composed of lithic artefacts made on local flint, collected in the Progno river. Due to the fine texture of the flint types available at the site and the nearby Pogno river (Arzarello, 2003), all kinds of traces are highly observable (Bianchi, 2011).The lithic artefacts were obtained with different knapping methods attested in the considered lithic assemblage, i.e. discoid, Levallois, S.S.D.A. and laminar applied by direct percussion with hard hammer (Boëda et al., 1990a; Boëda and Böeda, 1993; Boëda, 1994; Peresani, 2003; Arzarello et al., 2011). The experimental artefacts were used to process bone, meat, hide, wood and for butchering activities for 5 and 10 minutes (Fig. 5, Fig. 6 and Tab. 3 and 4). Concerning the pointed tools, an experiment was set in order to identify their possible use as spear points. With reference to Berger & Trinkaus' research (1995) on the anatomical distribution of traumatic lesions among the European and Near Eastern Neanderthals, it was hypothesized that among Neanderthals the use of pointed tools was common as hand-held thrusting spears. This data is also confirmed by the studies completed by Churchill (Churchill, 1993; Churchill and Rhodes, 2009), and the efficiency of the trusting spears (more then 500J of impact force) has also been demonstrated in recent studies conducted by Coppe and colleagues (Coppe et al., 2019). A 7 cm forequarter of pork, which included ribs and skin was used as a target. It was placed horizontally over a plastic sheet, on a stone floor "in a cleared space in the open to simulate an animal trapped in a pit" (Lombard et al., 2004). Far from replicating a living target, this option was

chosen because of technical constraints and to avoid related sanitary issues (Shea et al., 2002). Also, one should consider that the fractures on lithic tools are directly related to mechanical and physical variables, such as velocity and the force applied (Hutchings, 1999; Coppe et al., 2019). In the specific experiments, it was not possible to take force measurements: all the experiments were, therefore, performed by the same person in order to have some fixed parameters, i.e. gender (male), height (1,70 m) and weight (70 kg). The experiments under study were performed at a very close range from the target, using one single thrusting trial, which is accordingly and primarily a quasi-static loading action. This experiment is similar to the experiments conducted by other authors (Hutchings, 1997; Shea et al., 2002; Lombard et al., 2004). Six pointed flakes obtained with the S.S.D.A. method, were used as spearheads.
For the shaft, six pine-wood pieces were used, 120 cm long and with diameters spanning from 2 to 1,3 cm. The hafting system of the points on the shaft was obtained with two methods. Three spear shafts had one-sided notch and the other three had a simple notch (Lombard et al., 2004; Lombard, 2005b). To better stabilize the lithic tools on the spear shaft, glue was used, and they were secured with plant-fiber strings. It was decided to perform a single action of two-handed spear thrusting for each spear, and all the actions allowed hitting the target (skin, meat and ribs) without impacting the ground (Fig. 2 and Fig. 3) After use, each artefact was gently washed with warm water and soap, then soaked for 3 minutes in a mixture of demineralized water (75%) and alcohol (25%) in an ultrasonic tank and then dried in the open air. For each artefact the time of use, the manipulated material, and the action performed were registered in a database. The analysis of the lithic artefacts of the reference collection was completed using the same method above described.

Table 3: blanks used for the experimental collection divided by: action (T: transversal; L: longitudinal), time of use (5: 5 minutes; 10: 10 minutes) and production method.

Material	Discoid				Levallois				SSDA				Blade				
	T. 5	*L. 5*	*T. 10*	*L. 10*	*T. 5*	*L. 5*	*T. 10*	*L. 10*	*T. 5*	*L. 5*	*T. 10*	*L. 10*	*T. 5*	*L. 5*	*T. 10*	*L. 10*	
Butchering		2						1	1	1	1	1	2	2		1	
Fresh Hide						1	1		1		1		1		1		
Bone	1		1		1				1		1		1	1	1		
Wood						1			1	1		1	1	1	1	1	
Non woody plant										1				1		1	
Dry Hide			1								1		1	1			
Tot.	**1**	**2**	**2**		**1**	**2**	**1**	**1**	**4**	**3**	**4**	**2**	**6**	**6**	**3**	**3**	**Tot**
Tot. for typology	**5**				**5**				**14**				**20**				44

Figure 5: Experimental collection a): longitudinal work with flint artefacts on fresh wood; b): longitudinal work with flint artefacts on antler; c): longitudinal work with flint artefacts on hide; d): transversal work on bone; e):

example of hafting systems (from Fisher et al. 1984); g): hafting the experimental point 6 by the archaeologist Jorge Tiago Correia; thrusting experiment. A – thrusting; B – detail of spear perforation; C – detail of perforation mark.

Figure 6: Experimental collection a): longitudinal work on dry wood (line of polish from rough to smooth, with linkage of the topography of the polish); b): longitudinal work of butchering (smooth and flat spots (1) of polish-bone, band of rough polish (2) - fleshy tissue); c): transversal work on antler (line of smooth and flat polish); d): transversal work on dry wood (line of rough polish); A- dorsal surface before use; B – dorsal surface after use; tip detail, ventral surface (spin-off fractures).

Table 4: polish identified during the experimentation

Material	Type of polish
Hide	edge rounding with compact polish
Antler	line of smooth and flat polish and spots of the same type of polish
Fleshy tissues	band of rough polish
Wood	well-developed line of polish from rough to smooth, with linkage of the topography of the polish;
Herbaceous plants	line of polish rough with a closed linkage of its topography
Bone	smooth and flat spots of polish

5. Results

5.1 Blades and points use-wear analysis results

The use wear analysis of the 214 blades selected, allowed the identification of 158 artefacts with anthropic traces, of which 151 present only edge removals linked to use, while 7 also present polish on the edges. 135 have macro traces referable to the use on soft and medium soft materials, and only 23 present edge removals linked with hard or medium hard materials (Table 5).

Concerning the transversal action, 5 items present polishes: one presents traces linked to bone working, one exhibits traces linked to antler-processing and three exhibit traces of a mixed work (bone and meat) interpreted as a result of butchering activities (Fig. 7a and Fig. 8).

Polish traces on the edges linked to a longitudinal action were found on 3 artefacts: one presents a pattern of mixed polish linked to contact with bones and meat, therefore interpreted as a butchering activity; another shows traces linked to hide processing and traces linked only to meat treatment, interpreted as a the result of filleting activity, were identified on the last artefact (Fig. 7b and Fig.8).

Concerning the pointed tools, the use wear analysis allowed identification of traces on 9 artefacts. Only two of them (both Mousterian points) present clear DIFs : one has polish linked to contact with hide, while seven show traces linked to processing different materials (see Tab. 6): one pseudo Levallois point presents traces of transversal actions linked to butchering activities, one Mousterian point presents traces of transversal work on bone, two triangular flakes present traces linked with butchering activities and the last one presents traces of hide processing.

5.2 Results of the use-wear analysis of the layer 36

The use wear analysis of the lithic assemblage of layer 36 allowed to distinguish 23 artefacts with traces of use. Among them, 6 are Levallois flakes (3 lineal Levallois, 1 recurrent bipolar Levallois, 1 recurrent unipolar Levallois and 1 recurrent centripetal Levallois), 1 is a discoid flake and 16 are opportunistic/S.S.D.A. flakes, 2 of which are technical flakes. Two of the flakes with use-wear analysis show different zones of use: 1 sidescraper on a lineal Levallois flake has two different zones of use (Z.U.) referable to two types of traces (transversal work on indeterminable medium hard material and longitudinal work on fresh hide) and 1 unretouched recurrent unipolar Levallois flake with 2 Z.U. referable to the same type of traces (longitudinal action on bone). As shown in table 6, the use wear analysis led to the identification of different activities carried out in the site. They can be divided into three main groups: animal carcass processing (that include the categories of butchering, fresh and dry hide processing, and bone manipulation) (12), vegetal material processing (3) and manipulation of indeterminable materials (5) (Fig. 7, 8 and 9). If we only consider the formal tools, use-wear traces were found only on 7 side-scrapers (Tab. 8).

Figure 7: a) R.T. 614/5 t.36 76 (flake) use wear traces interpreted as longitudinal action on fleshy tissues: small, diagonally oriented edge-removals with a line of rough polish; b) R.T. 615/1 t.36 603 (flake) use wear traces interpreted as transversal action on bone: localized areas of smooth and flat polish; c) R.T. 614/5 t.36 591 (flake) use wear traces interpreted as hide working: edge rims are heavily worn and polished (compact polish); R.T. 614/5 t.36 88 (flake) use wear traces interpreted as transversal action on bone: small and localized areas of smooth and flat polish.

Figure 8: a) RT 634/6 t.34 160 (blade) use wear traces interpreted as traversal working on bone (periosteum removal);b) RT 615/2 t.34 42 (blade) use wear traces interpreted as transversal working on antler.

Figure 9: RT 614/3 t.34 561 (blade) use wear traces interpreted as longitudinal action of butchering: small, diagonally oriented edge-removals with a band of rough polish (fleshy tissues; a) and small and localized areas of smooth and flat polish (bone, b).

Table 5: Use-wear traces of the blades grouped by action, macro traces and polish.

Action identified	**Macro traces that indicate the status of the worked materials**	**Polish that indicate the type of the worked materials**	***Number***
Transversal	Hard	No	2
Transversal	Medium Hard	No	8
Transversal	Medium Hard	Butchering (bone and meat)	1
Transversal	Medium Hard	Bone	1

Transversal	Medium Hard/ Medium Soft	No	23
Transversal	Medium Hard/ Medium Soft	Antler	1
Transversal	Medium Soft	No	35
Transversal	Medium Soft	Butchering (bone and meat)	2
Transversal	Soft	No	18
Longitudinal	Hard	No	1
Longitudinal	Medium Hard	No	9
Longitudinal	Medium Hard/ Medium Soft	No	12
Longitudinal	Medium Hard/ Medium Soft	Butchering (bone and meat)	1
Longitudinal	Medium Soft	No	25
Longitudinal	Medium Soft	Hide	1
Longitudinal	Soft	No	17
Longitudinal	Soft	Meat	1
		Total	158

Table 6: Use-wear traces of the pointed elements grouped by action, macro traces, polish and presence of DIFs

Number	**Typology**	**Action identified**	**Macro traces that indicate the status of the worked materials**	**Polish that indicate the type of the worked materials**	**DIFs**
RT 169	Pseudo Levallois point	Transversal	Medium Soft	Meat/Hide	Non-diagnostic
RT 188	Mousterian point	Transversal	Hard	Bone	No
RT 212	Mousterian point	Longitudinal	Soft	Hide	Step fracture with a spin off > 6mm (ventral)
RT 342	Mousterian point	Longitudinal	Soft	No	Small hinge-terminated fracture, cone fracture and spin off > 6mm (dorsal)
RT 7	Triangular flakes	Transversal	Soft	Meat	No
RT 32	Triangular flakes	Longitudinal	Medium Hard	Butchering	No
RT 205	Triangular flakes	Longitudinal	Soft	Hide	No
RT 390	Triangular flakes	Longitudinal	Hard	No	No
RT 585	Triangular flakes	Longitudinal	Medium Soft	Meat	No

Table 7: Use-wear traces of the lithic artefacts of layer 36 grouped by action, method of debitage and worked material. (Tran. Act. =transversal action; Long. Act. = longitudinal action; Mix = mixed action; Indet. = indeterminate action).

Material	**Discoid**				**Levallois**				**Opp./SSDA/Indet.**				**Tot.**
	Tran. Act.	*Long. Act.*	*Mix.*	*Indet.*	*Tran. Act.*	*Long. Act.*	*Mix.*	*Indet.*	*Tran. Act.*	*Long. Act.*	*Mix.*	*Indet.*	
Butchering						1			1	2			4
Fresh Hide													0
Soft animal tissue						1				2		1	4
Bone	1					2			1	1			5
Wood					1				2				3
Non woody plant													0
Dry Hide									3				3
Indet hard material- stone?						1							1
Soft													0
Medium Soft						1		1					2
Medium Hard									1	1			2
Hard									1				1
Tot.	**1**	**0**	**0**	**0**	**1**	**6**	**0**	**1**	**9**	**6**	**0**	**1**	25
Tot. for method	**1**				**8**				**16**				25

.

Table 8: Use-wear traces of the formal tools of layer 36 grouped by action and worked material. (Tran. Act. =transversal action; Long. Act. = longitudinal action; Mix = mixed action; Indet. = indeterminate action).

Material	**Sidescrapers**				**Tot.**
	Tran. Act.	*Long. Act.*	*Mix.*	*Indet.*	
Butchering					0
Hide					0
Soft animal tissue		1			1
Bone/ Antler	2				2
Wood	2				2
Non-woody plant					0
Dry Hide	1				1
Indet.					0
Soft					0
Medium Soft					0
Medium Hard					0
Hard	1				1
Tot.	**6**	**1**	**0**	**0**	**7**

6. Discussion

6.1 Blades and points use-wear analysis discussion

The use-wear analysis of the blade assemblage from the Mousterian layers of Riparo Tagliente highlights some trends. The occurrence of intense activities is proved by the presence of blades characterized by different overlapping use-wear traces, thus demonstrating repeated and prolonged use over time. For longitudinal actions, the blades tend to be more elongated, exploited in a unilateral manner and characterized by overlapping traces that mainly affect the right edge of the support. These blades were being used mainly for the treatment of soft and medium-soft materials, referable to slaughtering activities and hide processing. The clear prevalence of transversal actions, especially directed towards the processing of soft and medium-soft materials, was found throughout the laminar assemblage analyzed. The comparisons of these results with other Mousterian contexts characterized by laminar productions is quite challenging. The main issue is the scarcity of similar studies, especially in the Italian context, together with the different methodologies applied to the analysis. Moreover, environmental and climatic factors, together with the variety of available resources affect the chance of making relevant comparisons. However, analogies can be found with the Mousterian deposit of Grotta Breuil (Lemorini, 2000), especially concerning the activities carried out and the choice of the blanks. As for Riparo Tagliente, transversal actions are dominant, if compared to the longitudinal ones, and in this case, slaughtering activities, hide processing and woodworking are the most frequently attested. For treatment flesh masses, the use of un-retouched blanks seems to be aimed at maximizing the functional potential of the cutting edge, as shown by experimental studies (Alhaique and Lemorini, 1996). Similar considerations can be made for the site of Riencourt-lès-Bapaume (Ameloot-Van der Heijden, 1993;

Beyries, 1993) which is mostly comprised of retouched blades,mainly exploited for slaughtering activities. In the Mousterian site of Santa Croce (Arrighi et al., 2009), the laminar production is primarily used for longitudinal actions, in contrast to what has been so far observed at Riparo Tagliente and Grotta Breuil. Unfortunately, considering the current state of research, the formulation of a reliable hypothesis about the general function of laminar tools in Mousterian contexts seems to be quite difficult. The apparent recurrence in the European area of blades used for the processing of flesh masses could be, in our opinion, conditioned by the reduced size of the sample being analyzed.

The use-wear analysis of Levallois, pseudo-Levallois, Mousterian points and triangular flakes allowed observation of traces on 9 blanks, coming from squares 635, 634, 614 and 615 and from layers 34 to 37 of the internal survey pit. Diagnostic Impact Fractures (DIFs) were identified on two Mousterian points (RT 212 and RT 342). Concerning the other points under study, they present use-wear traces linked to butchering activities (Tab.6). This data is consistent with what has been defined as the "mobile character of Middle Palaeolithic points" (Goval et al., 2016): i.e. the non-univocal use of these instruments as spearheads. Other studies obtained similar results, for example the work developed by Rots on the site of Biache-Saint-Vaast, in which pointed tools were used as butchering knives (Rots and Plisson, 2014).

<u>6.2 Discussion of the use-wear analysis of the layer 36</u>

The analysis of the lithic industry of layer 36 provided a good a comparison with the data obtained from the study of two particular categories: blades and pointed tools. More than one third (38%) of the selected sample from layer 36 shows diagnostic traces of use (23 artefacts). Moreover, a fraction of the selected artefacts could have been so lightly used that no visible traces developed, and another fraction may have suffered severe damage during storage that obliterated traces of use. Although probably under-represented, the total number of artefacts with use wear traces, suggests an interpretation of the use-wear patterns. The processing of animal carcasses was often performed, including different phases of carcasses exploitation: butchering, fresh and dry hide processing, bone and soft animal tissues treatment. Among artefacts classified as butchering tools there are some items with traces related to contact with fleshy tissues in association with traces of contact with bone or fresh hide (16%; 4 tools) that are referable to activities such as skinning, evisceration, disarticulation and de-fleshing of carcasses (Lemorini et al., 2006). The tools with traces of dry hide processing (3 tools in total) suggest the presence of some type of tanning activity performed in the site (Beyries, 1987; Anderson-Gerfaud, 1990; Lemorini, 2000; Palmqvist et al., 2005; Lemorini et al., 2016) (Fig.8). Bone manipulation (20%; 5 tools) can be referred to the periosteum removal (for the transversal action 2 artifacts) (Grayson, 1984), or to disarticulation activities (Fig.7,8). Both these activities are also attested by the archeozoological study of the faunal remains of layer 36 (Thun Hohenstein and Peretto, 2005; Thun Hohenstein, 2006). The tools with traces of contact with fleshy tissues (4) are probably linked to fillet activities (Fig.8). Three blanks show traces linked to woodworking. Many studies conducted on Mousterian sites observed that the processing of vegetal materials is very rarely recorded and usually it is absent or scarce as testified in numerous cases: Tares-Dordogne; La Combette - Vaucluse; Vault Romani – Catalonia; Grand Champ - Loire and La Mouline – Dordogmodene (Claud et al., 2013). Furthermore, in some Middle Paleolithic sites wooden remains , although not very abundant, are well-known: at Schöningen (300 Ka B.P.), several wooden spears have been found (Schoch et al., 2015); at Poggetti Vecchi, (171 Ka B.P.) 39 wooden tools have been found (Aranguren et al., 2018) and from Aranbaltza III, around 90 Ka B.P, a digging stick, in its last stages of production, was recovered (Rios-Garaizar et al., 2018). Diachronic studies such as the ones conducted at Atapuerca, show that the use of wood is more intense in the Middle Paleolithic than in the Lower Paleolithic (Bencomo Viala et al., 2020). This evidence allows us to speculate that the wood-working traces found can be interpreted as a result of the manufacture of spears or other useful wooden objects (Rots and Hardy, 2015; Bencomo Viala et al., 2020).

In the selected sample there are some formal tools (17 over 60): part of them have traces of use (7) and all are side-scrapers (Tab.8). The analysis of the use-wear data of the side-scrapers seems to indicate that there was a preferential use, although not exclusive, of these tools for the treatment of materials with a medium/high hardness, such as bone and wood. However, some use-wear analyses (Texier et al., 1998; Lemorini, 2000; Hardy, 2004; Claud, 2012; Wilkins et al., 2015; Zupancich et al., 2016b) performed on side-scrapers from Middle Paleolithic contexts indicate that these tools were used on a variety of materials and for different activities, such as the Riparo Tagliente case. Among the lithics showing wear traces from layer 36, there are two cases of used flakes that technologically belong to the phases of shaping and management of the cores (one is a flake of management of a Levallois core and the other one is a reshaping flake). This data suggests an "opportunistic behavior" of the Neanderthals; in fact, it seems that there weren't differences between the "products" and the management flakes resulting by applying predetermined knapping methods (Boëda et al., 1990b; Boëda, 1994). Therefore, we should, maybe, reconsider our conception of "waste products" for the Levallois and the other predetermined methods (Brantingham and Kuhn, 2001; Lycett and Eren, 2013; Picin and Vaquero, 2016; Picin et al., 2020b; 2020a).

7. Conclusions

In order to understand if there are differences in the use of *débitage* products according to the knapping method, the analysis of our results indicate that apparently no kind of relationship exists between these two elements, as also demonstrated by other studies on the matter (Lemorini et al., 2003; Lazuén and Delagnes, 2014; Berruti, 2017). A general opportunistic behavior in the use of flakes is also attested by the identification of wear traces even on flakes that usually, in the reconstruction of the *chaîne opératoires*, are considered as waste products. It refers to the use of flakes that technologically are attributed to phases of shaping and cores management

(one is a flake of management of a Levallois core and the other is a reshaping flake). This data, even though surprising, corresponds to what has been noted in several functional studies on Middle Paleolithic lithic assemblages (Lemorini, 2000; Lemorini et al., 2003; 2016; Hardy, 2004; Claud, 2012; Lazuén and González-Urquijo, 2014; Zupancich et al., 2016a). Concerning the relation between the use of the artefacts and their typology, the data collected suggests a relation between blades and butchering activities (See Tab.1), as already seen in other sites like Riencourt-lès-Bapaume (Ameloot-Van der Heijden, 1993; Beyries, 1993) and Grotta Breuil (Lemorini, 2000).
Lastly, the presence of various and well documented activities identified by the use wear-study of the lithic assemblage of layer 36 confirms a complex occupation of the shelter in this phase as base camp (Stiner, 2013). This hypothesis was already previously proposed on the base of different observations such as the increasing, in this layer of the stratigraphy, of the lithic implements and of the faunal remains with cut marks (Arzarello, 2003; Thun Hohenstein and Peretto, 2005; Thun Hohenstein, 2006; Arzarello and Peretto, 2005). The use wear analysis demonstrates that this layer of the internal survey pit of Riparo Tagliente is characterized by a strong exploitation of animal resources, with long lasting processes.

Acknowledgements
The authors would like to thank the Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Verona, Rovigo e Vicenza, Comune di Grezzana (Verona) and Regione Veneto. They also thank Prof. A. Guerreschi and Jorge Tiago Correia. We would like to thank Università degli Studi di Ferrara for the availability of equipment and laboratories and for the financial support for field and lab activities. We would like to thank the anonymous reviewers who helped improving the final version of the manuscript; Christine McCarty and Amedeo Ceresa Genet for reviewing the English.

Author statement:

G.L.F. Berruti: Conceptualization, Methodology, Data curation, Writing- Original draft preparation, Formal analysis, Investigation. **E. Bianchi**: Conceptualization, Data curation, Formal analysis, Investigation. **M. Gomes**: Conceptualization, Data curation, Formal analysis, Investigation. **S. Daffara**: Writing- Reviewing and Editing, Data curation. **A. Ceresa**: Writing-Reviewing and Editing. **C. Peretto**: Supervision. **M. Arzarello**: Conceptualization, Supervision. **F. Fontana**: Supervision.

Bibliography

Alhaique, F., Lemorini, C., 1996. Butchering with stone tools: an experimental approach to use-wear analysis and taphonomic studies of the archaeological material from Grotta Breuil. Quaternaria Nova VI.

Ameloot-Van der Heijden, N., 1993. L'industrie laminaire du niveau C.A. du gisement paléolithique moyen de Riencourt-lès-Bapaume (Pas-de-Calais). Bulletin de la Société préhistorique française 90, 324–327. doi:10.3406/bspf.1993.9641

Anderson-Gerfaud, P., 1990. Aspects of behavior in the Middle Paleolithic: functional analysis of stone tools from southwest France. In: Mellars, P. (Ed.), The Emergence of Modern Humans: An Archaeological Perspective. Edinburgh University, Edinburgh, pp. 389–418.

Aranguren, B., Revedin, A., Amico, N., Cavulli, F., Giachi, G., Grimaldi, S., Macchioni, N., Santaniello, F., 2018. Wooden tools and fire technology in the early Neanderthal site of Poggetti Vecchi (Italy). Proceedings of the National Academy of Sciences 201716068. doi:10.1073/pnas.1716068115

Arnaud, J., Peretto, C., Panetta, D., Tripodi, M., Fontana, F., Arzarello, M., Thun Hohenstein, U., Berto, C., Sala, B., Oxilia, G., Salvadori, P.A., Benazzi, S., 2016. A reexamination of the Middle Paleolithic human remains from Riparo Tagliente, Italy. Quaternary International 425, 437–444. doi:10.1016/j.quaint.2016.09.009

Arrighi, S., Freguglia, M., Ranaldo, F., Ronchitelli, A., 2009. Production and use in the lithic industry of the Mousterian in Santa Croce (Bisceglie, Italy). Human Evolution 24, 91–106.

Arzarello, M., 2003. Contributo allo studio del comportamento Tecno-Economico dell'uomo di Neandertal:L'industria litica della serie Musteriana del Riparo Tagliente (Stallavena di Grezzana, VR, Italia). Ferrara.

Arzarello, M., Peretto, C., 2005. Nouvelles données sur les caractéristiques et l'évolution techno-économique de l'industrie moustérienne de riparo Tagliente (Verona, Italie). In: Molines, M., Moncel, M.-H., Monnie, J.-L. (Eds.), In Données Recents Sur Les Modalités de Peuplement et Sur Le Cadre Chronostratigraphique. Archaeopress British Archaeological Reports International Series 1998, Oxford, pp. 281–289.

Arzarello, M., Peresani, M., Fontana, F., Peretto, C., 2011. Manuale di tecnologia litica preistorica: concetti, metodi e tecniche. Carocci.

Asryan, L., 2015. Azokh cave lithic assemblages and their contextualizationin the Middle and Upper Pleistocene of southwest Asia. Universitat Rovira i Virgili. doi:10.1007/s13398-014-0173-7.2

Asryan, L., Ollé, A., Moloney, N., 2014. Reality and confusion in the recognition of post-depositional alterations and use-wear: an experimental approach on basalt tools. Journal of Lithic Studies 1, 1–23. doi:10.2218/jls.v1i1.815

Bartolomei, G., A., B., Callatni, L., Cremaschi, M., Guerreschi, A., Mantovami, E., Peretto, C., 1982. I depositi wormiani del riparo tagliente. Annali dell'università di Ferrara III, 61–105.

Bartolomei, G., Cattani, L., Cremaschi, M., Favero, V., Paganelli, A., 1984. L'evoluzione dell'ambiente nel Quaternario. In: Aspes, A. (Ed.), Il Veneto Nell'antichità. Preistoria e Portostoria. B. P. d. Verona, Verna, pp. 43–141.

Bencomo Viala, M., Jardón Giner, P., Sirvent Cañada, L.M., Hortelano Piqueras, L., 2020. Understanding woodworking in Paleolithic times by means of use-wear analysis. Journal of Archaeological Science: Reports. doi:10.1016/j.jasrep.2019.102119

Berger, T.D., Trinkaus, E., 1995. Patterns of Trauma among the Neandertals. Journal of Archaeological Science 22, 841–852. doi:10.1016/0305-4403(95)90013-6

Berruti, G.L.F., 2017. Use-wear analysis of discoid-conception lithic industries. Universidade de Trás-os-Montes e Alto Douro.

Berruti, G.L.F., Daffara, S., 2014. Theory and methods of the use wear analyisis of the lithic tools. The example of the arrowhead from the Morgado superior Cave (

Tomar, PT). Antrope 221–242.

Berto, C., Luzi, E., Canini, G.M., Guerreschi, A., Fontana, F., 2018. Climate and landscape in Italy during Late Epigravettian. The Late Glacial small mammal sequence of Riparo Tagliente (Stallavena di Grezzana, Verona, Italy). Quaternary Science Reviews 184, 132–142. doi:10.1016/j.quascirev.2017.07.022

Bertola, S., 2001. Contributo allo studio del comportamento dei primi gruppi di Homo sapiens sapiens diffusi in Europa. Sfruttamento della selce, produzione dei supporti lamellari, confezione delle armature litiche nel sito aurignaziano della Grotta di Fumane nei Monti Less. Consorzio Universitario BO - FE - PR.

Beyries, S., 1987. Variabilité de l'industrie lithique au Moustérien: approche fonctionnelle sur quelques gisements français. British Archaeological Reports International Series 328, Oxford.

Beyries, S., 1993. Analyse fonctionnelle de l'industrie lithique du niveau CA: rapport préliminaire et directions de recherche. In: Riencourt-Les-Bapaume, Pas-de-Calais: Un Gisement Du Paléolithique Moyen, Editions de La MSH (DAF 37). pp. 53–61.

Beyries, S., Plisson, H., 1998. Pointes ou outils triagulares? Donnèes fonctionnelles dans le Moustèrien levantin. Paleorient 24, 5–24.

Bianchi, E., 2011. Approccio tracceologico all'interpretazione del débitage laminare nel Paleolitico medio: i livelli musteriani di Riparo Tagliente (Stallavena di Grezzana, Verona). Università degli studi di Ferrara.

Boeda, E., Connan, J., Dessort, D., Muhesen, S., Mercier, N., Valladas, H., Tisnèrat, N., 1996. Bitumen as a hafting material on Middle Palaeolithic artefacts. Nature 380, 336–338.

Boëda, E., 1993. Le débitage discoïde et le débitage Levallois récurrent centripède 392–404.

Boëda, E., 1994. Le concept Levallois: variabilité des méthodes. Archéo éditions.

Boëda, E., Böeda, E., 1993. Le débitage discoïde et le débitage Levallois récurrent centripède. Bulletin de la Société préhistorique française 90, 392–404.

doi:10.3406/bspf.1993.9669

Boëda, E., Geneste, J.-M., Meignen, L., 1990a. Identification de chaînes opératoires lithiques du Paléolithique ancien et moyen. Paléo 2, 43–80. doi:10.3406/pal.1990.988

Boëda, E., Geneste, J.-M., Meignen, L., 1990b. Identification de chaînes opératoires lithiques du Paléolithique ancien et moyen. Paléo 2, 43–80.

Bonilauri, S., 2010. Les outils du Paléolithique moyen, une mémoire technique oubliée? Approche techno-fonctionnelle appliquée à un assemblage lithique de conception Levallois provenant du site d'Umm el Tlel (Syrie centrale). Paris.

Brantingham, P.J., Kuhn, S.L., 2001. Constraints on Levallois Core Technology: A Mathematical Model. Journal of Archaeological Science 28, 747–761. doi:10.1006/jasc.2000.0594

Burbidge, C.I., Trindade, M.J., Dias, M.I., Oosterbeek, L., Scarre, C., Rosina, P., Cruz, a., Cura, S., Cura, P., Caron, L., Prudêncio, M.I., Cardoso, G.J.O., Franco, D., Marques, R., Gomes, H., 2014. Luminescence dating and associated analyses in transition landscapes of the alto ribatejo, central portugal. Quaternary Geochronology 20, 65–77. doi:10.1016/j.quageo.2013.11.002

Carmignani, L., 2017. Between the flake and the blade: Associated systems of production at Riparo Tagliente (Veneto, northern Italy). Journal of Lithic Studies 4, 1–37. doi:10.2218/jls.v4i1.xxx

Churchill, S.E., 1993. Weapon Technology, Prey Size Selection, and Hunting Methods in Modern Hunter-Gatherers: Implications for Hunting in the Palaeolithic and Mesolithic. Archeological Papers of the American Anthropological Association 4, 11–24. doi:10.1525/ap3a.1993.4.1.11

Churchill, S.E., Rhodes, J.A., 2009. The Evolution of Hominin Diets Integrating Approaches to the Study of Palaeolithic Subsistence. In: The Evolution of Hominin Diets Integrating Approaches to the Study of Palaeolithic Subsistence. p. 300. doi:10.1007/978-1-4020-9699-0

Claud, E., 2012. Étude tracéologique de l'outillage moustérien de type Quina du bonebed de Chez-Pinaud à Jonzac (Charente-Maritime). Nouveaux éléments en faveur d'un site de boucherie et de traitement des peaux. Gallia 54, 3–32.

Claud, E., Thiébaut, C., Coudenneau, A., Deschamps, M., Mourre, V., Colonge, D., 2013. Le travail du bois au Paléolithique moyen : nouvelles données issues de l'étude tracéologique de plusieurs industries lithiques d'Europe Occidentale. Regards croisés sur les outils liés au travail des végétaux 367–381.

Coppe, J., Lepers, C., Clarenne, V., Delaunois, E., Pirlot, M., Rots, V., 2019. Ballistic Study Tackles Kinetic Energy Values of Palaeolithic Weaponry. Archaeometry 61, 933–956. doi:10.1111/arcm.12452

Cruz, A., Berruti, G.L.F., 2015. Use-Wear Analysis of the Knapped Lithic Grave Goods From Gruta Do Morgado Superior (Tomar , Portugal) 81–94.

Dockall, J.E., 1997. Wear Traces and Projectile Impact: A Review of the Experimental and Archaeological Evidence. Journal of Field Archaeology 24, 321–331.

Fischer, A., Vemming, H.P., Rasmussen, P., 1984. Macro and Micro Wear Traces on Lithic Projectile Points. Journal Danish Archaeology 3, 19–46.

Fontana, F., Cilli, C., Cremona, M., Giacobini, G., Gurioli, F., 2009. Recent data on the Late Epigravettian occupation at Riparo Tagliente, Monti Lessini (Grezzana, Verona): a multidisciplinary perspective. Preistoria alpina 49–58.

Fontana, F., Bertola, S., Cremona, M.G., Cavulli, F., Falceri, L., Gajardo, A., Visentin, D., Guerreschi, A., 2018. Re-colonising the Southern alpine fringe: diachronic data on the use of sheltered space in the late Epigravettian site of Riparo Tagliente. In: Borgia, V., Cristiani, E. (Eds.), Palaeolithic Italy. Advanced Studies on Early Human Adaptation in the Apennine Peninsula. Sidestone Press, Leiden, pp. 287–310.

Forestier, H., 1993. Le Clactonien: Mise en application d'une nouvelle méthode de débitage s'inscrivant dans la variabilité des systèmes de production lithique du Paléolithique ancien. Paleo 5, 53–82.

Goval, E., Hérisson, D., Locht, J.L., Coudenneau, A., 2016. Levallois points and triangular flakes during the Middle Palaeolithic in northwestern Europe: Considerations on the status of these pieces in the Neanderthal hunting toolkit in northern France. Quaternary International 411, 216–232. doi:10.1016/j.quaint.2015.04.039

Grayson, D.K., 1984. Quantitative Zooarchaeology. Accademic Press, Orlando.

Groman-Yaroslavski, I., Zaidner, Y., Weinstein-Evron, M., 2016. Mousterian Abu Sif points: Foraging tools of the Early Middle Paleolithic site of Misliya Cave, Mount Carmel, Israel. Journal of Archaeological Science: Reports 7, 312–323. doi:10.1016/J.JASREP.2016.05.002

Hardy, B.L., 2004. Neanderthal behaviour and stone tool function at the Middle Palaeolithic site of La Quina, France. Antiquity 78, 547–565. doi:10.1017/S0003598X00113213

Hutchings, W.K., 1997. The paleoindian fluted point dart or armature? Simon Fraser University.

Hutchings, W.K., 1999. Quantification of fracture propagation velocity employing a sample of Clovis flakes. Journal of Archaeological Science 26, 1437–1447. doi:10.1006/jasc.1999.0416

Iovita, R., Schönekeß, H., Gaudzinski-Windheuser, S., Jäger, F., 2014. Projectile impact fractures and launching mechanisms: Results of a controlled ballistic experiment using replica Levallois points. Journal of Archaeological Science 48, 73–83. doi:10.1016/j.jas.2013.01.031

Kanada, T., Coppe, J., Rots, V., 1984. Focus on the target. The importance of a transparent fracture terminology for understanding projectile points and projecting modes. Journal of Archaeological Science: Reports 12, 109–123. doi:10.1016/j.jas.2011.04.018

Keeley, L.H., 1980. Experimental Determination of Stone Tool Uses: A Microwear Analysis. The University of Chicago Press, Chicago.

Lazuén, T., 2012. European Neanderthal stone hunting weapons reveal complex behaviour long before the appearance of modern humans. Journal of

Archaeological Science 39, 2304–2311. doi:10.1016/j.jas.2012.02.032

Lazuén, T., Delagnes, A., 2014. Lithic tool management in the Early Middle Paleolithic: an integrated techno-functional approach applied to Le Pucheuil-type production (Le Pucheuil, northwestern France). Journal of Archaeological Science 52, 337–353. doi:10.1016/j.jas.2014.08.029

Lazuén, T., González-Urquijo, J., 2014. Recycling in the Early Middle Paleolithic: The role of resharpening flakes assessed through techno-functional analysis. Quaternary International 361, 229–237. doi:10.1016/j.quaint.2014.04.008

Lemorini, C., 1992. Variabilité ou spécialisation fonctionelle? Une révision du rapport entre forme et fonction au Moustérien. Analecta Prehistorica Leidensia 25, 17–24.

Lemorini, C., 2000. Reconnaître des tactiques d'exploitation du milieu au Paléolithique moyen. La contribution de l'analyse fonctionnelle Étude fonctionnelle des industries lithiques de Grotta Breuil (Latium, Italie) et de la Combette (Bonnieux, Vaucluse, France). British Archaeological Reports International Series 858. Archaeopress, Oxford.

Lemorini, C., Peresani, M., Rossetti, P., Malerba, G., Giacobini, G., 2003. Techno-morphological and use-wear funtional analysis: An integrated approach to the study of a discoid industry. In: Peresani, M. (Ed.), Discoid Lithic Technology. Advances and Implications. BAR International Series, pp. 257–275.

Lemorini, C., Stiner, M.C., Gopher, A., Shimelmitz, R., Barkai, R., 2006. Use-wear analysis of an Amudian laminar assemblage from the Acheuleo-Yabrudian of Qesem Cave, Israel. Journal of Archaeological Science 33, 921–934. doi:10.1016/j.jas.2005.10.019

Lemorini, C., Plummer, T.W., Braun, D.R., Crittenden, A.N., Ditchfield, P.W., Bishop, L.C., Hertel, F., Oliver, J.S., Marlowe, F.W., Schoeninger, M.J., Potts, R., 2014a. Old stones' song: Use-wear experiments and analysis of the Oldowan quartz and quartzite assemblage from Kanjera South (Kenya). Journal of Human Evolution 72, 10–25. doi:10.1016/j.jhevol.2014.03.002

Lemorini, C., Venditti, F., Assaf, E., Parush, Y., Barkai, R., Gopher, A., 2014b. The Function of Recycled Lithic Items at Late Lower Paleolithic Qesem Cave, Israel: An Overview of the Use-Wear Data. Quaternary International 361, 103–112. doi:10.1016/j.quaint.2014.07.032

Lemorini, C., Bourguignon, L., Zupancich, A., 2016. A scraper's life history: Morpho-techno-functional and use-wear analysis of Quina and demi-Quina scrapers from Qesem Cave, Israel. Quaternary International 398, 86–93. doi:10.1016/j.quaint.2015.05.013

Lombard, M., 2005a. A method for identifying stone age hunting. The South African Archaeological Bulletin 60, 115–120.

Lombard, M., 2005b. Evidence of hunting and hafting during the Middle Stone Age at Sibidu Cave, KwaZulu-Natal, South Africa: A multianalytical approach. Journal of Human Evolution 48, 279–300. doi:10.1016/j.jhevol.2004.11.006

Lombard, M., Parsons, I., Ryst, M.M. Van Der, 2004. Middle Stone Age lithic point experimentation for macro-fracture and residue analyses: The process and preliminary results with reference to Sibudu Cave points. South African Journal of Science 100, 159–166. doi:Article

Lycett, S.J., Eren, M.I., 2013. Levallois economics: an examination of 'waste' production in experimentally produced Levallois reduction sequences. Journal of Archaeological Science 40, 2384–2392. doi:10.1016/j.jas.2013.01.016

Martínez, K., Rando, J.M., 2001. Organización y funcionalidad de la producción lítica en un nivel del Paleolítico Medio del Abric Romaní. Nivel Ja (Capellades, Barcelona). Trabajos de Prehistoria 58, 51–70. doi:10.3989/tp.2001.v58.i1.233

Moncel, M.H., Chacón, M.G., Coudenneau, A., Fernandes, P., 2009. Points and convergent tools in the European Early Middle Palaeolithic site of Payre (SE, France). Journal of Archaeological Science 36, 1892–1909. doi:10.1016/j.jas.2009.04.018

Moss, E.H., 1983. The Functional analysis of flint implements Pincevent and Pont d'Ambon: two case studies from the French final Palaeolithic. British

Archaeological Reports International Series 177. Archaeopress, Oxford.

Odell, G., 1981. The mechanism of use-breakage of stone tools: some testable hypothesis. Journal Field Archaeology 8, 197–209.

Odell, G.H., Cowan, F., 1986. Experiments with Spears and Arrows on Animal Targets. Journal of Field Archaeology 13, 195–212. doi:10.1179/009346986791535780

Palmqvist, P., Martínez-Navarro, B., Toro, I., Espigares, M.P., Ros-Montoya, S., Torregrosa, V., Pérez-Claros, J.A., 2005. Réévaluation de la présence humaine au Pléistocène inférieur dans le Sud de l'Espagne. Anthropologie 109, 411–450. doi:10.1016/j.anthro.2005.06.001

Pargeter, J., 2013. Rock type variability and impact fracture formation: Working towards a more robust macrofracture method. Journal of Archaeological Science 40, 4056–4065. doi:10.1016/j.jas.2013.05.021

Peresani, M., 2003. Discoid Lithic Technology : Advances and Implications, British archaeological Reports - International Series. Archaeopress British Archaeological Reports International Series 1998, Oxford.

Peresani, M., 2010. Notes on the Neanderthal behaviour during the isotope Stage 3 in the alpine fringe of Italy. Gortania Geologia,Paleontologia,Paletnologia 31, 87–96.

Picin, A., Vaquero, M., 2016. Flake productivity in the Levallois recurrent centripetal and discoid technologies: New insights from experimental and archaeological lithic series. Journal of Archaeological Science: Reports 8, 70–81. doi:10.1016/j.jasrep.2016.05.062

Picin, A., Chacón, M.G., Soler, B.G. De, Blasco, R., Rivals, F., Rosell, J., 2020a. Journal of Archaeological Science : Reports Neanderthal mobile toolkit in short-term occupations at Teixoneres Cave. Journal of Archaeological Science: Reports 29, 102165. doi:10.1016/j.jasrep.2019.102165

Picin, A., Chacón, M.G., Soler, B.G. De, Blasco, R., Rivals, F., Rosell, J., 2020b. Neanderthal mobile toolkit in short-term occupations at Teixoneres Cave. Journal of Archaeological Science: Reports 29, 102165. doi:10.1016/j.jasrep.2019.102165

Rios-Garaizar, J., López-Bultó, O., Iriarte, E., Pérez-Garrido, C., Piqué, R., Aranburu, A., Iriarte-Chiapusso, M.J., Ortega-Cordellat, I., Bourguignon, L., Garate, D., Libano, I., 2018. A Middle Palaeolithic wooden digging stick from Aranbaltza III, Spain. PLOS ONE 13, e0195044. doi:10.1371/journal.pone.0195044

Rots, V., 2010. Prehension and Hafting Traces on Flint Tools: A Methodology. Leuven University Press, Leuven.

Rots, V., Hardy, B.L., 2015. Residue and microwear analyses of the stone artifacts from Schöningen. Journal of Human Evolution 89, 298–308. doi:10.1016/j.jhevol.2015.07.005

Rots, V., Plisson, H., 2014. Projectiles and the abuse of the use-wear method in a search for impact. Journal of Archaeological Science 48, 154–165. doi:10.1016/j.jas.2013.10.027

Schoch, W.H., Bigga, G., Böhner, U., Richter, P., Terberger, T., 2015. New insights on the wooden weapons from the Paleolithic site of Schöningen. Journal of Human Evolution 89, 214–225. doi:10.1016/j.jhevol.2015.08.004

Shea, J., 1997. Middle Paleolithic Spear Point Technology. In: Knecht (Ed.), Projectile Technology. Interdisciplinary Contributions to Archaeology. Springer, Boston.

Shea, J., Klenck, J., 1993. An Experimental Investigation of the Effects of Trampling on the Results of Lithic Microwear Analysis. Journal of Archaeological Science 20, 175–194.

Shea, J.J., Davis, Z., Brown, K., 2001. Experimental Tests of Middle Palaeolithic Spear Points Using a Calibrated Crossbow. Journal of Archaeological Science 28, 807–816. doi:10.1006/jasc.2000.0590

Shea, J.J., Brown, K.S., Davis, Z.J., 2002. Controlled Experiments with Middle Paleolithic Spear Points: Levallois Points. In: Experimental Archaeology:

Replicating Past Objects, Behaviors, and Processes. pp. 55–72.

Shoumacker, A., 1993. Apports de la technologie et de la pétrographie pour la caractérisation des meules. In: Anderson, P.C., Beyries, S., Otte, M., Plisson, H. (Eds.), Traces Et Fonction, Les Gestes Retrouvés. Presented at the Actes Du Colloque International de Liège, 8-9-10 Décembre 1990. Centre de Recherches Archéologiques du CNRS & Etudes et Recherches Archéologiques de l'Université de Liège, Valbonne, pp. 165–176.

Sisk, M., Shea, J., 2003. European Upper Paleolithic Stone Tool Typology: An annotated translation of the de Sonneville-Bordes and Perrot typology. In: Handbook of Paleolithic Typology: Lower and Middle Paleolithic of Europe. pp. 1–31. doi:10.7274/R03R0QR2

Stiner, M.C., 2013. An Unshakable Middle Paleolithic? Current Anthropology 54, S288–S304. doi:10.1086/673285

Terradillos-Bernal, M., Rodríguez-Álvarez, X.P., 2017. The influence of raw material quality on the characteristics of the lithic tool edges from the Atapuerca sites (Burgos, Spain). Quaternary International 433, 211–223. doi:10.1016/j.quaint.2015.10.122

Texier, P.-J., Lemorini, C., Brugal, J., Wilson, L., 1998. Une activité de traitement des peaux dans l'habitat moustérien de La Combette (Bonnieux, Vaucluse, France). Quaternaria Nova 6, 369–392.

Thun Hohenstein, U., 2006. Strategie di sussistenza adottate dai Neandertaliani. In: Sala, B., Tecchiati, U. (Eds.), Archaeozoological Studies in Honour of Alfredo Riedel. Druck und Bindung, Bolzano, pp. 31–38.

Thun Hohenstein, U., Peretto, C., 2005. Faunal exploitation in the Middle Palaeolithic: evidences from Riparo Tagliente (Verona, Italy). In: Moncel, M.-H., Monnier, J.-L. (Eds.), Les Premiers Peuplements En Europe. Colloque International: Donnees Recents Sur Les Modalites de Peuplement et Sur Le Cadre Chronostratigraphique, Geologique et Paleogeographique Des Industries Du Paleolithique Inferieur et Moyen En Europe. BAR International Series, Oxford, pp. 261–268.

VanGijn, A.L., 2014. Science and interpretation in microwear studies. Journal of Archaeological Science 48, 166–169. doi:10.1016/j.jas.2013.10.024

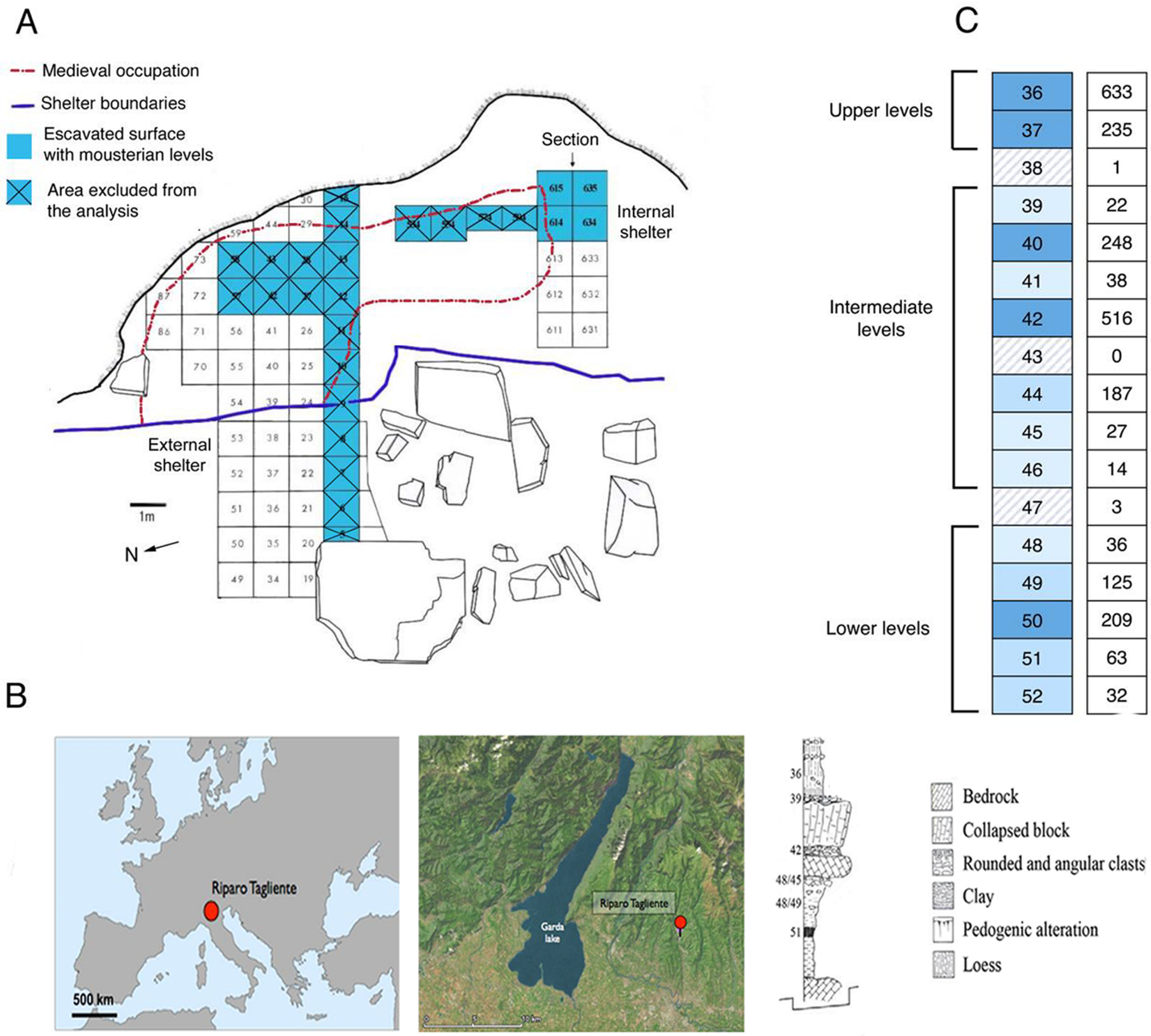
Wilkins, J., Schoville, B.J., Brown, K.S., Chazan, M., 2015. Kathu Pan 1 points and the assemblage-scale, probabilistic approach: a response to Rots and Plisson, "Projectiles and the abuse of the use-wear method in a search for impact." Journal of Archaeological Science 54, 294–299. doi:10.1016/j.jas.2014.12.003

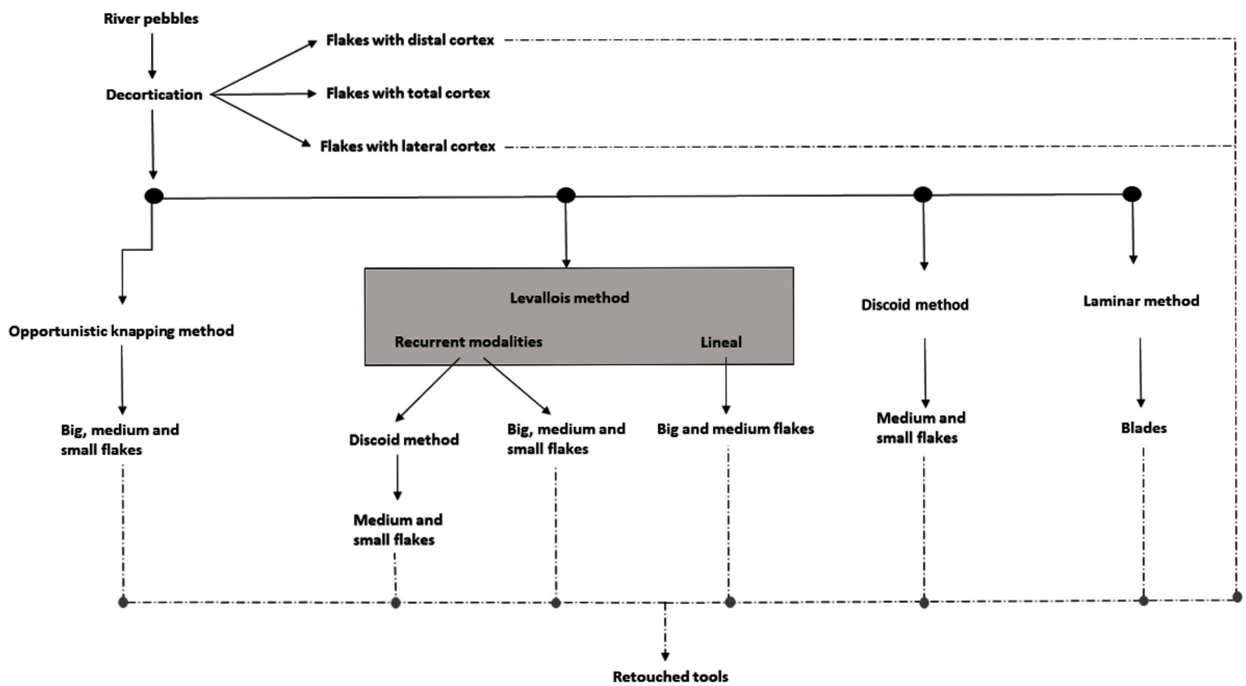
Ziggioti, S., 2005. Tecnologia e Funzione. Apporto dell'analisi funzionale delle industrie litiche dell'Epigravettiano recente nelle Prealpi orientali italiane. Consorzio universitario di Bologna, Ferrara e Parma.

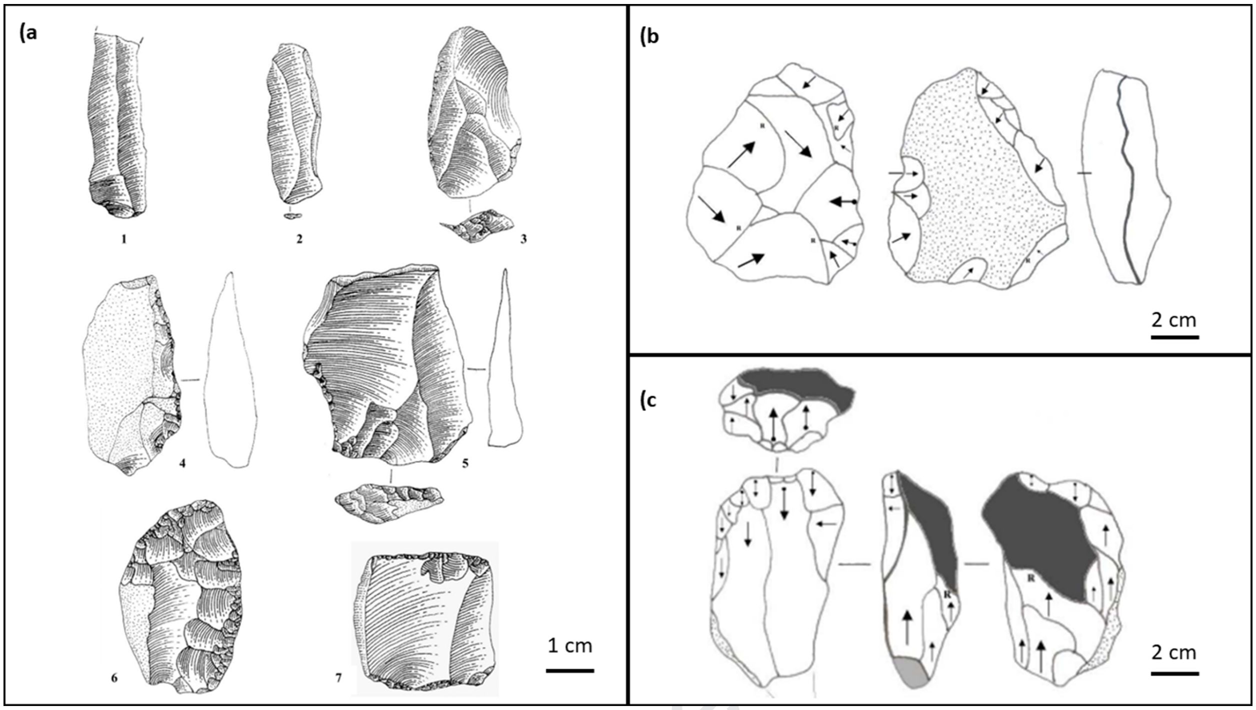
Ziggioti, S., 2011. Lo studio funzionale delle industrie litiche scheggiate. In: Arzarello, M., Peresani, M., F., F. (Eds.), Manuale Di Tecnologia Litica Preistorica.

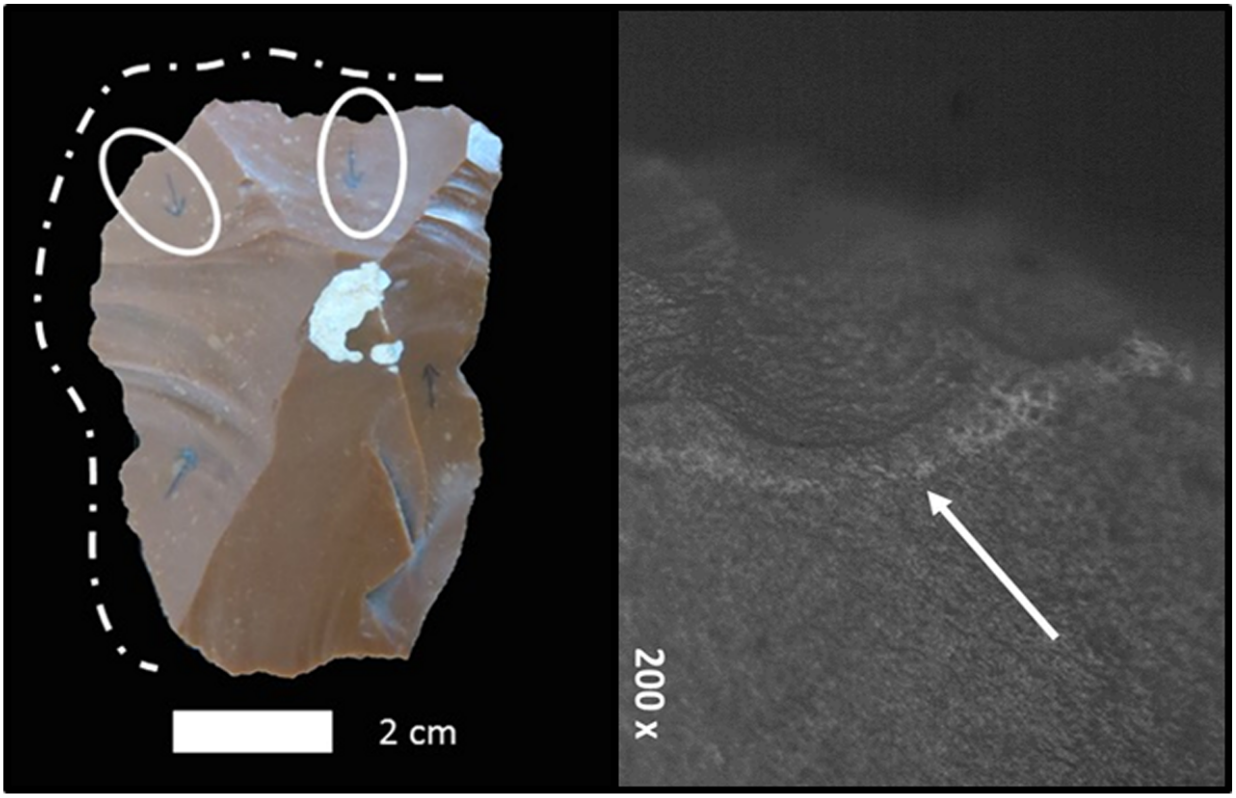
Zupancich, A., Nunziante-Cesaro, S., Blasco, R., Rosell, J., Cristiani, E., Venditti, F., Lemorini, C., Barkai, R., Gopher, A., 2016a. Early evidence of stone tool use in bone working activities at Qesem Cave, Israel. Scientific Reports 6, 37686. doi:10.1038/srep37686

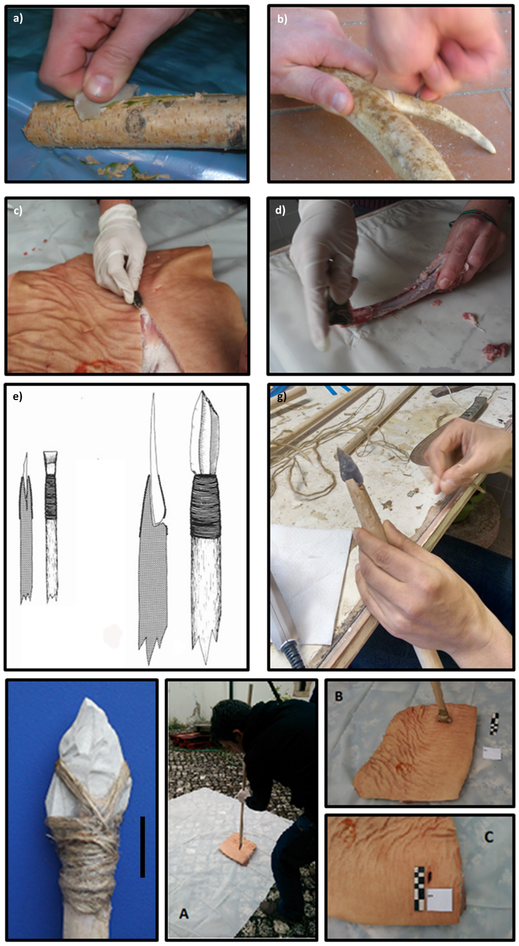
Zupancich, A., Lemorini, C., Gopher, A., Barkai, R., 2016b. On Quina and demi-Quina scraper handling: Preliminary results from the late Lower Paleolithic site of Qesem Cave, Israel. Quaternary International 398, 94–102. doi:10.1016/j.quaint.2015.10.101

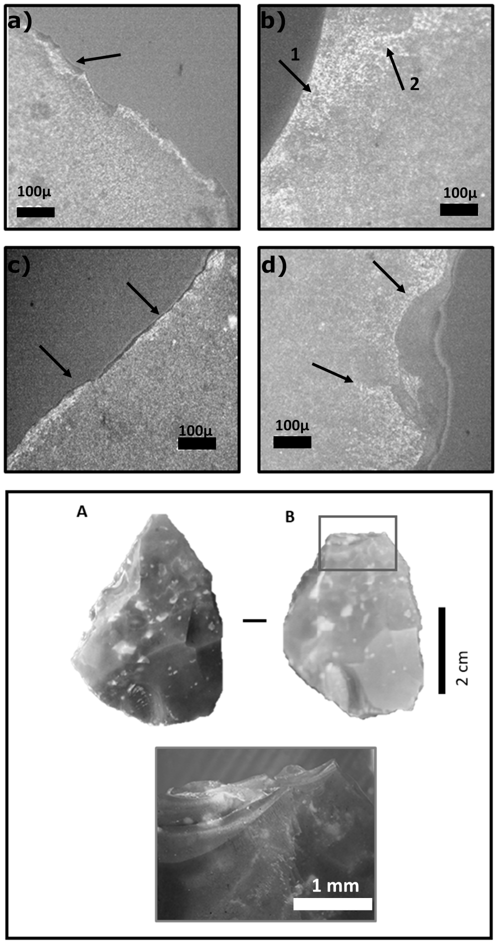

A
Medieval occupation
Shelter boundaries
Escavated surface
with mousterian levels
Area excluded from
the analysis
Section
Internal
shelter
External
shelter
1m
N
B
Riparo Tagliente
500 km
Garda
lake
Riparo Tagliente
Bedrock
Collapsed block
Rounded and angular clasts
Clay
Pedogenic alteration
Loess
C
Upper levels
Intermediate
levels
Lower levels
36 633
37 235
38 1
39 22
40 248
41 38
42 516
43 0
44 187
45 27
46 14
47 3
48 36
49 125
50 209
51 63
52 32

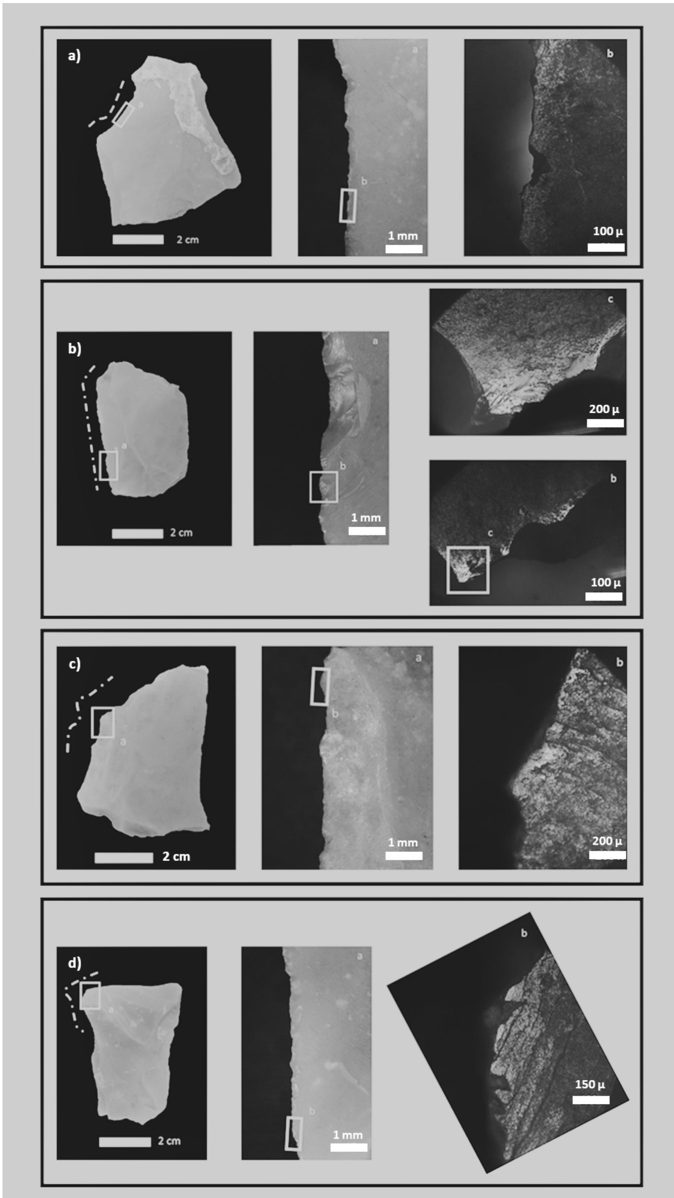

River pebbles
Decortication
Flakes with distal cortex
Flakes with total cortex
Flakes with lateral cortex
Opportunistic knapping method
Levallois method
Recurrent modalities
Lineal
Discoid method
Laminar method
Big, medium and small flakes
Discoid method
Big, medium and small flakes
Big and medium flakes
Medium and small flakes
Blades
Medium and small flakes
Retouched tools

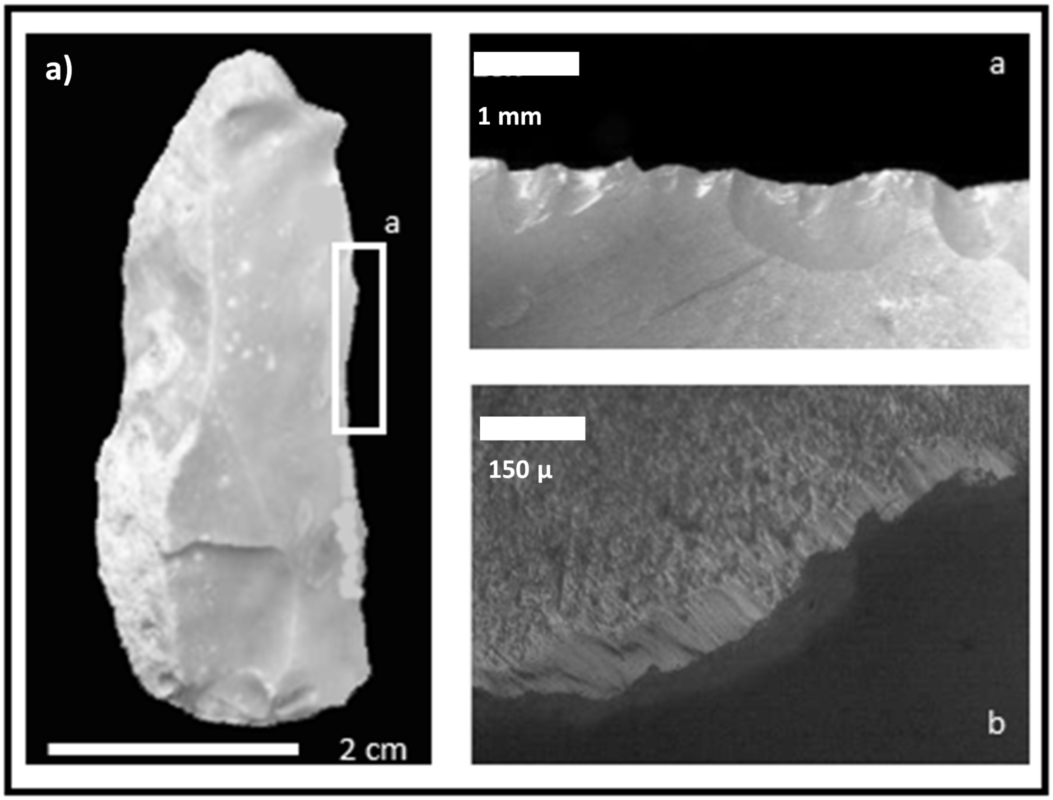

(a
1
2
3
4
5
6
7
1 cm
(b
2 cm
(c
R
R
2 cm

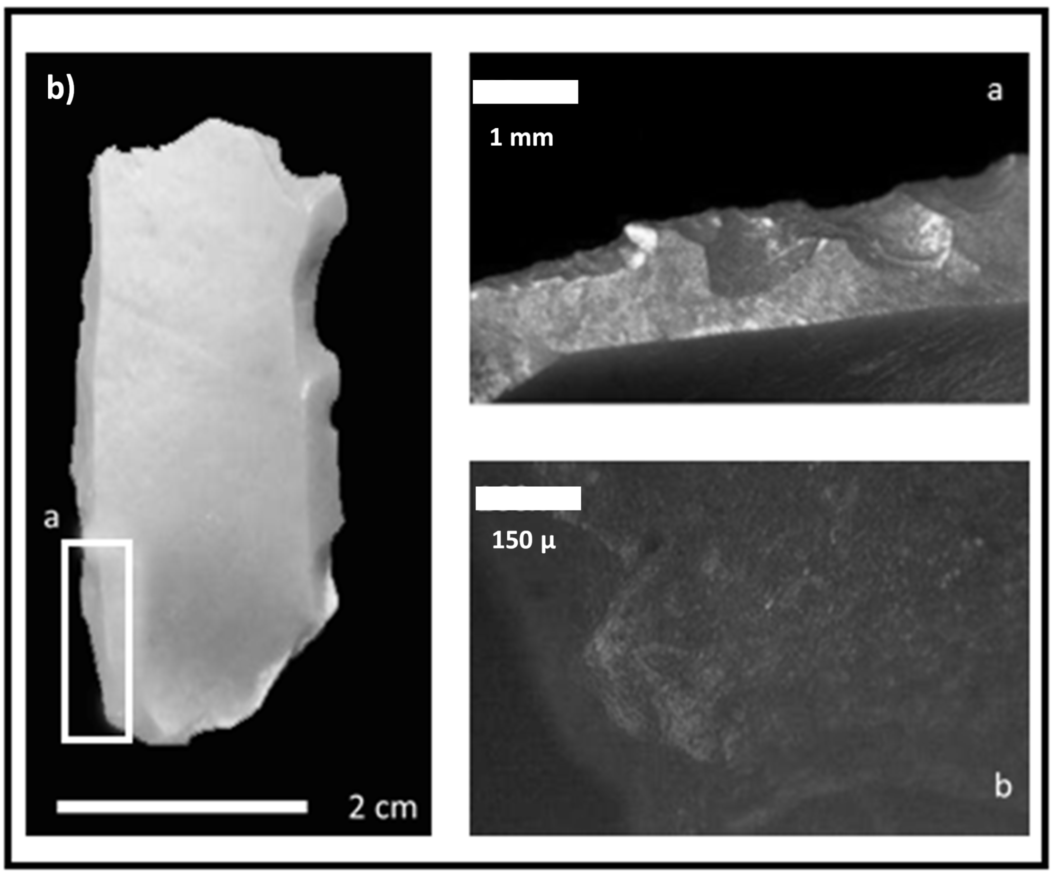

2 cm
200 x

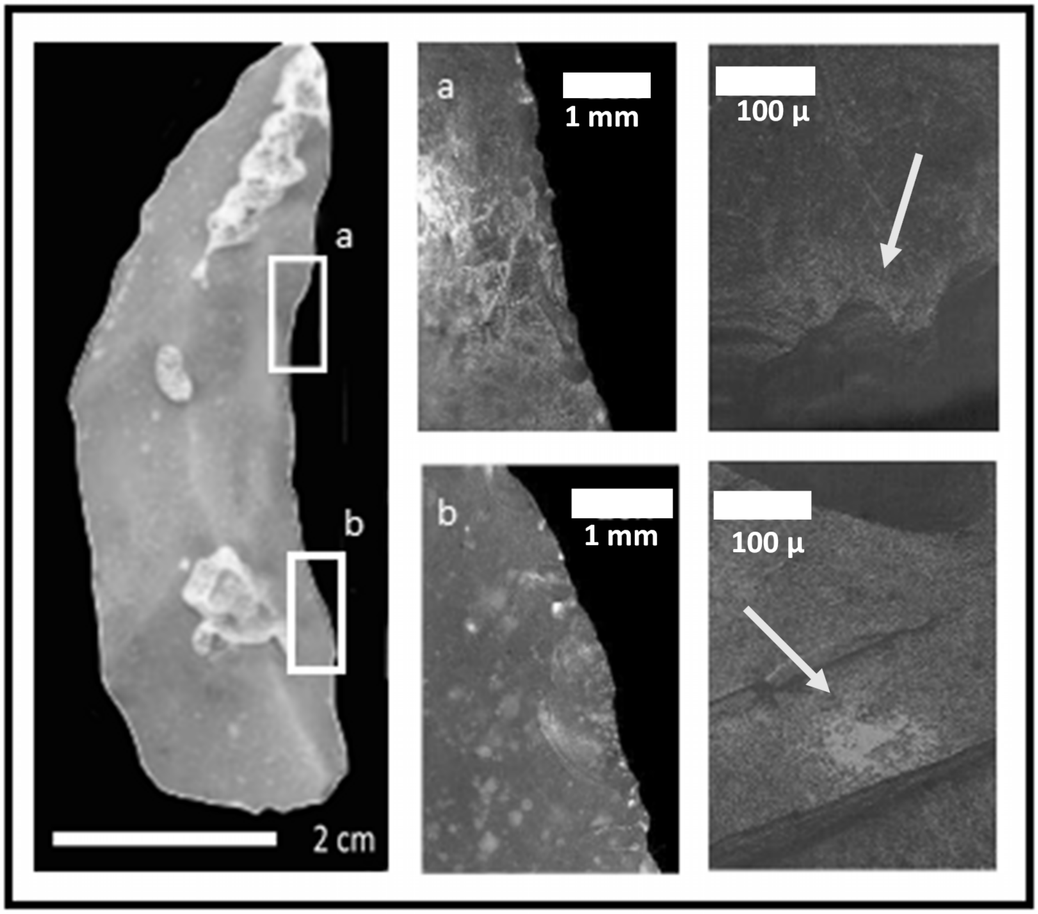

a)
b)
c)
d)
e)
g)
B
C
A


a)
100µ
b)
1
2
100µ
c)
100µ
d)
100µ
A
B
2 cm
1 mm


a)
2 cm
a
b
1 mm
b
100 µ
b)
2 cm
a
b
1 mm
c
200 µ
b
c
100 µ
c)
2 cm
a
b
1 mm
b
200 µ
d)
2 cm
a
b
1 mm
b
150 µ


a)
a
2 cm
1 mm
a
150 µ
b


b)
a
2 cm
1 mm
a
150 µ
b


a
b
2 cm
a
1 mm
100 µ
b
1 mm
100 µ

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: