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Abstract

Recently recognized as part of Final Lateglacial tool-kits, trapezoids remain enigmatic tools. The analytical part of this paper focuses on macro and micro-wear traces observed on Late Laborian trapezoids (GS1-Holocene transition, Atlantic facade) and their meaning from a utilitarian point of view. The consistency in the nature and organization of the traces leads us to interpret these implements as transverse projectile tips. These results confirm previous assumptions and establish the emergence of the Late Laborian trapezoids as an unprecedented innovation, marking a break from previous local weapon technology (points of piercing type and/or lateral inserts). These results provide a starting point to discuss the origin and significance of these artifacts. Their presence in different parts of Europe during the Lateglacial had been tentatively interpreted fifteen years ago as the result of large-scale cultural renewals in a context of progressively milder climatic and environmental conditions. At the current state of research, this diffusionist hypothesis suffers from a lack of geographic, techno-economic and functional continuity. Although techno-functional investigations inevitably raise the question of the target of these projectile points, current data do not provide a precise answer. It is however suggested that variations in stone points type during the Late Laborian was not necessarily related to prey type.

Key-words: Lateglacial - Late Laborian - trapezoids - use-wear analysis - transverse projectile tips

1. Introduction

Identified at the end of the nineteenth century, the Trapezoids - i.e. geometric microliths with a trapezoidal outline - are strong cultural markers of the Late Mesolithic and Neolithic European techno-complexes. Although the presence of Trapezoids has previously been noted in Final Paleolithic contexts (for an extensive bibliography see Ferrari and Peresani, 2003; Dalmeri *et al.*, 2004), the limited number of assemblages with such artifacts, geographical discontinuity of archaeological occurrence, morphological variability, and uncertain stratigraphic integrity of cultural layers may explain why these objects were broadly overlooked in previous analyses.

In Western Europe, the presence of trapezoids in Lateglacial industries was firstly seriously considered in Italy following the excavation of several sites where these implements were relatively abundant - i.e. La Cogola Rock shelter (Dalmeri *et al*., 1995) and Bus de la Lum (Peresani *et al*., 1999-2000). These excavations securely associated geometrics with the late Epigravettian industries of the Venetian Pre-Alps (northern Italy) during GS1. These findings motivated a large scale re-examination of the literature to track the occurrences of trapezoids in Lateglacial industries across Europe (Ferrari and Peresani, 2003; Dalmeri *et al.*, 2004). This bibliographic review led the authors to point out the presence of these artifacts in other Final Paleolithic contexts and to propose these items indicate the diffusion of ideas from the Near-East to the Laborian and Ahrensbourgian traditions of Northwestern Europe (Ferrari and Peresani, 2003; Dalmeri *et al*., 2004). These results went largely unnoticed by French archaeologists, with the presence of these artifacts in Final Lateglacial sites from Western France attributed to intrusions from Late Mesolithic and Neolithic occupations.

In 2005, a new study of Lateglacial assemblages from Northwestern France suggested trapezoids are typical tools of the Pleistocene/Holocene transition (Naudinot, 2008). In 2007, the discovery of a large corpus of trapezoids during the excavation of the final Lateglacial open-air site at La Fosse (Naudinot and Jacquier, 2009, 2014; Fig.1, Tab.1) provided a more secure context for these artifacts in France. Despite the apparent integrity of the cultural layer and technological evidence differentiating these trapezoids from their Mesolithic or Neolithic counterparts (Naudinot and Jacquier, 2009; Naudinot, 2010, 2013), the presence of trapezoids in the French Final Paleolithic record was not universally accepted. Subsequently, a review of the site of La Borie del Rey (Langlais *et al.*, 2014b) and a new excavation at Peyrazet (Langlais *et al.*, 2015), further supported the presence of trapezoids in Lateglacial archaeological assemblages in France. At the same time, two symposia discussing the Final Paleolithic in Les Eyzies-de-Tayac in 2010 (Michel and Naudinot coord., 2014) and in Bordeaux in 2012 (Langlais *et al.* dir., 2014) took place, leading to the acceptance of trapezoids as part of the Lateglacial lithic toolkit in France. Since then, new sites with trapezoids, such as Alizay in Normandie (Bemilli and Biard, 2014; Biard and Bemilli, 2018) and Vaise (Jallet and Bouvier dir., 2012; Treffort *et al.*, 2017; Langlais *et al.*, in press), were excavated while other sequences like le Cuze de Sainte-Anastasie (Langlais *et al.*, 2018) were reevaluated. Today these artifacts are broadly recognized as a cultural marker of the Late Laborian.

Fig.1: Location of the Late Laborian sites mentioned in this paper. 1: La Borie del Rey; 2: Gare de Couze; 3: Auberoche; 4: Le Moulin du Roc; 5: Roc d'Abeilles; 6: Peyrazet; 7: Le Cuze de Ste-Anastasie; 8: Vaise; 9: Les Prises; 10: La Vigie Romaine; 11: La Cadiais; 12: Pen ar Roz; 13: La Fosse; 14: Rochefort; 15: Auvours; 16: Alizay.
Tab.1: List of sites depicted in figure 1 and trapezoid numbers.

Between the second half of GS-1 (Greenland Stadial-1, also referred to as Younger-Dryas; Walker *et al.*, 2009) and first half of Preboreal (ca 12.5-11 Ka cal. BP), the European archaeological record can be divided into two techno-complexes: the Late/Terminal Epigravettian in the northern Mediterranean Basin and central-eastern Europe and industries characterized by the return of a well-developed blade technology in Northwestern Europe (Naudinot *et al.*, 2014, 2017; Tomasso *et al.*, 2018). Due to their technological consistency, these latter industries have been integrated in a large Western European techno-complex called "*Regular Blades and Bladelets Industries*" (Valentin 2008), "*Pre-Mesolithic Straight Blade and Bladelet Industries* " (Naudinot, 2010) or “Flat Blades Techno-complex (FBT)” (Naudinot et Jacquier, 2014). These complexes subsume several cultural traditions defined by various types of projectile points. The Laborian, stratigraphically situated between the Late Azilian and the Early Mesolithic, is one of these cultures and occupies an area extending at least from the Pyrenees to the Paris Basin, and from the Atlantic to the Alps (Langlais *et al.*, 2014a, in press; Mevel *et al.*, 2014; Naudinot *et al.*, 2019).

The exploitation of large game typical of open temperate landscapes (i.e., aurochs, horses and red deer), the persistence of bone barbed points, artistic conventions (engraved pebbles) along with several symbolic innovations, such as the development of a unique zoomorphic art, are among important elements typical of the Laborian (Langlais *et al.*, in press, Naudinot *et al.*, 2019). Recent work suggests this tradition to be divided in two phases with possible chronological significance, Early Laborian and Late Laborian (Langlais *et al.*, in press). Although not clearly distinguished in terms of ^{14}C dates (Langlais *et al.*, 2014b), Early and

Late Laborian are assumed to correspond respectively to the second half of Younger-Dryas and the first half of the Preboreal (Langlais *et al.*, in press). While these two phases of the Laborian share technological standards (*e.g.* production of normalized, regular, straight in profile and flat in section blades), the Late Laborian (*ca* 11.5-11 Ka cal. BP) shows a development of bladelet production (essentially for the manufacture of a new projectile point, i.e. Blanchères points; Naudinot 2010, 2013; Langlais *et al*., 2014b, in press; Naudinot *et al*., 2019). Of these phases this paper focuses primarily on the Late Laborian since it is this phase where trapezoids are recognized.

Although trapezoids are now broadly accepted as part of some Final Paleolithic tool-kits, their functional significance remains unclear. Analogy with their European Mesolithic and Neolithic counterparts found hafted on arrow shafts (Evans, 1878; Clark, 1936; Troels-Smith, 1960; Muller, 1917), lodged in animal or human bones (Noe Nygaard, 1974; Nuzhnyj, 1989; Beyneix, 2001; Kozlowski, 2009), or studied through use-wear analysis (*e.g.*, Odell, 1978; Fischer *et al*., 1984; Gassin, 1996; Domingo Martínez, 2004; Gibaja and Palomo, 2004; Critiani *et al*., 2009; Mazzucco et al., 2012; Philibert *et al.* 2014; Tomasso *et al*., 2015), suggest their use as projectile inserts and particularly transverse stone tips. This hypothesis was recently suggested for the Late Laborian trapezoids on the basis of a few macroscopic evidences (Naudinot and Jacquier, 2009; Naudinot, 2010, 2013; Langlais *et al.*, 2015, 2018). Recognized as a remarkable innovation, these artifacts are also linked to changes in hunting strategies (Naudinot, 2010, 2013). Concomitantly, in Northern Italy, functional studies suggest that Lateglacial trapezoids were versatile tools used as either composite knife elements (cutting of soft animal tissues or plant), projectile barbs or transverse projectile tips (Bertola *et al*., 2007; Ziggiotti and Dalmeri, 2008).

This paper provides new techno-functional data through the study of trapezoids from Late Laborian contexts. These data are used to discuss the modalities of emergence and diffusion of this technology and more generally to investigate the socio-economic significance of this development.

2. Methodology

The study reported here is part of a larger project targeting the evolution of economic and technological strategies during the Lateglacial (Magdalenian, Azilian and post-Azilian techno-complexes). In recent years more than 5000 artifacts from 7 post-Azilian period sites have been analyzed (Jacquier, 2014a, 2014b, 2015; Jacquier *et al*., 2019; Naudinot and Jacquier, 2014; Jacquier and Naudinot, 2015; Langlais *et al*., 2015, 2018). This very large sample allows us to detect patterns related to blank selection, retouch significance, tool function and taphonomy.

Each Late Laborian assemblage studied exhibited good preservation allowing high magnification analysis although this technique was not employed on the entire sample of artifacts. Rather, as argued by Van Gijn (2014), artifacts were carefully observed through stereomicroscope in order to identify implements that require an in-depth study. The analysis was then conducted by constantly alternating the optical scales (macro and microscopic) in order to describe the usewear traces, to understand their organization and relationships (particularly chronological) with technological modifications. This combination of macro and microscopic approaches makes it possible to reconstruct tool function (kinematics and material worked) and the technical and functional sequences preceding tool discard. This approach follows well-established methods developed by Semenov (1964) and Keeley (1980) and used by most European use-wear analysts and recognizes use-wear analysis as an interpretive discipline (Van Gijn, 2014), based on empirical knowledge and whose observations must be accompanied by clear and intelligible macro and microphotography.

The same approach was used to analyze the trapezoids presented in this paper. None of the scars or striations described and pictured here are considered individually as a diagnostic impact feature. Thus, this method departs from the classic DIF approach (Diagnostic Impact Fractures). Here, functional inference is based on the combination of multiple attributes and the consistency of their distribution on the sample. This approach is similar to the attribute-based system advocated by Coppe and Rots (2017), and fully comparable with the one pursued to infer any tool function. Like any use-wear analysis, it requires experience to distinguish wear traces resulting from different processes (technological, functional, post-depositional), as well as extensive experimental collections.

The purpose of this use-wear analysis is to characterize the macro and micro wear on the trapezoids, to evaluate the consistency of the use-wear patterns on these objects, and infer the way these artifacts worked. Considering these expectations, the consistency of archaeological evidence (see below) and the number of previously published studies examining the use of transverse projectile tips and their experimental counterparts (Fisher *et al*., 1984; Albarello, 1986; Nuzhnyj, 1990; Gibaja and Palomo, 2004; Pargeter, 2007; Lombard and Pargeter 2008; Yaroshevich *et al*., 2010; Brizzi and Loi, 2013; Lammers-Keijsers *et al*., 2014; Sano and Oba, 2014; Tomasso *et al*., 2015; Sano *et al*., 2016; Yamoaka, 2017; Antolinos-Basso, 2017; Calvo Gomez *et al*., submitted), the study was carried out without performing new experiments. In our view, additional experiments would not have contributed substantively to our analysis.

The terms used for describing traces are taken from those studies referenced above. More specifically, the vocabulary of fractures is based on the terminology of the Ho Ho Committee (Committee 1979), first used by Fisher *et al*. (1984) to describe impact damage.

Two optical devices were used: a stereomicroscope (Olympus SZX12 - magnification 7-90x) and a metallographic, incident light microscope (Olympus BX41M-LED - magnifications 100-200-500x). The photographs have been acquired with a Leica DFC295 camera mounted on the trinocular tubes.

As no residues were identified during the macro and microscopic analysis, we did not undertake any further studies on this point.

3. The studied material

The study sample comes from four Late Laborian assemblages from Western France. With the exception of the recently reevaluated site of La Borie del Rey (Langlais *et al*., 2014b) which was excavated in the 1950s (Coulonges, 1963), the studied sites were excavated using modern methods (i.e. 3D recording of objects, fine sieving sediment, taphonomical analysis), ensuring good archeostratigraphic control and the integrity of the trapezoids uncovered. These four sites include both rock shelters (La Borie del Rey, Peyrazet, Le Cuze de Sainte-Anastasie) and one open-air site (La Fosse). Previous studies of these sites revealed different functional orientations: from the very brief hunting camps at Cuze de Sainte-Anastasie (Langlais *et al.,* 2018) to the residential camp of La Fosse (Naudinot and Jacquier, 2014). It should be noted that most of the analyzed material comes from La Borie del Rey level 3 and

La Fosse, which constitute the richest deposits of trapezoids recorded so far in Late Laborian contexts (Tab.1).

The Late Laborian trapezoids are made on small blades and less frequently bladelets. Laborian trapezoids never bear evidence of the micro-burin technique (Naudinot, 2010, 2013; Langlais *et al.*, 2014a) in contrast to the Late Mesolithic trapezoids (*e.g.* Binder, 1987; Marchand, 1999; Perrin and Binder, 2011). This technological choice constitutes one of the several criteria used to distinguish Lateglacial trapezoids from more recent examples (Naudinot, 2010, 2013; Langlais *et al.*, 2014a). Truncations occasionally occur on transverse bending fractures (Fig.2) indicating that retouch sometime takes place on broken blanks. The use of intentional breakage as part of the retouch process is not assumed however.

Fig.2: Examples of truncations made on broken blanks.

The assemblages show some variability in the size and morphology of the original blanks, the orientation of the truncations, the infrequent backing of the small base (Fig.3, n°2 and 11), and the occasional use of bladelets at La Borie del Rey which generally gives a slender shape to the final products (Fig. 3, n°17-21). These choices condition the final morphology of the trapezoids and call into question the functional homogeneity of these artifacts.

Fig.3: Overview of trapezoid variability. 1-21: La Borie del Rey; 22-41: La Fosse; 42-43: Peyrazet, drawings S. Ducasse, from Langlais *et al.*, 2015; 44: Le Cuze de Sainte-Anastasie, drawings G. Devilder from Langlais et *al.*, 2018 ; CAD JJ.

Fig.4: Metric variability of the unbroken trapezoids of the corpus.

4. Results of wear analysis

According to the nature and organization of wear attributes, the macroscopic and microscopic observation of the sample allows us to distinguish 4 types of wear (Tab.2). The first type consists of snap bending fractures (Fig. 5). These fractures sometime remove a large angle of the long base (7 cases) or split the trapezoids in two parts along the technological axis of the blanks (6 cases). In those cases, these fractures intensely modify the shape of the artifacts. However, half of the snap bending fractures only remove small chips (Fig.5, n° 2 and b; Tab.2). These small breaks affect the angles of large and small bases alike. None of these fractures should be interpreted as evidence of use however, as they may have occurred as a product of manufacture, use or post-depositional processes.

Tab.2: Frequency of the four types of wear observed on the artifacts. Snap bending fractures have been categorized into 3 types. Type a: fractures that split the trapezoids in two parts along the technological axis of the blanks; Type b: fractures that remove a large angle of the long base; Type c: fractures that remove small chips of the long or small base. In the "wear association" sections, "+" means "and";" /" means "and/or". Thus, 7 (out of 8) burin like fractures initiated from the long base (type 2') are accompanied by long scars (type 2); 6 (out of 10) striations (type 3) are accompanied by type 2 or 2' wear; and 1 out of 3 burin like fractures initiated from the truncation (type 4) are accompanied by type 2, 2' or 3 wear.

Fig.5: Snap bending fractures from La Borie del Rey (1-2) and La Fosse (3-12). 1-7: fractures affecting the angles of long bases. 2: example of «small angle break» that only slightly modifies the shape of the implement. 8-12: Fracture which splits the trapezoids in two parts along the technological axis.

The second type of wear consists of scars and burin like fractures initiated along the long base of the trapezoid (Fig.6 and 7). All of them are composed of bending initiations and extended on the faces or along the truncations (burination) up to 8 millimeters in length. The terminations are diverse (feather, step and hinge). These long scars and burin like fractures occur on 12 trapezoids. In half of these cases, fractures and scars coexist (Fig.6, Tab.2).

Fig.6: Location and orientation of damage (scars, burin like fractures and striations) initiated from the large bases of trapezoids and oriented perpendicularly to it. 1-8: La Borie del Rey; 9-15: La Fosse; 16: Le Cuze de Sainte-Anastasie; drawing and CAD JJ.

Fig.7: Scars and burin like fractures initiated from the large bases of trapezoids. a: Fig.6, n°4; b-c: Fig.6, n°8; d-f: Fig.6, n°6; g-h: Fig.6, n°10; i: Fig.6, n°9; j-k: Fig.6, n°14.

Considering their location on the implements, burin like fractures initiated from the truncations form a distinct wear set and appear on three trapezoids. These burinations removed thin spalls along the long (2 cases) or short (1 case) bases (Fig. 8) and are 2 to 4.5 millimeters in length.

Fig.8: Burin like fractures initiated from truncations. 1-2: La Borie del Rey; 3: La Fosse.

Finally, striations or linear polish have been observed on 10 artifacts (Fig.6). Although the presence of these wear traces has always been perceived on the macroscopic scale, observation under the microscope makes it possible to identify other more discrete details. All of these traces are distributed close to the long base and perpendicular to it. They appear isolated or in clusters. Polishes are shiny under the stereomicroscope and are generally broad and flat-bottomed at high magnifications (Fig.9) and fully comparable to those observed on experimental projectile armatures (*e.g.* Fischer *et al*. 1984). Most of macroscopic striations and linear polish exceed two millimeters in length. They are always associated with long base damages but in half of the cases, the damages are inframillimetric and undifferentiated. The remaining striations are accompanied by large bending scars (more than 2 millimeters in length) or burin like fractures initiated from the long base (Fig.6).

Fig.9: Macro and microphotography of the striations observed on trapezoids 3 and 13 illustrated in Fig.6.

Momentarily leaving aside the three burination scars initiated from truncations that removed parts of the long or small bases, the damages observed on trapezoids show a consistent pattern. Striations and high amplitude scars always appear on the long base of trapezoids and are oriented perpendicular to it. Because they share common location and orientation, the most parsimonious explanation for these features is a single origin, even if these attributes are frequently dissociated on the sample. Considering the consistency of the pattern, the polarization of the damages on the large base and the strict organization of the striations, the origin of the traces through natural or manufacturing processes can be excluded. Finally, the intensity of edge damages and the nature of the wear considerably limit the functional hypotheses. In view of the nature and size of the implements, the use of trapezoids as transverse projectile heads is the only scenario consistent with the traces observed. These traces are also perfectly analogous with published experimental results (see for example Fischer *et al*., 1984; Tomasso *et al*., 2015; Sano *et al*., 2016; Calvo Gomez *et al*., submitted).

The only traces mismatching this interpretation are the few scars initiated from truncations and which removed a thin spall along the large or small base (Fig. 8). The low occurrence of these fractures, the fact that they indifferently impact the long or the small bases, and the absence of correspondingly orientated striae, does not support the hypothesis of alternative axial hafting. This damage must, in our view, be understood as incidental scars created during use (transport, withdrawing projectiles from the carcass, etc.) or post-depositional processes.

No residue of adhesive was identified on the implement presented in this paper, nor were any traces convincingly associated with hafting observed. It is likely, however, that some snap bending fractures situated around the small base were generated by the hafting as suggested for some Mesolithic and Neolithic trapezoids (*e.g.* Odell, 1978; Cristiani *et al.*, 2009).

5. Discussion

Although the results of this study must be replicated through the study of additional assemblages to confirm these findings, the consistency in the nature and organization of the use-wear traces reported here leads us to interpret these implements as transverse projectile tips. This result supports the hypotheses generated from previous investigations (Naudinot and Jacquier, 2009; Naudinot, 2010, 2013; Langlais *et al.*, 2014, 2018). Currently, the variations observed in the shape and technological attributes of trapezoids (see above) do not seem to be associated with functional variations. In fact, traces indicative of use as projectile tips are recognized on artifacts of varied shapes, even the slender implements from La Borie del Rey, made on bladelets. Given these findings, Late Laborian trapezoids should be considered as a single functional type of transverse projectile tip, and their morphological variations understood as circumstantial, idiosyncratic and/or cultural. It can be assumed however that once hafted to the shaft, the shape variations of trapezoids may for the most part no longer be visible.

Considering the way they were used (transverse tip), Late Laborian trapezoids appear as an unprecedented innovation in Northwestern Europe weaponry (Naudinot, 2010, 2013). Although there is still a great deal of uncertainty surrounding the issue of Late Paleolithic weapons, the use of transverse projectile tips would mark a break from previous weapon technology (points of piercing type and/or lateral inserts), and, in that respect, represents a historical discontinuity. This technological “break” raises the question of whether these artifacts are attributable to the process of diffusion or to local innovation. The adoption of this new type of weaponry also raises questions concerning the significance of this technical change.

5.1 Diffusion or local innovation?

According to Ferrari and Peresani 2003 and Dalmeri *et al*. 2004, trapezoids appear in several Lateglacial complexes across Europe - Balkans, Italian peninsula, Crimea, Near East (Jordan and Syria) - at the end of the LGM (second half of GS-2, Andersen *et al*., 2006). According to previous authors, these implements are rare during this early phase (2-3 trapezoids per sites), with the exception of the Near East Kebaran culture. The number of assemblages containing trapezoids increases during the Lateglacial spreading to many regions of Europe, up to the Final Magdalenian and Laborian assemblages of Southwestern France, Epigravettian sites in South-eastern Europe and the Ahrensbourgian complex of Northwestern Europe. Given this pattern the authors above cautiously suggest the spread of trapezoids may have been "the result of large-scale cultural renewals occurring within a context of progressively milder climatic and environmental conditions" (Dalmeri *et al*., 2004, p. 7). Conversely, we suggest this scenario needs to be discussed in relation to the level of confidence of the archaeological sequences involved in building this hypothesis and the functional significance of these implements and not only their shape.

It is firstly necessary to reevaluate the sequences in which trapezoids were identified at the European level. Most of the Upper Paleolithic sequences used to discuss this phenomenon were excavated before the large scale adoption of modern techniques and lack archeostratigraphic confidence. A reevaluation of these sequences, which are mostly rock-shelters with sediment mixing, would make it possible to refine the chronology of the emergence of trapezoids during the Final Paleolithic. Regarding the Final Paleolithic in Southwestern France, a review of archaeological sequences undertaken in the last decade makes it possible to reconsider the Azilianisation model proposed forty years ago (see Mallye *et al*., 2018). This model (Fitte and Sonneville-Bordes, 1962; Bordes and Sonneville-Bordes, 1979) considered that the Final Magdalenian gradually accumulated later elements. Recent studies show however that this progressive enrichment in Azilian elements to be more a matter of taphonomic rather than cultural factors. Reevaluation of several Magdalenian sites now makes it possible to individualize the Azilian and Laborian occupations at these locations (Langlais *et al*., 2014a and b, 2018; Fat Cheung, 2015; Mallye *et al*., 2018; Mallye and Laroulandie, 2018; Langlais and Fat Cheung, 2019). At the same time, several sites in northwestern France, once considered Magdalenian, were re-evaluated and reassigned to the Laborian (Naudinot, 2010, 2013). These recent studies indicate trapezoids do not exist in France during the Final Magdalenian and appear only briefly around the GS1-Holocene transition in Late Laborian contexts.

The idea of a large-scale diffusion of trapezoids across Europe during the final Paleolithic also needs to be discussed in terms of function rather than shape alone. Based on the use-wear evidence described in this paper, Late Laborian trapezoids likely represent transverse projectile tips. In the Venetian Late Epigravettian, use-wear analysis suggests these implements to be versatile tools used either as projectile barbs, transverse projectile tips, or composite knife elements (Bertola *et al*., 2007; Ziggiotti and Dalmeri, 2008). In the Geometric Kebaran (ca. 16.5-14.5 ka cal BP), trapezoids and rectangles are much more elongated than Laborian or Epigravettian standards and were predominantly hafted as side elements (Yaroshevich *et al*., 2010). In Northwestern Europe, between GS1 and the beginning of the Holocene, trapezoid shapes are common among Ahrensburgian geometric microliths (*e.g.*, Taute, 1968; Dewez, 1987; Johansen and Stapert, 1998; Ferrari and Peresani, 2003; Dalmeri *et al*., 2004; Cooper, 2006; Naudinot, 2010, 2013). Referred to as Zonhoven points - *i.e*. small blade with an oblique truncation at the tip and with or without additional retouch at the base (Taute, 1968) -, Ahrensburgian geometric microliths are infrequently symmetrical, differing substantial from those in Western France. This brief overview shows that assuming functional similarity based upon analogous shapes obscures significant variation in the concepts and significance of each tool type.

Moreover, assuming the appearance of trapezoids in the European archaeological record arises from diffusion also forces us to reevaluate the terms used to describe the process. As stated in the introduction, the European archaeological record is divided into two distinct entities following the Gravettian period (Breuil, 1913): the "classical" Upper Paleolithic sequence in Northwestern Europe (Solutrean, Badegoulian, Magdalenian, Azilian and then Laborien/Ahrensbourgian/Swiderian) and the Epigravettian in the Northern Mediterranean and Eastern Europe. The Epigravettian differs from the Northwestern sequence particularly in regard to the continuity of the traditions, with a distinct tendency toward the simplification of debitage throughout the period (Naudinot *et al*., 2017; Tomasso *et al*., 2018). When trapezoids appear in the Venetian pre-alps during GS1, shortly before their Late Laborian counterparts (beginning of Holocene), the technological traditions are very different between regions in terms of techno-economic organization: where "*a massive return of blades and bladelets with high qualitative standards occurred in Western Europe while the simplification process is still in course in the Epigravettian region*" (Naudinot *et al*., 2017). Given the current state of research, the diffusionist hypothesis suffers from a lack of geographic and techno-economic continuity, especially when compared to the late Mesolithic diffusion process recently highlighted by a wide scale examination of archaeological data and refined analysis of radiocarbon dates (Marchand and Perrin, 2017). Although the problems pointed out above force us to question the diffusionist scenario, the current state of research does not rule out this possibility making the acceptance of local innovation as the driver of this innovation as premature as well.

5.2 The elusive significance of the Late Laborian transverse projectile tips

Although use-wear shows that the Late Laborian trapezoids were most likely used as transverse projectile head, the question of the *function* of it - i.e. the "*whole sets of ends for which it is put to use*" (Sigaut, 1991) - remains unresolved. Based on experiments and ethnographic sources, much has been said about the utility of transverse arrowheads. Following shooting experiments that failed to penetrate targets, several authors proposed that the wide active edge of transverse stone tips was not intended to deeply penetrate flesh but rather to knockdown small game, especially birds (Lombard and Pargeter, 2008; Brizzi and Loi, 2013; Gibaja and Palomo, 2014). Other actualistic shooting experiments have shown transverse arrowheads have a good ability to penetrate the flesh of large game (Fischer *et al*., 1984; Albarello, 1986; Fisher, 1985; Gassin, 1996; Calvo Gomez *et al*., submitted), supporting the proposal that transverse stone tips were intended to cause extensive wounds and abundant bleeding (Fischer, 1985; Nuzhnyj, 1989, 1990). Recently, shooting experiments targeting pig scapula encased in ballistic gelatin and covered with wild boar hide (4 to 19 mm thick) were carried out to compare the wounding capabilities of Late Laborian trapezoids used as transverse stone tips and Blanchères points used as piercing arrowheads with a disto-lateral hafting (Antolinos-Basso, 2017). In this experimental context, transverse stone tips penetrated the skin less effectively (9 of 15, i.e. 60%) compared to piercing tips (100% of the 13 shooting), but once through the hide the wounding capabilities of trapezoids were considered much higher in terms of depth of penetration and damage to both soft tissue and bone (*ibid*.).

Ethnographic and ethnohistoric data show that transverse arrowheads have been used in many contexts, with or without poison, to kill or injure humans as well as animals, ranging from elephants to birds (*e.g*., Buisson, 1950; Clark *et al*., 1974; Garlake, 1987; Jessop, 1996; Loads, 2013). These tools may even have been used in naval warfare for ripping open enemy sails during medieval times (Loads, 2013). These diverse uses suggest shape alone belies the true use of transverse arrowheads. It should be noted however, that most ethnographic or historic transverse projectile tips are made of steel. Conversely, an extensive search of the ethnographic and ethnohistoric literature by Ellis (1997) suggested that the general purpose of any stone-tipped projectile is large animal hunting (> 40kg) including use against humans.

Unfortunately, the resolution of use-wear analysis does not allow for such detailed interpretations and no current examples of trapezoids lodged in animal or human bone exist in Late Laborian contexts. In Europe, no such examples appear until the Mesolithic and Neolithic. From these direct examples and several bone injuries interpreted as resulting from hunting with these weapons (Noe Nigaard, 1974), transverse projectile tips were used to shoot deer, aurochs, wild boar, swans and humans (Noe Nigaard, 1974; Cordier, 1990; Beyneix, 2001). Despite the case of the swan, still a large bird, these examples support the assertions of Ellis. The diversity of animals hunted with transverse projectile tips in the Danish Mesolithic (Noe Nigaard, 1974) also suggests that, in practice, these weapons were used with some flexibility.

In terms of the Late Laborian, trapezoids are always associated with other more numerous projectile inserts, especially points made from bladelets referred to as Blanchères points (Rozoy, 1978). Furthermore, few Late Laborian sites with trapezoids and faunal remains are known. These few sites show however, that similar diversified hunting equipment (trapezoids and Blanchères points) exists in both specialized - aurochs hunting at Alizay (Bemilli and Biard, 2014; Biard and Bemilli, 2018) - and broad-spectrum foraging localities (Langlais *et al*., 2014b, 2015). We note that although various game could have been killed on Late Laborian sites, aurochs, horses and deer still dominate (Langlais *et al*., in press).

These available data remain insufficient to clarify the use of Late Laborian transverse stone tips. Considering the issues discussed above (general purpose of stone tips in ethnographic record; use of trapezoids during Mesolithic and Neolithic; faunal data in Late Laborian contexts), it is tempting to speculate that trapezoids, and Blanchères points, were used against large animals; with small game trapped or hunted with organic tips. Perhaps it is even necessary to consider that the duality of the stone points during the Late Laborian was not related to the hunting of specific game species. According to Ellis (1997), variations in stone point type is rarely related to the prey hunted. He states "*it is much more common to find variation in stone tips within certain groups explained with reference to the war arrow in comparison to hunting arrow dichotomy [...], or even to idiosyncratic variation*" (Ellis, 1997, p. 46). While idiosyncrasy is likely irrelevant in the case of Blanchères points and trapezoids since variation at the level of the individual concerns design details rather than entire point forms (*e.g.* Wiessner, 1983), the hunting or war arrow dichotomy is still an issue. Hunting or combat experience or age or social status, could also have supported these variations (*e.g.* Petrequin and Petrequin, 1990).

Our objective is not to oppose the hypothesis that Late Laborian trapezoids were used to hunt specific game, large or small, or even to suggest that they were use in the context of human conflicts. Our aim is rather to point out the difficulty of going beyond the first level of interpretation, namely recognizing trapezoids as transverse projectile tips, and to argue that it reveals very little about the function that hunter-gatherers collectively assigned to these implements in the early Holocene.

6. Conclusion

This functional study of Late Laborian trapezoids indicates these artifacts functioned as transverse projectile tips, supporting previous hypotheses and establishing the emergence of the Late Laborian trapezoids as an unprecedented innovation of Northwestern European weaponry. This result presents an opportunity to question the origin and function of these tools. Although trapezoids appear in different geographic areas in Europe during the Late Glacial, we propose previous hypotheses of diffusion (Ferrari and Peresani, 2003; Dalmeri et al., 2004) be treated cautiously and reevaluated when sites containing these items and these objects themselves have been reassessed and studied from a techno-functional perspective. The relative scarcity of trapezoids in Late Laborian sites, their quick disappearance, the historical discontinuity they represent and their low damage rate make them enigmatic tools. The resolution of archaeological data is not yet sufficient to uniquely identify their utilitarian role. Ethnographic data provide limited additional information since the function of objects and forms has always been subject to a cultural definition. The same is true for shooting experiments since the relative advantage of one type of point over another is not universal but is culturally constructed according to specific expectations. In other words, the reasons for the use and adoption of the trapezoids at the end of the Lateglacial cannot be simply deduced from their intrinsic characteristics or the ballistic performance inferred from experiments.

The utilitarian role of Late Laborian trapezoids remains to be determined and there can therefore be no obvious reason to explain the development of this discreet and quickly abandoned innovation. These artifacts briefly appear at a time when no change is perceptible in terms of hunted game (no significant variation in the taxonomic composition between Early and Late Laborian; Langlais *et al.*, in press). Linking the emergence of this geometric projectile tip with the appearance of the bow and arrow technology also fails since the bow probably appeared well before this point form. We should remember that the first direct evidence for bow and arrow comes from the Ahrensburgian level (GS-1) of Stellmore in Northern Germany (Rust, 1943), and that this weapon might well have been in use long before, perhaps in association with other projectile delivery systems (*eg*. Cattelain 1997).

Archaeologists are generally tempted to interpret variations in stone tips as the results of adaptive strategies (*e.g*. Fischer, 1985; Bleed, 1986; Nuzhnyj, 2000; Pelegrin, 2000), assuming that characteristics of resources or acquisition strategies shape the design of stone artifacts. This reasoning assigns to weapons an idealized function (causing abundant bleeding for example) that finds a relative rationality in the correlation with contemporary environmental or technological changes (with the development of forest cover, wounded animals can be more easily tracked by blood). However, a certain circularity becomes apparent since the argument consists in assuming as a precondition (nature dictates a technical response) what the argument is intended to prove. Although this utilitarian view of technology is based on several principles (necessity is mother of invention; form follows function; the meaning of an artefact is a surface matter of style) that have long been criticized by social anthropologists (*e.g.*, Pfaffenberger, 1992), it is still very difficult to break away from these paradigms. Social anthropology show that “a technique appears to us (and to the actors) as a means to achieve a given physical goal by particular (and coherent) material means, whereas in the creative process of innovation, these "technical" elements were in fact chosen mostly in accordance with various "social" strategies and meanings” (Lemonier, 1993, p. 3). In the case of the Late Laborian trapezoids, one can thus wonder whether the initial meaning that prehistoric populations gave to these transverse projectile tips resided in the singular, even counter-intuitive, character of this hafting mode rather than in the physical effect of this new tool form.

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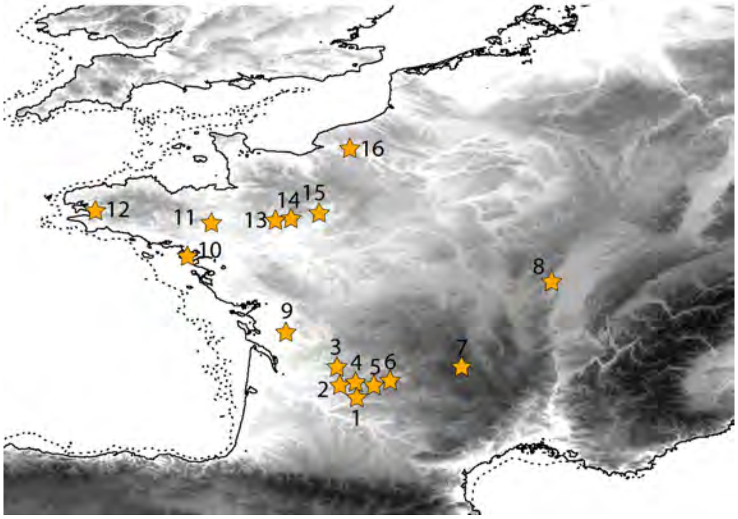
n°	Sites	Layer	Nb of trapezoids	References
1	La Borie del Rey (Blanquefort-sur-Briolance, Lot-et-Garonne)	3	46	Langlais *et al.*, 2014b
2	Gare de Couze (Lalinde, Dordogne)	different levels	<10	Fitte and Sonneville-Bordes, 1962
3	Auberoche (Le Change, Dordogne)	unique level	1	Langlais and Fat Cheung, 2019
4	Le Moulin du Roc (Saint-Chamassy, Dordogne)	different levels	<5	Detrain et al., 1996
5	Roc d'Abeilles (Calviac, Dordogne)	Upper layer	2	Champagne and Espitalié, 1970
6	Peyrazet (Creysse, Lot)	1 and 2	2	Langlais et al., 2015
7	Le Cuze de Ste-Anastasie (Sainte-Anastasie, Cantal)	4 and 5	4	Langlais et al., 2018
8	Vaise (Lyon, Rhone)	unique level	9	Pasty *in* Treffort *et al.*, 2017
9	Les Prises (Brizambourg, Charente-Maritime)	unique level	27	Naudinot, 2010
10	La Vigie Romaine (Le Croisic, Loire-Atlantique)	unique level	3	Sicard-Marchand *et al.*, 2004
11	La Cadiais (Bourg-des-Comptes, Ille-et-Vilaine)	unique level	1	Naudinot, 2010
12	Pen ar Roz (Châteaulin, Finistère)	unique level	1	Hinguant *et al.*, 2016
13	La Fosse (Villiers-Charlemagne, Mayenne)	unique level	32	Unpublished reports
14	Rochefort (Saint-Pierre-sur-Erve, Mayenne)	3.1	1	Naudinot, 2010
15	Auvours (Saint-Mars-le-Brière, Sarthe)	unique level	11	Naudinot, 2010
16	Alizay (Eure)	unique level	4	Biard *et al.*, 2018

		1				2	2'	3	4	**Wear association**		
	Studied artifacts	**Snap bending fractures**				**Long scars from the long base**	**Burin like fractures from the long base**	**Striations**	**Burin like fractures from the truncation**	**2+2'**	**2/2'+3**	**2/2'/3+4**
Sites		Type a	Type b	Type c	Total							
La Borie del Rey	46	0	1	6	7	5	3	7	2	3	4	0
La Fosse	32	5	6	6	17	5	4	3	1	3	2	1
Peyrazet	2	1	0	1	2	0	0	0	0	0	0	0
Le Cuze de St. A.	1	0	0	0	0	1	1	0	0	1	0	0
Total	**81**	**6**	**7**	**13**	**26**	**11**	**8**	**10**	**3**	**7**	**6**	**1**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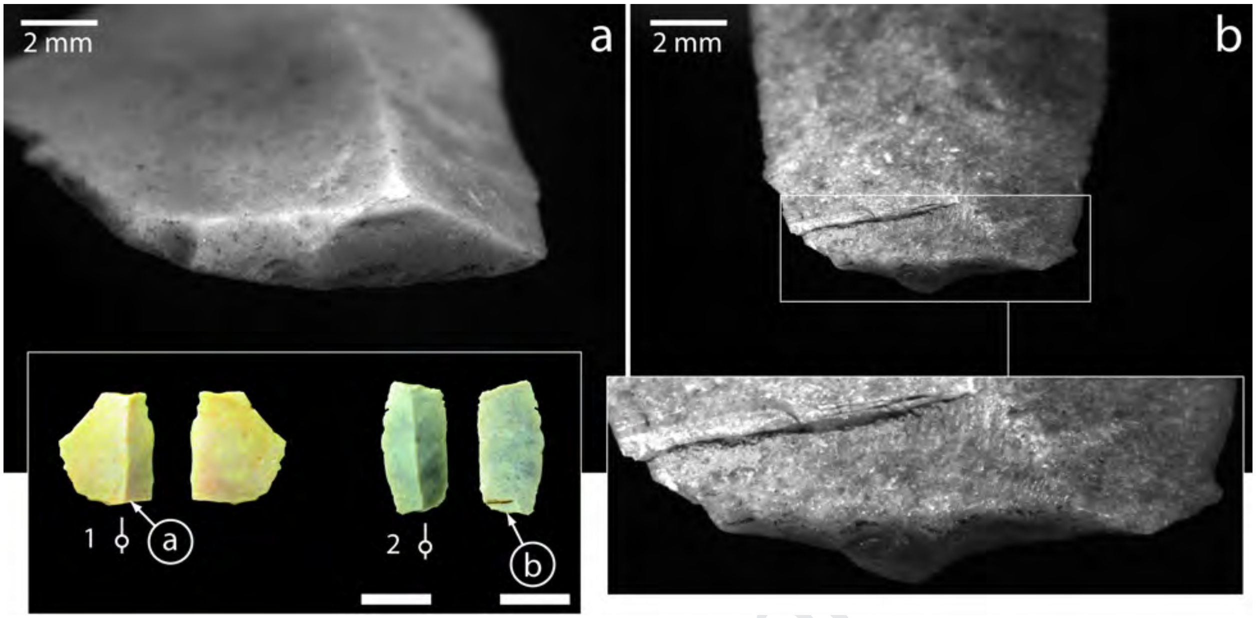
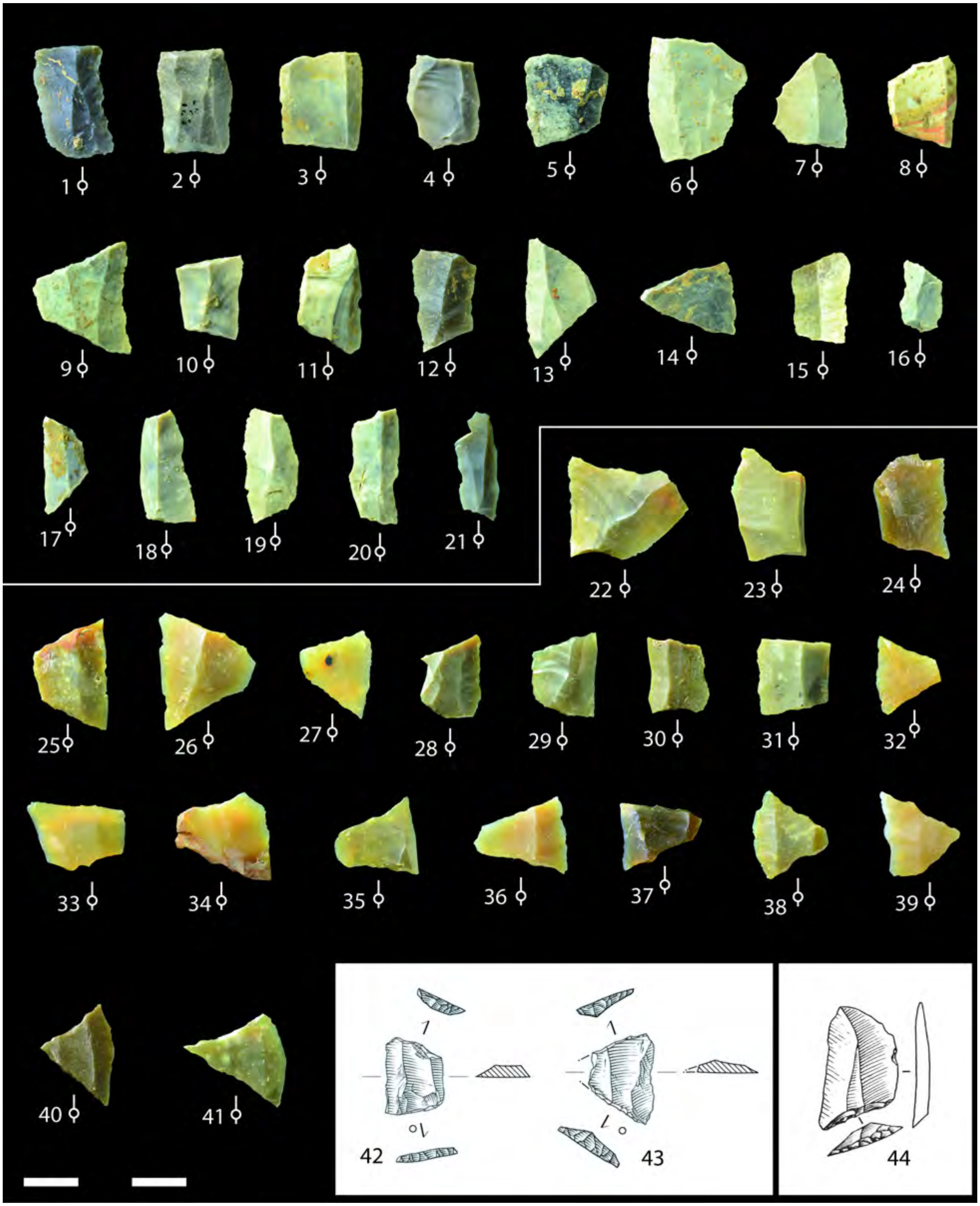

2 mm
a
2 mm
b
1
a
2
b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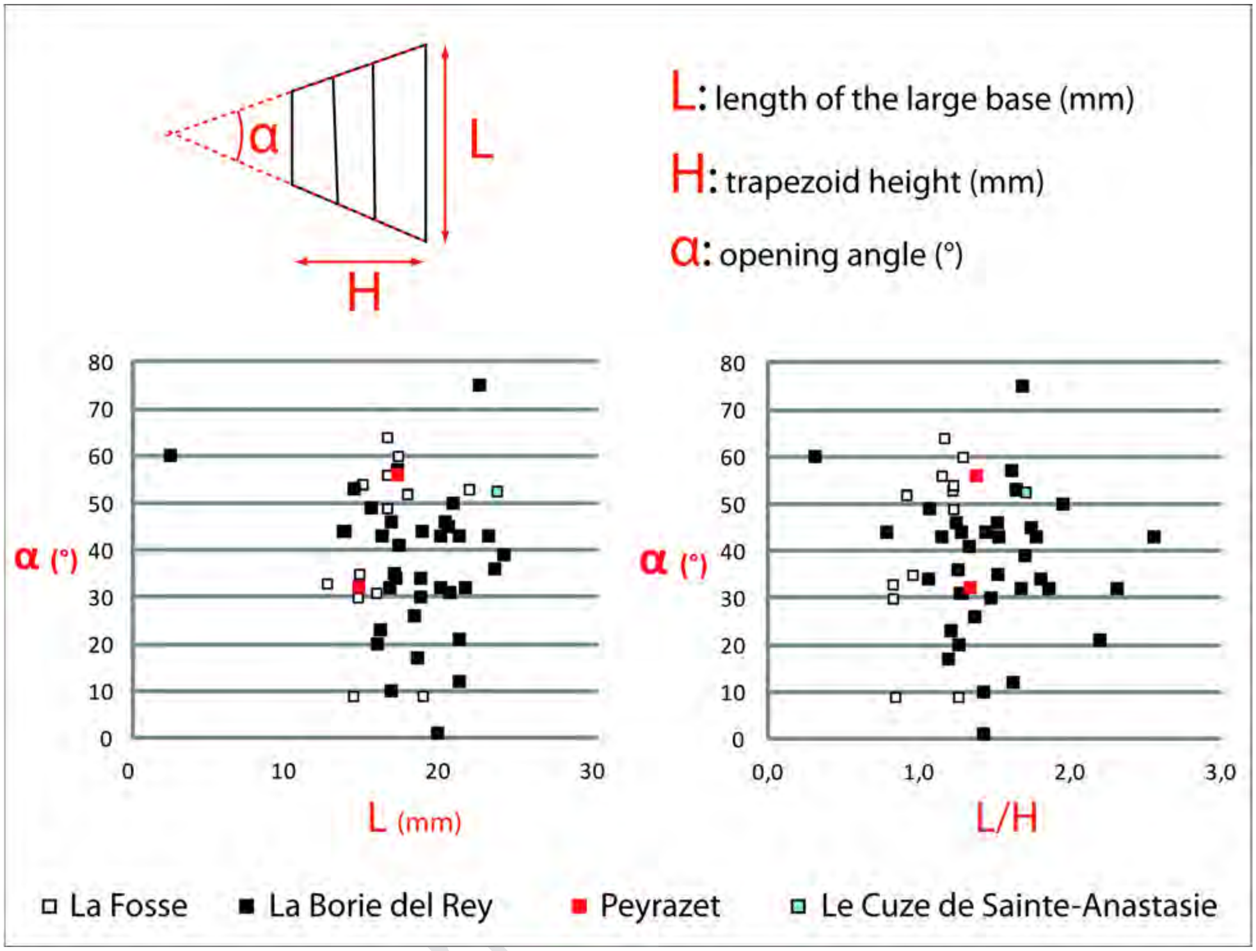
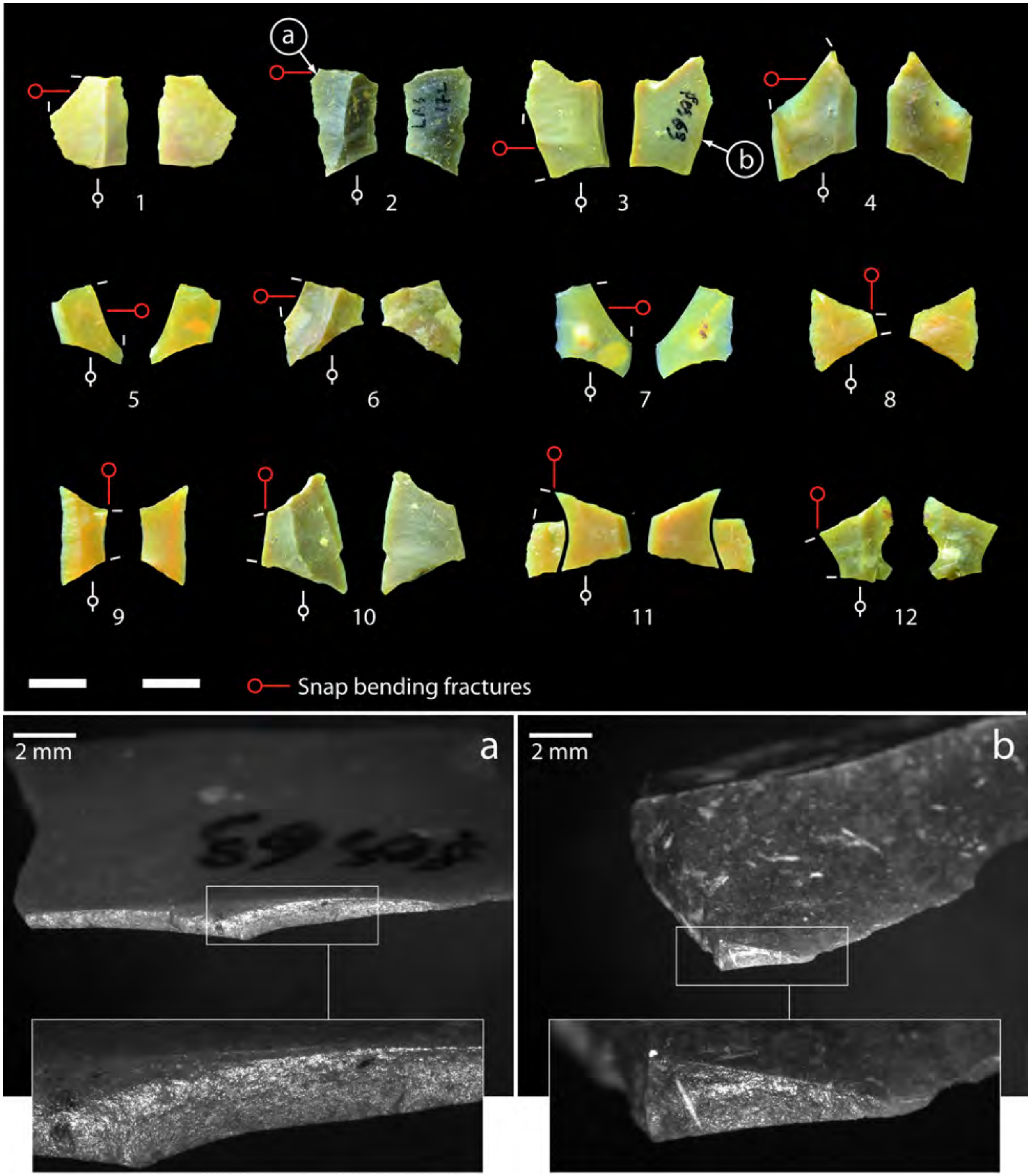

α
L
H
L: length of the large base (mm)
H: trapezoid height (mm)
α: opening angle (°)
α (°)
L (mm)
L/H
La Fosse
La Borie del Rey
Peyrazet
Le Cuze de Sainte-Anastasie


a
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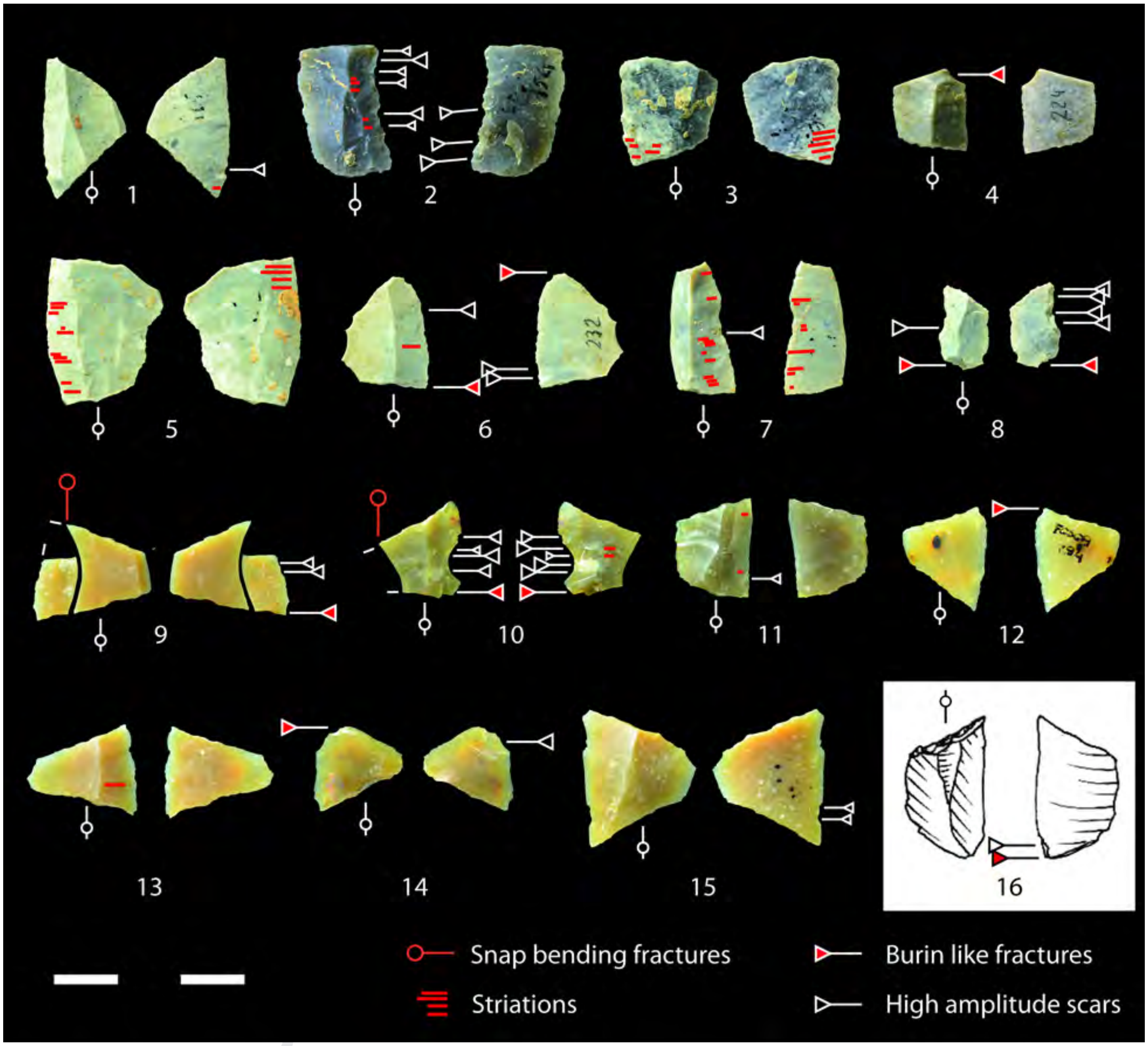
12
Snap bending fractures
2 mm
a
2 mm
b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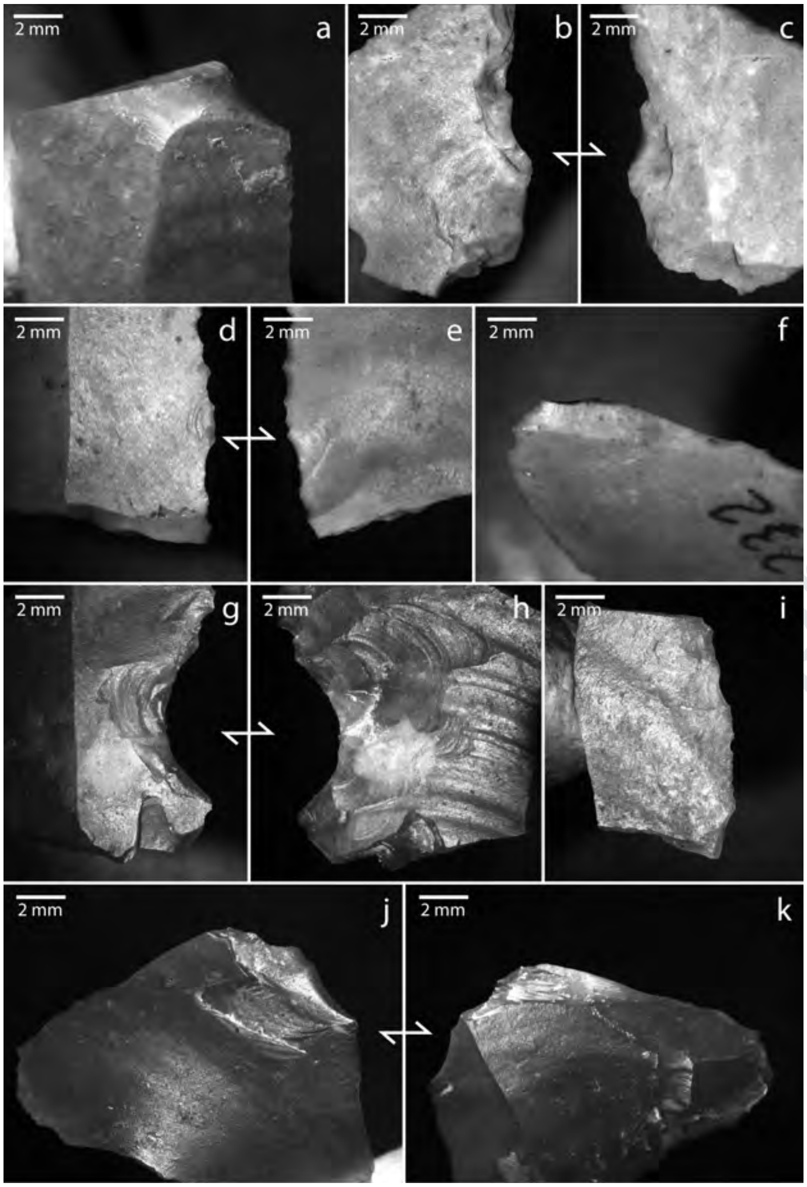
16
Snap bending fractures
Burin like fractures
Striations
High amplitude scars


2 mm
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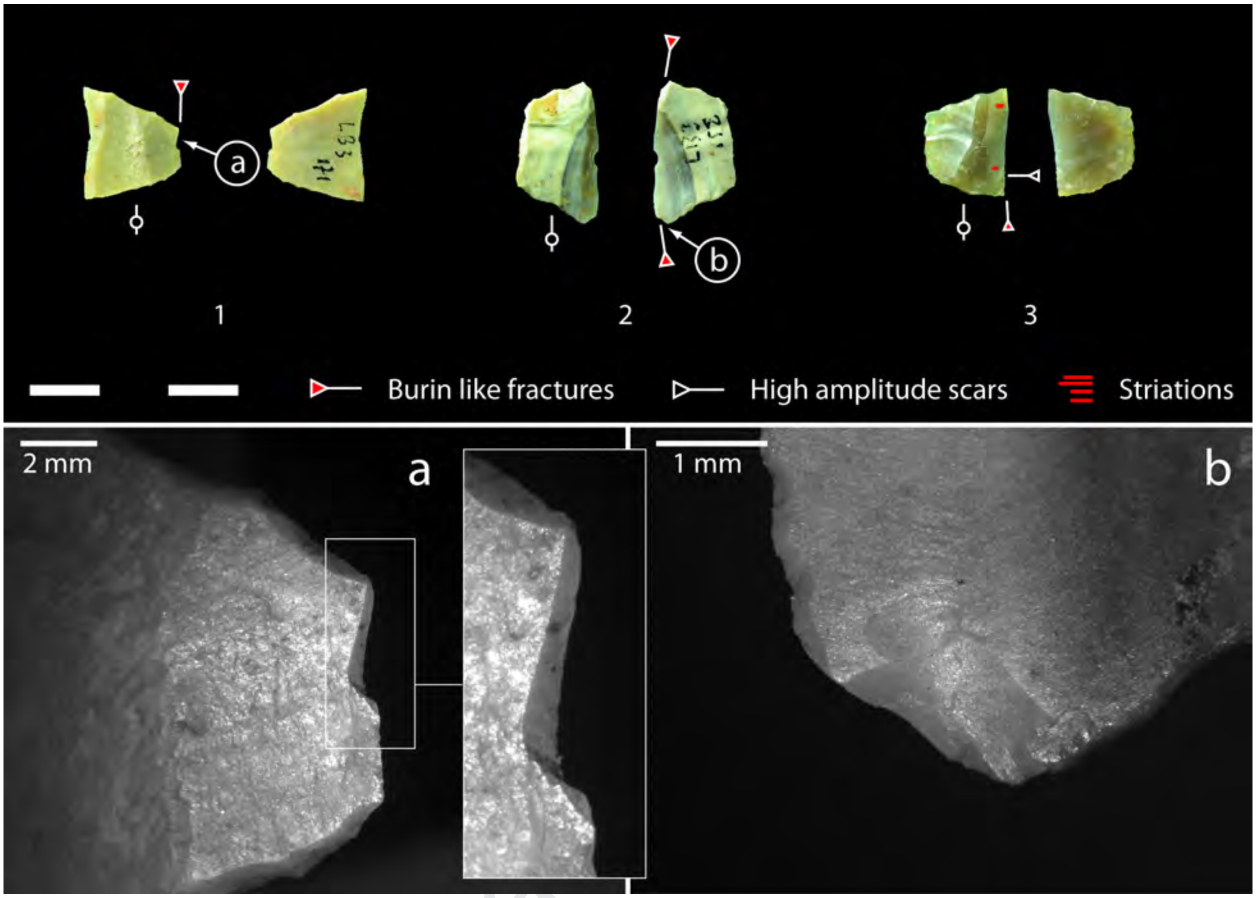

a
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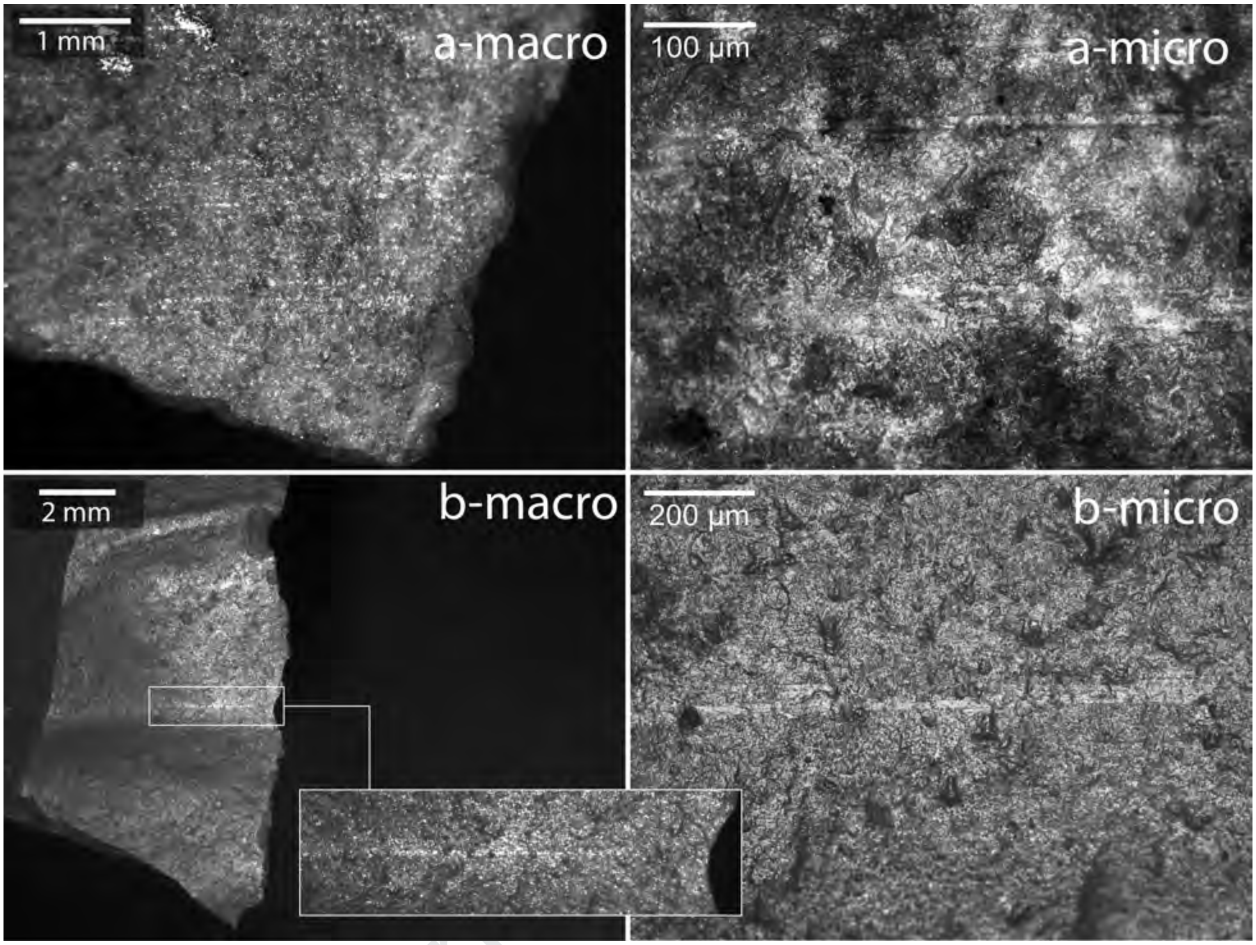
Burin like fractures
High amplitude scars
Striations
2 mm
a
1 mm
b


1 mm
a-macro
100 µm
a-micro
2 mm
b-macro
200 µm
b-micro

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: