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# EXPERIMENTAL EVIDENCE OF SPEAR-THROWER USAGE IN THE LATE UPPER PALAEOLITHIC (UPPER MAGDALENIAN) FROM THE ISTURITZ CAVE SITE, PYRÉNÉES-ATLANTIQUES, FRANCE

*Пам'яті Д. Ю. Нужного*

*The authors organized a projectile experiment including the use of bow and spear-thrower in conditions replicating Palaeolithic hunting. Experimental copies of antler points from the Late Upper Palaeolithic showed proximal fractures characteristic of spear-thrower use. Similar fractures are found on archaeological specimens from the Upper Magdalenian occupation of the Isturitz site, thus bringing arguments in favour of the persistence of this weapon at least until ca. 16—14 cal ka BP in Western Europe.*

*Keywords: antler industry, bow, experimental archaeology, Isturitz, Magdalenian, spear-thrower, Upper Palaeolithic.*

Dating the appearance of the spear-thrower and the bow among Palaeolithic hunter-gatherers has long been an important concern for prehistoric research, because the introduction of these new weapon systems is generally considered of fundamental importance in the evolution of hunter-gatherer hunting techniques and general subsistence activities (e.g., Nuzhnyi 1990; Нужний 2007; Sano et al. 2019; Lombard 2019). This question has been explored for the European Palaeolithic, the prehistory of North America and, more recently, in the archaeological record of Southern Africa and South Asia (Langley et al. 2020). Projectile experiments carried out by the authors in the Cedarc / Musée du Malgré-Tout (Treignes, Belgium) had brought new data into this debate, concerning the use of the spear-thrower in the Isturitz cave site (Pyrénées-Atlantiques, France) in the Late Upper Palaeolithic, during the Upper Magdalenian (ca. 16—14 cal ka BP).

These experiments were carried out in 2003—2004. They were published, in French, as chapters in a book derived from one of the authors' PhD (Pétillon 2006). Other articles drawn from these experiments were mostly focused on the impact fractures analysis on the target animals bones (Letourneux, Pétillon 2008 and references therein). This article is thus the first international publication of the results regarding the impact fractures on the projectile points, and their implications for the reconstruction of Palaeolithic weaponry. Before presenting these results, it is necessary to replace them in the broader context of weapon evolution during the Late Upper Palaeolithic — particularly since this period yielded the totality of the direct evidence for the Palaeolithic use of bow and spear-thrower.

## *Spear-thrower and bow in the Late Upper Palaeolithic of Western Europe: the direct evidence*

A spear-thrower is an elongated device at the distal end of which is a hook or a socket (with or without a spur) to engage the butt of a projectile. It acts as a lever to increase the initial velocity of the projectile and thus, theoretically, to increase its efficiency (Cattelain 1997; Whittaker 2016). In Western Europe, the Palaeolithic use of this weapon is documented by the discovery of spear-thrower distal parts (“hooks”), generally made of reindeer antler. About 115 unambiguous specimens are

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known from 37 sites, the majority of which are in south-west France, with others in Germany, Switzerland and Spain. Chronologically, with the exception of a possibly Solutrean specimen (Cattelain 1989), all are from the Middle and Late Magdalenian culture, ca. 19—14 cal ka BP (Cattelain 1988, 2017a; Stodiek 1993).

Bow and arrow remains, on the contrary, are known only from the Epipalaeolithic onwards: the oldest finds are the pine arrows from the Ahrensburgian level at Stellmoor (Schleswig-Holstein, Germany; Rust 1943), dated to around 12—11.5 cal ka BP, significantly later than the end of the Magdalenian (Fischer, Tauber 1986). Other Mesolithic finds of bow and arrows from Germany, Denmark, Sweden and Russia are all dated to later millennia (for reviews see: Junkmanns 2001; Cattelain 2004). Together, this evidence led to the idea that, somewhere around the end of the Magdalenian, the spear-thrower disappeared and was replaced by the bow among Western European hunter groups. This theory was consistent with the assumption that the bow was a more efficient hunting weapon than the spear-thrower, and/or that the development of the bow in Europe might have been triggered by environmental change — i.e., the warm-up and reforestation of the GIS-1/Bölling-Allerød (e.g., Nuzhnyi 1990; Нужний 2007; Rozoy 1992; Whittaker, Cao, Leverich 2018). There are, however, two objections to this classical hypothesis.

The first objection is that the chronology of the spear-throwers inside the Magdalenian hasn't still been well known (Cattelain 2017a; in the following pages, the term "spear-thrower" refers to the archaeological remains of this weapon, and is used for convenience instead of "distal part of antler spear-thrower"). The earliest spear-thrower type is a simple hook, undecorated or adorned with engraved lines only (fig. 1). It is usually manufactured from an antler cortex sliver (*baguette*); when preserved, the proximal part, originally hafted to the weapon's main shaft, is almost always single-beveled. The specimen usually considered as the oldest was recovered from the Combe-Saunière I cave (Dordogne, France), in layer IVb, along with an Upper Solutrean assemblage (Cattelain 1989), but with conflicting radiocarbon dates. The 14 other specimens from this type are either from poorly documented contexts, or from assemblages attributed to the Early Middle Magdalenian, dated between ca. 19 and 18 cal ka BP (Cattelain 2017b).

Most of the other spear-throwers, including the famous decorated specimens (fig. 2), were recovered either from ancient excavations with no reliable stratigraphy, or from the Late Middle Magdalenian from the French and Spanish zones. With a few exceptions, the available AMS $^{14}C$ dates from the assemblages that yielded these objects are distributed between ca. 18 and 16 cal ka BP (Cattelain 2017a).

For the Upper and Final Magdalenian, the situation is unclear. It is usually considered that there are very few, if any, spear-throwers in this period. Still, according to its excavators (Capitan, Peyrony 1928, p. 68), one of the spear-throwers from La Madeleine (Dordogne, France) comes from an Upper Magdalenian layer. U. Stodiek (1993, p. 144) also points out that the spear-thrower from the Teufelsbrücke (Thüringe, Germany) and the six specimens from the Kesslerloch (Schaffhausen, Switzerland) could be dated from the Upper Magdalenian as well. H. Breuil already reported the recent date of the Kesslerloch series, quoting a personal communication from the site's excavator, Pr. Heierli (Cartailhac, Breuil 1907, p. 14, footnote 1; see also Garrod 1955, p. 21). Similarly, radiocarbon dates and an extensive review of the material led A.-C. Welté to place almost all the spear-throwers from the Aveyron valley sites in the Upper Magdalenian (Welté 2000). In our opinion, this reattribution is quite hazardous for the Lafaye and Montastruc rockshelters (Tarn-et-Garonne, France), but fairly convincing for the spear-thrower from the Plantade rockshelter (Tarn-et-Garonne, France) and maybe the eight specimens found in the Courbet cave (Tarn, France). Importantly, with one exception — the uncertain spear-thrower fragment from Plantade — all of these possible Upper Magdalenian spear-throwers from France, Switzerland and Germany belong to the same type, called "type 3" in our typology (Cattelain 2020): "hooked spear-thrower adorned with a ruminant head or forequarters, in bas-relief or ronde-bosse, whose presence does not alter the general stick-like shape of the object" (fig. 3). Furthermore, the only two existing direct $^{14}C$ dates on Magdalenian spear-throwers are contemporary with the Upper Magdalenian: a date of 13155 ± 75 BP (ca. 16—15.5 cal ka BP, OxA-X-2523-44) on the "type 3" specimen from Saint-Michel (Pyrénées-Atlantiques, France: Pétillon et al. 2015); and a date of 12245 ± 60 BP (ca. 14.5—14 cal ka BP, OxA-19837) on an unfinished specimen of unknown type from Isturitz (Pyrénées-Atlantiques, France: Szmidt et al. 2009).

The existing evidence therefore suggests that at least the "type 3" spear-throwers might have persisted later than the Middle Magdalenian, at least

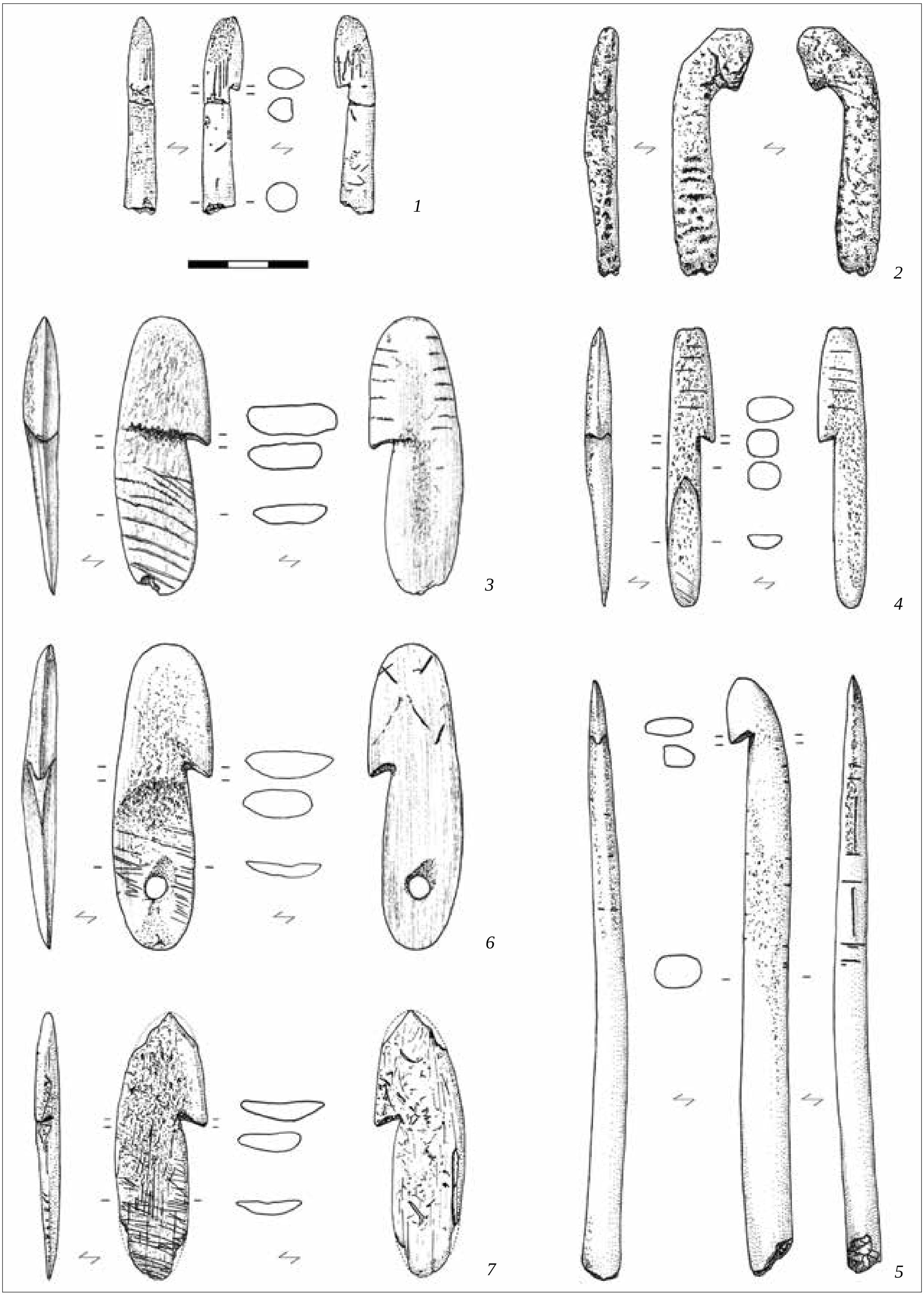

*Fig. 1*. Palaeolithic spear-throwers of the type 2. *1* — Combe-Saunière I (Dordogne, France); *2* — El Castillo (Santander, Spain); *3—5* — Le Placard (Charente, France); *6—7* — Le Roc-de-Marcamps (Gironde, France). Drawings made by C. Bellier and P. Cattelain.

into the beginning of the Upper phase. However, this hypothesis remains fragile, mostly because of the ancient age of many excavations. We can only conclude that today, the direct evidence does not provide us with a clear view of weapon evolution during the Upper Magdalenian — the very period that may have witnessed the transition from the spear-thrower to the bow.

## *Looking for indirect evidence: the projectile points*

The second and more radical objection to the classical hypothesis of "spear-thrower and bow succession" is that both weapons can be entirely manufactured from non-durable materials, such as wood, not preserved in usual archaeological contexts. Mesolithic bow and arrow remains, for instance, were only recovered because of their exceptional deposit conditions in the water-saturated sediments of Northern Europe. It is therefore altogether possible that the spear-thrower did last longer than the Magdalenian, and/or that the bow did appear sooner than the Epipalaeolithic, both leaving no archaeological trace.

Due to this problem, archaeologists turned to indirect evidence. Since the most commonly preserved parts of prehistoric weaponry are the stone and osseous projectile points, these artefacts have been the subject of numerous studies attempting to answer the following question: among archaeological points assemblages, how is it possible to tell arrowpoints from tips of spears (or darts) propelled with a spear-thrower? Several morphometric criteria have been suggested (based on point size, weight and etc.). The use of such indices remains, however, controversial, notably due to the high degree of overlap between these two categories, with the debate on the subject continuing for several decades with no real consensus in sight (for a critical review see: Clarkson 2016).

Confronted with this problem, several researchers tried to indirectly identify the weapon used by Palaeolithic people through the study of the points' impact fractures. The rationale was based on the fact that bow and spear-thrower are two very different projectile delivery systems. In gross terms, the former works like a spring or an elastic, releasing energy that propels light, generally short projectiles at high speed; the latter could be better compared to a lever, amplifying the thrower's strength to launch longer and heavier darts, that will have a lower speed, a more irregular trajectory, but a higher kinetic energy due to their much greater mass. Thus, it could be hypothesized that the mechanical stress of the impact would be different in each case, hopefully resulting in different fracture morphologies and/or frequencies on the projectile tips.

However, although many projectile experiments with replicas of prehistoric points have been undertaken for the past forty years, few addressed this question. Being primarily concerned with determining any diagnostic pattern of breakage for projectile points, most authors did not develop a comparative study of the two weapons. Among the exceptions are the experiments by P. Cattelain and M. Perpère (1993) with replicas of flint points from the Gravettian culture: they demonstrated that those launched with a spear-thrower more frequently exhibited fractures than those shot with a bow, but also that certain fracture morphologies ("tongued" or "stepped") were better represented amongst the spear-thrown examples while the average size of the fractures was greater on those shot with a bow. Equally treating Gravettian and micro-Gravettian points, J. Coppe and V. Rots (2017) suggested that the location of certain fracture types can be influenced by the propulsion method: on arrow points, scars initiated from a previous fracture surface mostly concerned the distal part, while identical scars are found primarily on the mesial-proximal portion of dart points. Experiments carried out by the TFPS (Technologie Fonctionnelle des Pointes de projectiles Solutréennes) research group using shouldered points from the Solutrean culture equally demonstrated that certain well-developed bending breaks (transverse bending breaks that broke along the width of the piece) were more frequent on spear points (Rots, Plisson 2014, fig. 9). Still, these three experiments concentrated on lithic points from the Gravettian and the Solutrean.

This is one of the reasons why an experimental session centered on antler projectile tips, and on the critical period of the Upper Magdalenian, was organized.

## *Archaeological setting*

The archaeological sample was the assemblage of antler points from the Upper Magdalenian layer at the Isturitz cave site. This major Palaeolithic site is located at the western end of the Pyrenees and opens 150 m above current sea level on the northern and southern sides of a limestone hill overlooking the Arberoue valley (fig. 4; Normand 2017). The inner surface

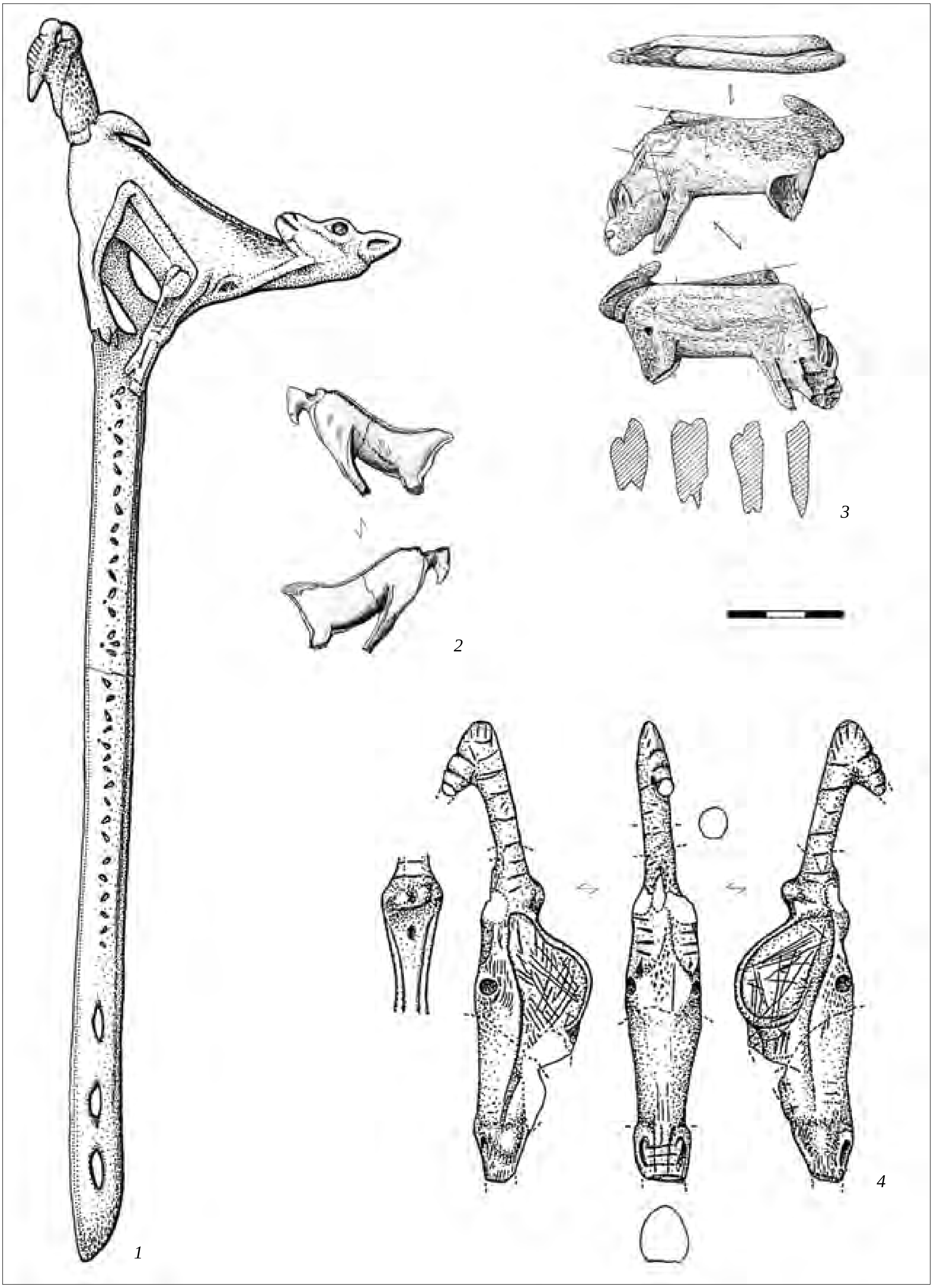


*Fig. 2.* Palaeolithic spear-throwers of the type 4. *1* — Le Mas d'Azil (Ariège, France; drawing made by F. Le Brun); *2* — Labastide (Ariège, France; drawing made by R. Simonnet); *3* — Enlène (Ariège, France; drawing made by F. Le Brun); *4* — Le Mas d'Azil (Ariège, France; drawing made by D. Buisson).

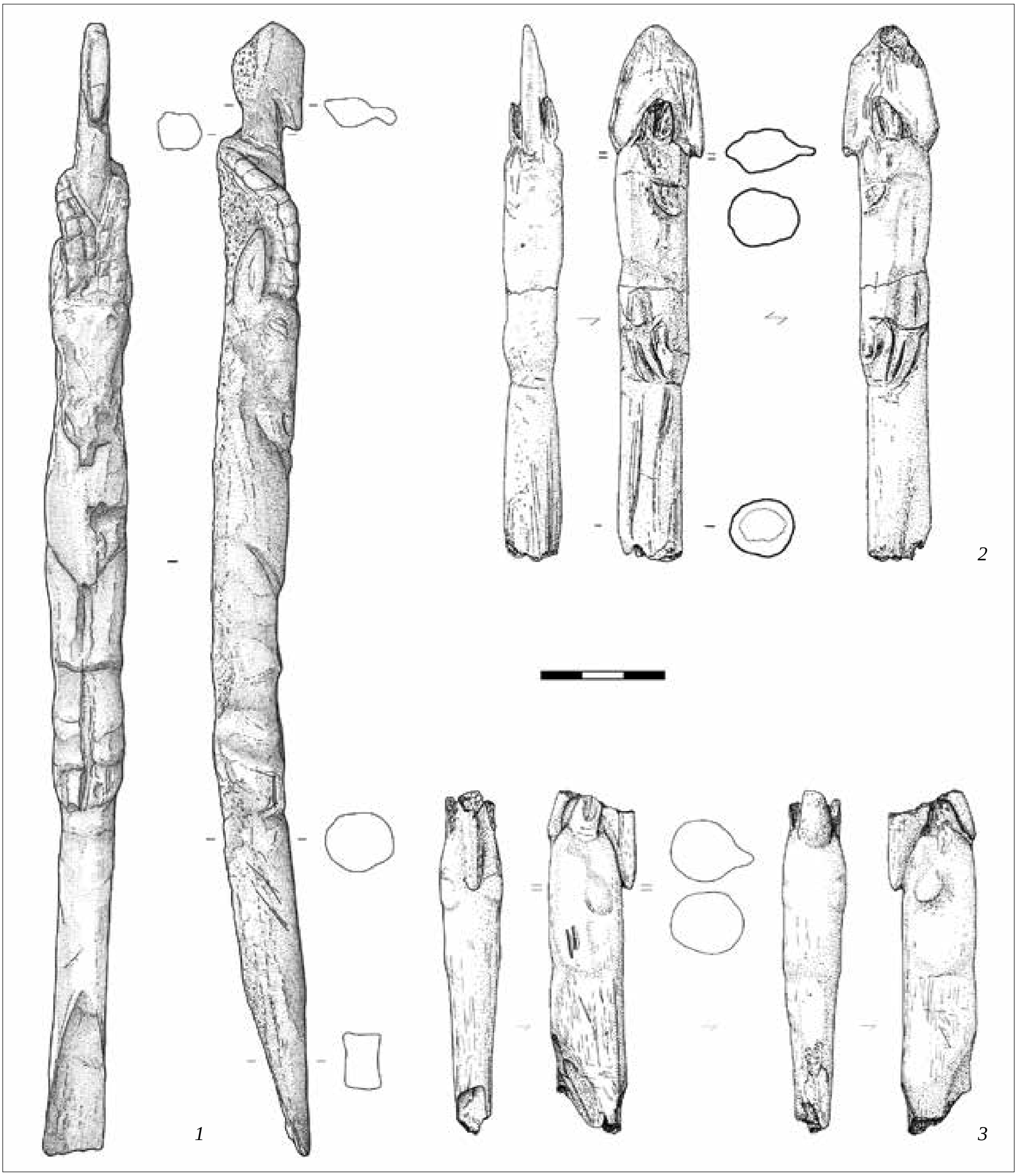


*Fig. 3.* Palaeolithic spear-throwers of the type 3. *1* — Le Mas d'Azil (Ariège, France; drawing made by M. Baumann); *2* — Isturitz (Pyrénées-Atlantiques, France; drawing made by C. Bellier and P. Cattelain); *3* — La Madeleine (Dordogne, France; drawing made by C. Bellier).

of the cave, over 2500 m$^2$, is divided into four main chambers. The Upper Magdalenian layer, I/F1, was from 5 to 60 cm thick and stretched to the totality of the *Grande Salle* (Great Chamber: 800—900 m$^2$). It was completely excavated in the first third of the 20th century by E. Passemard (1912—1922 excavations: Passemard 1924, 1944) and R. and S. de Saint-Périer (1928—1935 excavations: Saint-Périer 1936). The archaeological material is now curated, for the most part, in the Musée d'Archéologie nationale (Saint-Germain-en-Laye, Yvelines).

The six AMS $^{14}$C dates done on material from layer I/F1 cover most of the chronological range of the Upper Magdalenian, between ca. 16 and 14 cal ka BP (Szmidt et al. 2009; Barshay-Szmidt et al. 2016). The very complex stratigraphy, the ancient excavation techniques, the partial dispersal of


*Fig. 4.* Location of the Isturitz cave in south-west Europe. Map showing the maximum sea level regression (–120 m) and the maximum extension of the continental glaciers. Map by A. Sécher.

the collections before their arrival in the museum inevitably reduce the quality of the archaeological information, but not to the extent of forbidding any analysis with modern methods. The collecting of the faunal remains was obviously biased towards easily identifiable pieces such as teeth and epiphysis; still, the zooarchaeological analysis allowed to characterize in layer I/F1 a diversified hunting centered on bovids, red deer, horse and reindeer, the latter being the dominant game. Birds, especially the alpine chough and several species of prey birds, were also actively sought (Pétillon, Letourneux, Laroulandie 2017).

Out-of-date excavation techniques also probably account for the underrepresentation of lithic hunting weapons in the industries: backed bladelets — Magdalenian typical projectile tips — make up less than 5% of the flint tool kit (Esparza San Juan 1995, p. 204; Langlais 2010, p. 247).

Reindeer antler projectile tips are, on the contrary, the most common artefact type in the osseous industries. The 705 pieces (fig. 5) include 419 fork-based points, 122 double-beveled points and five nearly complete foreshafts. Almost all the foreshafts present a forked extremity opposed to a double-beveled extremity; metric analysis, *in situ* finds of similar specimens in other sites and ethnographic correlates all suggest that they were used in combination with the fork-based points to form long composite tips, the distal fork of the foreshaft being interlocked with the proximal fork of the point. The rest of the series comprises 38 possible foreshaft fragments, and 121 mesial and distal fragments that cannot be attributed to a specific point type.

Both fork-based and double-beveled points have relatively standardized dimensions (Table 1). While the double bevel is the most common hafting system on Upper Magdalenian antler points, the forked base is much rarer and limited to the Pyrenean and Cantabrian area (Pétillon 2006); however since it was the dominant point type at Isturitz, it was at the center of our experimental project.

## *The projectile experiments*

The experiments took place at the Cedarc / Musée du Malgré-Tout (Treignes, Belgium), in two separate sessions in January 2003 and February 2004. 42 fork-based points were manufactured and used in 2003, and an additional 36 in 2004. The 2004 session also included the manufacture and use of 18 double-beveled points and four foreshafts (hafted in combination with the fork-based points as described above). All points and foreshafts were taken from antler cortex slivers (the raw material coming from Fennoscandian reindeer herds) and shaped with flint burins

*Table 1.* **Dimensions of the fork-based and double-beveled antler points from the Isturitz Upper Magdalenian, in millimeters. NMS = number of measureable specimens. CV = coefficient of variation. For the double-beveled points, dimensions are given for the dominant sub-type only (n = 95 specimens, 82% of the total number of double-beveled points).**

| | **Fork-based points** | | | | | **Double-beveled points** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NMS | min | max | mean | CV | NMS | min | max | mean | CV |
| Total length | 71 | 46.6 | 163.5 | 100.3 | 28.0 | 14 | 64.1 | 112.3 | 9.8 | 15.9 |
| Length of mesio-distal part | 115 | 25.0 | 126.0 | 69.2 | 34.7 | 23 | 16.4 | 84 | 60.06 | 28.1 |
| Length of fork or bevel | 210 | 20.4 | 55.0 | 33.7 | 19.1 | 59 | 20.0 | 41.8 | 29.9 | 16.7 |
| Maximum width | 379 | 6.1 | 17.2 | 9.3 | 20.1 | 93 | 6.0 | 9.5 | 7.9 | 10.3 |
| Maximum thickness | 394 | 4.6 | 12.0 | 7.1 | 15.8 | 95 | 5.0 | 8.4 | 7.0 | 9.7 |

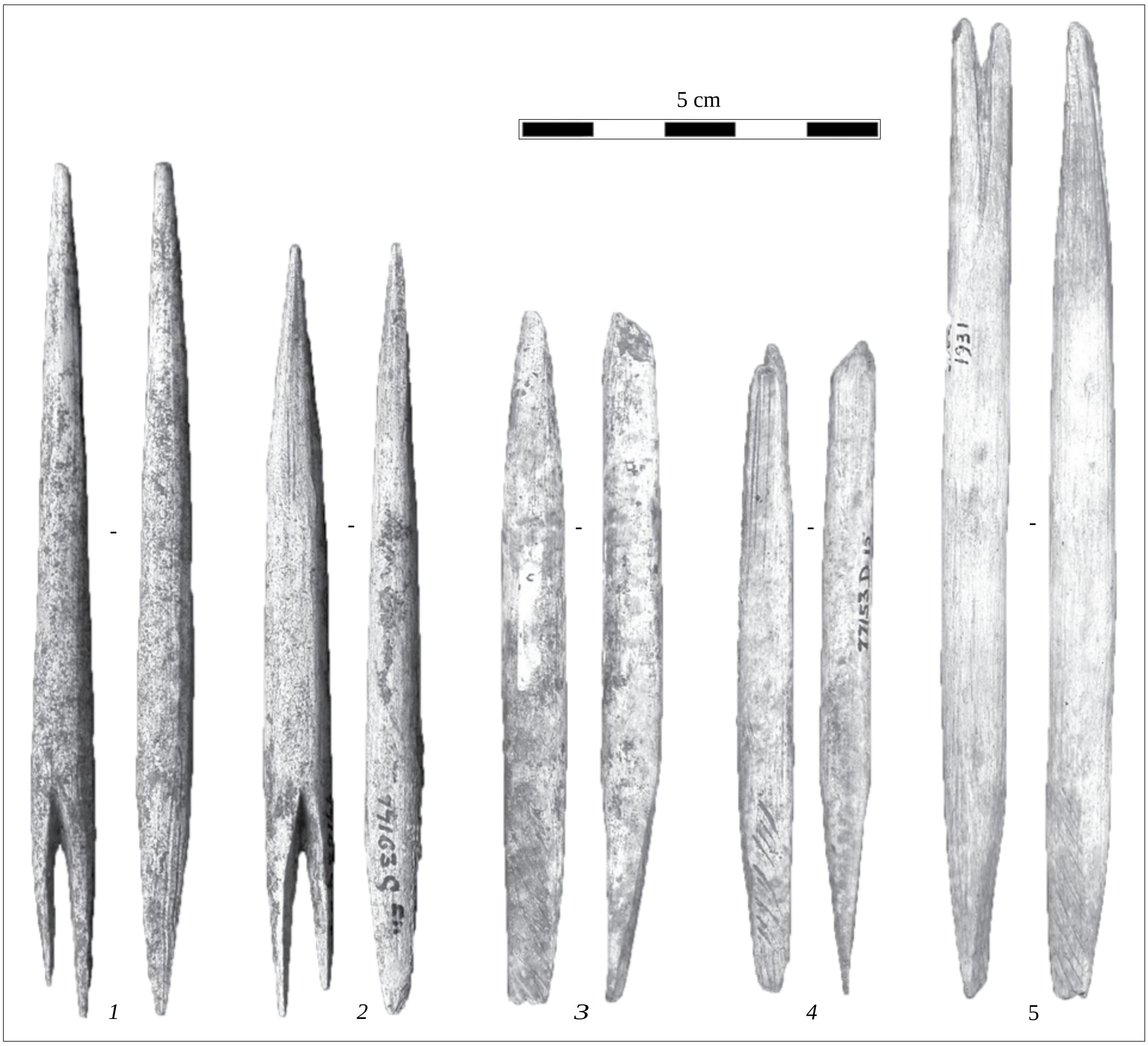


Fig. 5. Antler projectile tips from Isturitz, Upper Magdalenian (layer I/F1). *1—2* — fork-based points; *3—4* — double-beveled points; *5:* foreshaft with double-beveled and forked ends. *1—4* — Musée d'archéologie nationale, Passemard excavation; *5* — Musée d'archéologie nationale, Saint-Périer excavation. All photographs made by J.-M. Pétillon.

to reproduce the dimensions of the archaeological sample (Table 2).

Half of the points were then hafted to arrow shafts and the other half to spear shafts. Secure hafting was achieved with hiden glue, plus lashing with bison or red deer sinew (fig. 6). All spear and arrow shafts were made of pine wood and fletched with three radial feathers. The arrows were 80 cm long, 0.9 cm in diameter and weighted in average 26 g (without the point). The spears were 240 to

*Table 2.* **Dimensions of the experimental fork-based and double-beveled antler points, in millimeters. CV = coefficient of variation.**

| | **42 fork-based (2003)** | | | | **36 fork-based (2004)** | | | | **18 double-beveled (2004)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | max | mean | CV | min | max | mean | CV | min | max | mean | CV |
| Total length | 62.7 | 160.0 | 108.3 | 19.2 | 59.8 | 154.0 | 104.5 | 24.7 | 66.8 | 106.7 | 90.2 | 14.1 |
| Length of mesio-distal part | 36.1 | 121.7 | 76.7 | 23.8 | 28.8 | 116.6 | 70.9 | 31.9 | 36.7 | 79.4 | 61.1 | 22.1 |
| Length of fork or bevel | 24.0 | 42.0 | 31.4 | 12.9 | 25.7 | 42.7 | 33.6 | 14.3 | 21.7 | 36.8 | 29.1 | 14.1 |
| Maximum width | 7.0 | 11.4 | 9.4 | 11.6 | 7.5 | 12.9 | 9.2 | 16.0 | 7.2 | 8.7 | 7.9 | 5.7 |
| Maximum thickness | 4.2 | 8.1 | 6.1 | 13.6 | 5.7 | 9.0 | 7.0 | 11.5 | 6.1 | 7.7 | 6.9 | 7.0 |

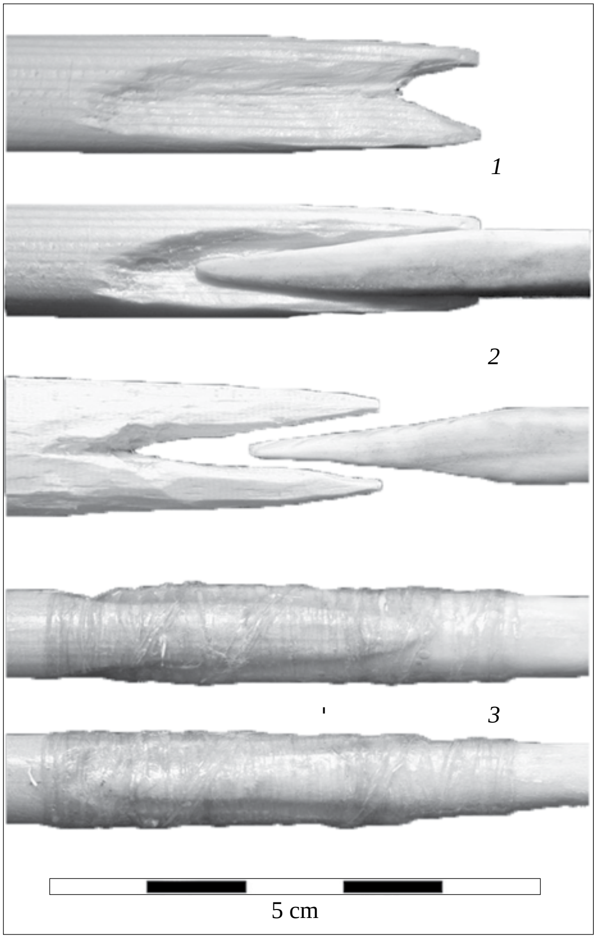


*Fig. 6.* Experimental haftings. *1* — two lateral views of the hafting shape for the fork-based points, without and with the point; the distal fork of the shaft is interlocked with the proximal fork of the point (spear shaft, 2003); *2* — lateral view of the hafting shape for the double-beveled points (spear shaft, 2003); *3* — upper and lateral view of the sinew lashing (fork-based point, arrow shaft, 2004).

260 cm long, 1.2 or 1.4 cm in diameter and had a mean weight of 172 g (without the point). The average weight of the points was 5,5 g.

All projectiles were then shot with bow or spear-thrower, by experimented shooters. Since our goal was to obtain diagnostic use-wear damage, each arrow or spear was shot repeatedly until the point, shaft or hafting was damaged. A total of 618 shots were performed. The targets were two calves (in 2003) and two fallow deer (in 2004); the complete bodies were suspended 10 to 13 meters away from the shooters (fig. 7). Of course, these animals are not perfect substitutes for reindeer, which is the dominant game in the Isturitz Upper Magdalenian; however, since reindeer bodies were not available, we had to use replacements, and these were among the less unsatisfying solutions. After the shooting sessions, the bodies of the targets were processed in order to recover all point fragments and to study the impact traces on the bones. Further details on the experimental protocol are available in J.-M. Pétillon (2006).

## *Results*

The experimental results were published in detail elsewhere (Pétillon 2006). In this article, we will focus on the interpretation of the three main characteristics of the impact fractures observed on the projectile points.

1. After use, 17 experimental points showed distal beveled breaks (fig. 8). This type of fracture occurred on both fork-based and double-beveled points, shot either with bow or with spear-thrower; similar damage had already been noticed by other researchers during previous projectile experiments with osseous points (Tyzzer 1936, pl. 19b, no. 1; Arndt, Newcomer 1986; Bergman 1987, fig. 1, nos. 2 and 5; Stodiek 1993, p. 203-206; Pokines 1998; Nuzhnyi 1998; Bradfield, Lombard 2011; Foletti 2012, p. 138-144; Doyon, Katz Knecht 2014; Wild et al. 2018, fig. 4). Beveled breaks are very common in our archaeological sample: 155 occurrences (fig. 9). This similarity confirms that the damage on the Isturitz points is compatible with their use as projectile tips (Pétillon, Plisson, Cattelain 2016).

2. The experimental antler points proved to be very resistant weapon tips. Most damage occurred, because of an impact on the target's limb bones, pelvis or shoulder blade, or because of spear-thrower missed shots hitting solid obstacles such as the frozen topsoil. Outside of these "shooting accidents" — for instance, as long as the projectile hit the rib cage, the zone most likely to be aimed at by a hunter — the same point could usually be reused many times without suffering any visible damage. Similar statements have been made by almost all researchers who tested experimental osseous points (Bertrand 1999, p. 110; Knecht 1993, p. 37; Pokines, Krupa 1997, p. 255; Pokines 1998; Nuzhnyi 1998; Ikäheimo, Joona, Hietala 2004; Buc 2011). The distal fractures themselves were usually close to the tip of the point: points with beveled breaks lost in average 8.2 mm of their initial length (see comparable results in Pokines 1998, p. 878, with a mean value of 11.5 mm), and could have been quickly and easily repaired by longitudinal scraping with a flint tool such as a burin. It must be noted, however, that many archaeological points show impact damage of a greater extent — especially beveled breaks that apparently occurred near the middle of the point, breaking off

*Fig. 7.* General view of the experimental setting during the 2004 spear-thrower session. To the right, fallow deer body suspended to a wooden frame. The shooter's spot is on the left. Photograph made by D. Henry-Gambier.

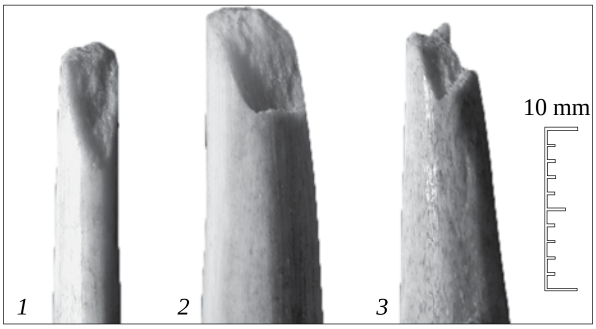


*Fig. 8.* Experimental distal fractures. *1* — beveled fracture (spear impact, 2003); *2* — step-terminating beveled fracture (spear impact, 2003); *3* — hinge-terminating beveled fracture (arrow impact, 2004).

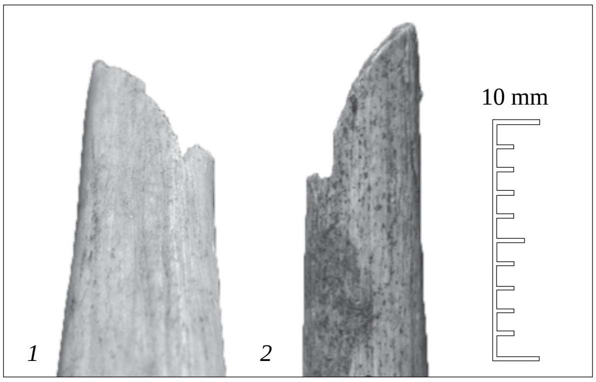


*Fig. 9.* Comparison between experimental and archaeological distal fractures. *1* — experimental beveled hinge-terminating fracture (spear impact, 2003); *2* — same fracture on the point from Isturitz (Musée d'archéologie nationale, Saint-Périer excavation).

a large portion of it. We were not able to reproduce these fractures in our shooting sessions. Later experiments showed that they could be experimentally replicated by impacts against harder natural obstacles, such as rocks and pebbles (Pétillon, Plisson, Cattelain 2016).

3. At the end of the experiments, 14 of the 78 fork-based points showed proximal fractures on one or two of the fork's tines. Either part of a tine was broken (fig. 10: 1), or a tine was broken at its base (fig. 10: 2), or the two tines were broken off simultaneously (fig. 10: 3). These fractures were always the result of a spear-thrower shot, and never occurred with the bow. This difference is probably due to the much greater size and mass of the spears compared to the arrows, as well as their more irregular trajectory: all these parameters obviously place the point under greater bending forces upon impact, sometimes resulting in the snapping of the forked base.

Proximal fractures are very frequent on the fork-based points from Isturitz: out of 419 specimens, 95 show fracture damage at the fork. The majority of these fractures (68%) have close equivalents in the experimental sample (fig. 11). Here again, however, certain fracture types — or fracture combinations on the two tines — of important extent, noticed on the Isturitz points, were not observed experimentally. Nevertheless, the similarities between the archaeological and experimental samples are determining enough to conclude that the Isturitz fork-based points

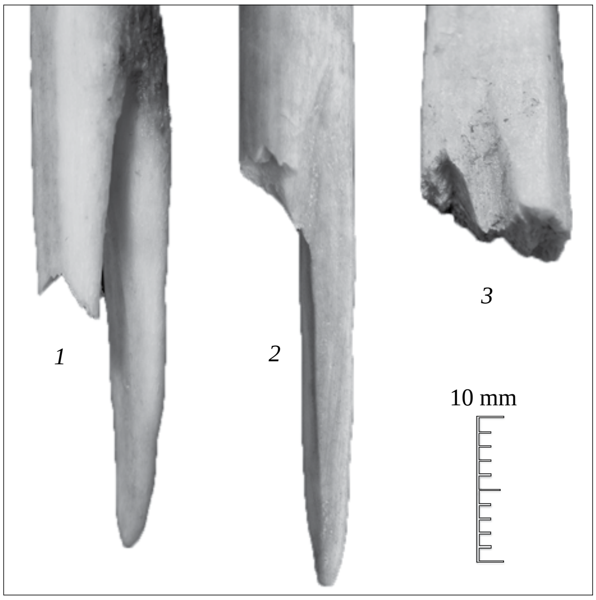


*Fig. 10.* Experimental proximal fractures on fork-based points. *1* — breakage of the proximal part of a tine; *2* — breakage of a tine; *3* — breakage of the two tines. All specimens are from the 2004 spear-thrower session.

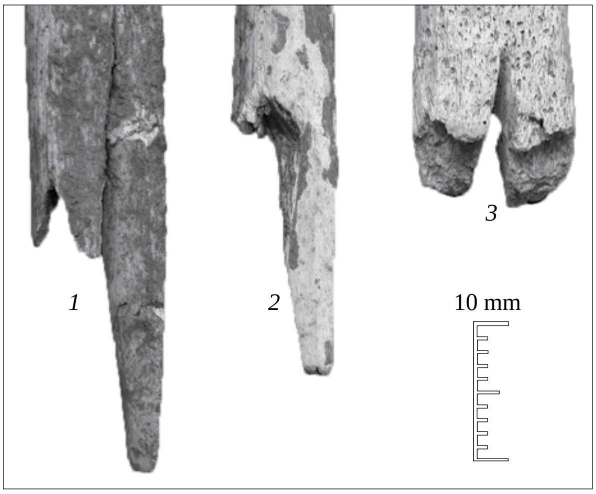


*Fig. 11.* Proximal fractures on the Isturitz fork-based points; comparing with fig. 10. *1* — breakage of the proximal part of a tine; *2* — breakage of a tine; *3* — breakage of the two tines. All specimens are from the Musée d'archéologie nationale, Passemard excavation, except no. 1 (Saint-Périer excavation).

were probably used to tip spears projected with a spear-thrower, rather than arrows shot with a bow. It is, to our knowledge, the only case of a projectile experiment with antler points yielding a positive result about a fracture type being specific of a given weapon.

## *Experimental results in archaeological perspective*

In the Isturitz Great Chamber, the Upper Magdalenian layer I/F1 that yielded the fork-based points overlays a Middle Magdalenian layer named II/E. One of the differences between the two layers is that the Upper Magdalenian layer I/F1 yielded no antler spear-throwers, while a series of such objects (seven certain specimens and four possible specimens: Cattelain 2017a) was recovered from the Middle Magdalenian layer II/E. Considering that our experimental results nevertheless indicate the use of the spear-thrower in the Upper Magdalenian, two non-exclusive hypotheses can be considered:

1. At Isturitz, after the Middle Magdalenian, antler spear-throwers disappear, but this weapon persists in the Upper Magdalenian, where it was probably entirely manufactured from wood (for a comparable reasoning with different methods in another archaeological context, see: Hutchings 2015).

2. Due to the complexity of the stratigraphy and the imprecise excavation techniques used in the first third of the 20th century, the distinction between the Middle and Upper Magdalenian phases at Isturitz is not always clear-cut, and some of the antler spear-throwers ascribed to the layer II/E are actually dated to the Upper Magdalenian.

The second hypothesis found a first confirmation a few years after the experiment, when a series of radiocarbon dates were done on material from the layer II/E (Szmidt et al. 2009; Henry-Gambier, Normand, Pétillon 2013; Barshay-Szmidt et al. 2016). While five of the nine dates from this layer are consistent with a Middle Magdalenian chronology (ca. 18.5—16.5 cal ka BP), the four others are coeval with the Upper Magdalenian (ca. 15.5—14.5 cal ka BP), indicating stratigraphic mixing. Among these four Upper Magdalenian dates is an unfinished specimen of antler spear-thrower (dated 12245 ± 60 BP, ca. 14.5—14 cal ka BP, OxA-19837: see above).

Our experiments thus show that the fork-based antler points from the Isturitz Upper Magdalenian (ca. 16—14 cal ka BP) were mounted on spear-thrower-launched projectiles rather than on arrows, and the direct dating of one of the spear-throwers from the same site confirms this association. It remains plausible, however, that the few antler spear-throwers presented in the archaeological record were complemented by other, maybe more numerous, spear-throwers entirely manufactured from perishable materials. In fact, such is the case for the vast majority of the ethnographic spear-throwers: antler distal parts similar to the Magdalenian ones are the exception rather than the rule.

Of course, it must be remembered that the use of the spear-thrower in the Upper Magdalenian at Isturitz does not mean that the bow did not already exist at that time. Both weapons can co-exist in the same group: such is the case, for example, among the Aztecs, and the Greenland and Bering Strait Inuit, Yupik and Aleuts (Nuttall 1891, 1975; Bogoras 1904; Jochelson 1908; Lantis 1984). This question remains open, since our experiments did not show any fracture pattern specific for the bow, a pattern that could have been used to trace the existence of this weapon in our archaeological context. Nevertheless, our results are one more element to be integrated in the broader question of the evolution of weaponry at the end of the Palaeolithic.

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## ЕКСПЕРИМЕНТАЛЬНІ ДОКАЗИ ВИКОРИСТАННЯ СПИСОМЕТАЛКИ В ПІЗНЬОМУ ВЕРХНЬОМУ ПАЛЕОЛІТІ (ВЕРХНІЙ МАДЛЕН) З ПЕЧЕРИ ІСТЮРИЦ, АТЛАНТИЧНІ ПІРЕНЕЇ, ФРАНЦІЯ

Час появи списометалки та лука в палеолітичних мисливців-збирачів уже давно є важливою проблемою доісторичних досліджень. У Західній Європі, виходячи з безпосередньо доведеного використання списометалок із середньомадленського часу, 19—16 тис. кал. р.т., та соснових стріл з Аренсбургу, які мають дату приблизно 12—11,5 тис. кал. р.т., припускається, що луки змінили списометалки або ж значною мірою замінили їх у використанні наприкінці мадленського періоду. Однак перебіг цього процесу та еволюція зброї у вказаний період досі залишаються недослідженими. На відміну від морфометрії вістер, порівняльні дослідження варіантів їхніх зламів відкривають цікаві перспективи для визначення різних способів доставки вістер до цілі. Проте різні варіанти зламів вістер як маркер для ідентифікації різних видів метального озброєння розглядалися рідко, особливо для верхньомадленського часу.

Експерименти з використання різних типів метальної зброї, проведені в Центрі археологічних досліджень та документації Музею Малґр-Ту (м. Трень, Бельгія) на початку 2000-х, надали нові дані для цих досліджень. Як списометалка, так і лук застосовувалися в умовах, що мали відтворити умови палеолітичного полювання. Метальне озброєння було оснащене експериментальними копіями рогових вістер із виделкоподібними базальними частинами, які відомі з верхньомадленського часу (16—14 тис. кал. р.т.) стоянки в печері Істюриц. Унаслідок експериментальних випробувань частина вістер, використаних за допомогою списометалки, отримала специфічні злами в проксимальній частині. Імовірно, їх появу можна пояснити тим, що списи зі списометалок мають більший розмір і більшу масу, порівняно зі стрілами, випущеними з лука, а також більш неправильною траєкторією їх польоту. Можливість застосування списометалки у верхньомадленський час додатково підтверджує радіовуглецева дата одного рогового зразка списометалки з Істюрицу. Окрім того, видається цілком імовірним використання списометалок із матеріалів, що швидко псуються, як і не можна виключати одночасне існування лука.

*Ключові слова: рогова індустрія, лук, експериментальна археологія, Істюриц, мадлен, списометалка, верхній палеоліт.*

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