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PAPERS IN THE MEMORY OF JACQUES TIXIER

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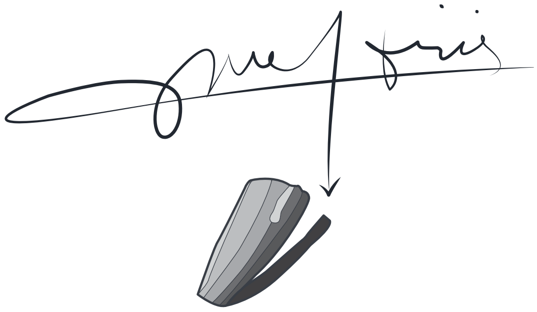

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PAPERS IN THE MEMORY OF JACQUES TIXIER

Jacques Tixier, the scholar of lithic technology passed away on April 3rd, 2018. He was one of the great French archaeologists who have renewed the study of Palaeolithic sites and assemblages for reconstructing the life of past humans. He taught how lithics communicate their biography via technological stigmata and showed the importance of lithic experiments in understanding what past knappers were and were not able to do in stone tool production. Jacques' talks and demonstrations were always engaging which emerged from a lucky combination of two characters of human nature: charm and professionalism. He fundamentally affected our thinking about Prehistory, and his loss reminded us we have forgotten to thank him for all he did for us.

Shame on us for being late, we would like to express our gratitude by dedicating the volumes of 2020 to the memory of Jacques Tixier.

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STUDIES COMMEMORATING JACQUES TIXIER
A LITIKUM JOURNAL SPECIAL VOLUME

Reflections upon Discussions with Jacques Tixier

Christopher Bergman

Abstract • Kivonat In memoriam Jacques Tixier. The author shares his experiences about the archaeology in the Near East and reflects upon the role of Jacques Tixier in a personal account.

Keywords *Jacques Tixier, in memoriam, stone tools, Levant, Ksar 'Aqil, Üçağızlı Cave, Upper Palaeolithic*

Kulcsszavak *Jacques Tixier, in memoriam, kőeszközök, Levante, Ksar 'Aqil, Üçağızlı-barlang, felső paleolitikum*

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"The spiritual aspect of knowledge about the world taught the people that relationships must not be left incomplete... Completing the relationship focuses the individual's attention on the results of his or her actions." (Vine Deloria, Jr., *Oglala Lakota*)

Introduction

Both Jacques Tixier and I were affected by the events of the civil unrest in Lebanon, a profound human tragedy the causative factors of which are still reverberating throughout the region today.

For Tixier, the onset of the war terminated his long anticipated and important excavations at Ksar 'Aqil (Ksar 'Akil, Ksâr 'Akil) resulting in just a handful of papers detailing his investigations. I believe the discontinuation of his work was lamented by all prehistorians in the region, due to the fact that the site's 23 meters of deposits represents the longest and most complete record of any Levantine Upper Palaeolithic site. Indeed, in 1987 Ofer Bar-Yosef commented to me that he wished Tixier would publish more of his ideas on Ksar 'Aqil and the technology of blade and bladelet manufacture, especially twisted *débitage*.

For me, I spent the years 1974-1979 as a student at the American University of Beirut, a direct witness to the horrific events of the Lebanese Civil War. This included sustaining shrapnel wounds from an 82 mm mortar round on the American University campus, the kidnapping and death of family and friends, and the ongoing daily destruction of the city. These memories have remained with me throughout my later years, but it was during this time that I met Ingrid Azoury (who passed away on September 29, 2017) and, under her guidance, started working on Ksar 'Aqil by examining the small collections made by Alfred E. Day in the 1920s. When lulls in the fighting occurred, I often visited Ksar 'Aqil and looked at Tixier's excavation sections, which remained open as he had left them in 1975.

Préhistoire du Levant – 1980

The first time I met Tixier was at the 1980 conference entitled, *"Préhistoire du Levant,"* held in Lyon. He was attending with Marie-Louise Inizan and presenting the results of his 1969-1975 excavations at Ksar 'Aqil. We did not interact too much during the meeting as I was a new graduate student, although I did pay close attention to his thoughts

Figure 1. Liliane Meignen, Jacques Tixier, Christopher Bergman, Catie Tixier, Institute of Archaeology, London, 1987.

on the site. It was clear that he did not regard the material collected in the 1930s and 1940s to be of much scientific value. Later, in 1988, he rightfully took me to task for my paper which, admittedly, provided weak definitions of the el-Wad point and its variants.

I think Tixier's concerns about the earlier excavations, sometimes voiced rather vehemently, are well founded and still need to be addressed. Echoing his words of caution, I would point out that: 1) the 1937-1938 and 1947-1948 stratigraphic designations are not the same and a complete correlation between the two field seasons does not exist, except for the later Upper Palaeolithic levels that also align with Tixier's 1969-1975 excavations; and 2) in as much as the general assemblage descriptions throughout the sequence appear similar from researcher to researcher, up to and including recent analyses that place greater emphasis on the technology of core reduction, it remains to establish the level of confidence that can be placed in the reported results. It is my thought that broad trends can be discerned and compared to more up-to-date investigations like those at Üçağızlı Cave, for example. However, given that materials from 1937-1938 and 1947-1948 are currently being used to consider questions related to precision dating and models for human dispersal, we must seriously assess the quality of these data for addressing this exacting level of research, while bearing in mind they provide the only samples from the Initial and Early Upper Palaeolithic.

The Levantine Aurignacian with Special Reference to Ksar 'Aqil, Lebanon – 1987

In 1987, I organized a roundtable discussion entitled, "*The Levantine Aurignacian with Special Reference to Ksar Akil, Lebanon*," which was held at the Institute of Archaeology, London. The roundtable was modelled after a 1969 Wenner Gren Symposium, which focused on the Institute of Archaeology's Ksar 'Aqil collections and included, among many other prominent participants, the late François Bordes. The focus in 1987 was to bring together a number of prehistorians working in the northern and southern Levant to consider changing paradigms for cultural development in the region, but most specifically to address what constitutes the Levantine Aurignacian.

The participants working in the southern Levant described the then newly modelled framework of two discrete Upper Palaeolithic traditions, the "blade-oriented" Ahmarian and the "flake-oriented" Levantine Aurignacian. While considering the latter, Tixier interjected, "what about the bladelets?" He was referring to the presence of significant numbers of twisted bladelets, many quite tiny and comma-shaped in appearance, found in levels he regarded as the Levantine Aurignacian evolving *in situ*. Twisted bladelets occur throughout Tixier's excavations and, indeed, twisted *débitage* appears in the form of larger blades detached from single platform cores in the levels just below the depth he reached. During one of the breaks, we had a long discussion about twisted bladelets and their production from a variety of cores, flat-faced burins, burins on a notch, carinated scrapers and burins, lateral carinated scrapers, etc., and the methods for inducing a twist by delivering a percussive blow offset to the main axis of the flaking face.

When the debates got heated some attendees reverted to their first languages, evoking an image of the "Tower of Babel." This might be the reason why it has been suggested that the roundtable was not as influential as its predecessor in 1969. However, it did provide some pause for thought as follows: 1) there was considerable geographic and chronological variation in what was described as Ahmarian in the northern and southern Levant; 2) the Levantine Aurignacian was not just a flake-based industry and its technological expression needed better description; 3) Tixier's insistence upon more accurate characterization of lithic manufacturing sequences was essential for addressing cultural affinity; and 4) Ksar 'Aqil, not surprisingly, was more closely connected with developments in the northern Levant and did not represent a region-wide type sequence as previously thought.

At the closing social event (Figure 1), I handed Tixier an opposed platform blade core made from Brandon flint. He asked who had made it, thinking it was perhaps Mark Newcomer. I said no, and indicated I had prepared the core. He passed it back and said, "Ahmarian!," a subtle poke at the tendency for some Levantine prehistorians to treat technology in a typological manner, rather than identifying the distinct operating chains that are more accurate cultural signatures.

Préhistoire du Levant 2 – 1988

Based on the results of the roundtable, Francis Hours asked me to chair the Upper Palaeolithic session for the conference, "*Préhistoire du Levant 2*," also held in Lyon. Regretfully, Père Hours passed away before the conference and I never had the opportunity to thank him for his confidence in me. The session was small and included only four papers by Isaac Gilead, Gerd Albrecht, Jim Phillips, and me. It was during the general discussion that Tixier not only criticized my rather poor attempt to define the el-Wad point, a shortcoming of which I was not the only guilty party, but also the tendency for some prehistorians to use frequencies of various debitage classes to define prehistoric cultures rather than a careful mapping of the step-by-step procedures used to work stone.

After the session I sat down with Tixier, literally on the floor, and he told me he was quite cross upon reading the published results of the 1987 roundtable where Nigel Goring-Morris and I reverted to the 1937-1938 Ksar 'Aqil sequencing, rather than that of 1969-1975, as the basis for characterizing cultural development at the site. He was right to complain and it took me 30 years to correct this inaccuracy (see Bergman, C., Williams, J., Douka, K., and Schyle, D., 2017. The Palaeolithic Sequence of Ksar Akil, Lebanon. In: Enzel, Y. and Bar-Yosef, O. (eds.), *Quaternary of the Levant*. Cambridge University Press: 267–276). Hopefully, Tixier would have been satisfied with this revision, albeit greatly delayed, because it makes more sense as he indicated.

A final memory of this meeting concerns an ill-advised comment made by an American archaeologist who intimated that Near Eastern prehistorians had a more sophisticated methodological approach than their French counterparts. Needless to say, this immediately caught Tixier's attention and he responded in a fit of pique, "Speak about what you know!" Wise words, professionally or otherwise, and I have never forgotten them.

Reflections

The last time I saw Tixier was in 1988 and I showed him some pictures of the refitting I was doing at Boxgrove. He was quite interested in these results and we discussed the nuances of preparing the tip of an ovate handaxe for delivering a *tranchet* blow, while looking at some refitted examples. After disagreeing about the merits of the old collections at Ksar 'Aqil, this was an area we could agree on, the value of the experimental approach for elucidating aspects of prehistoric technology.

I have been flintknapping since the mid-1970s and while I certainly have not achieved the level of artisanship demonstrated by many other colleagues, the tools I make are quite functional. In the early 1980s, working with Mark Newcomer and Nick Barton, I studied blade and bladelet-based projectile point technologies, specifically breakage patterns resulting from impact. Others have pursued similar studies, for example by standardizing experimental parameters through use of synthetic materials to cast morphologically identical points or by examining the incidence of impact fractures to try and isolate the expected frequency of occurrence.

Looking back at my own work on projectile technology, I think there was a marked *naïveté* in the design of the experiments and their results. Simply put, they were not very realistic, even if they did provide a certain level of insight into the morphology of impact breakage. Obviously, the use of dead targets and purposeful attempts to induce breakage do not consider the operational dynamics of projectile use in actual hunting situations. The focus of hunting is not to break points, but to kill game.

Since 2016, I have been bow hunting with friends using a number of projectile point styles including facsimiles of


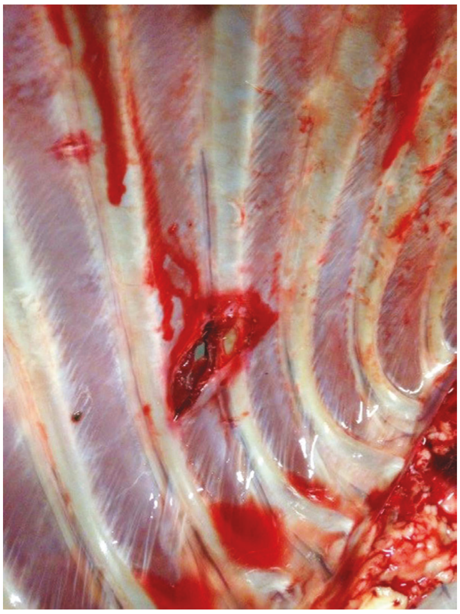
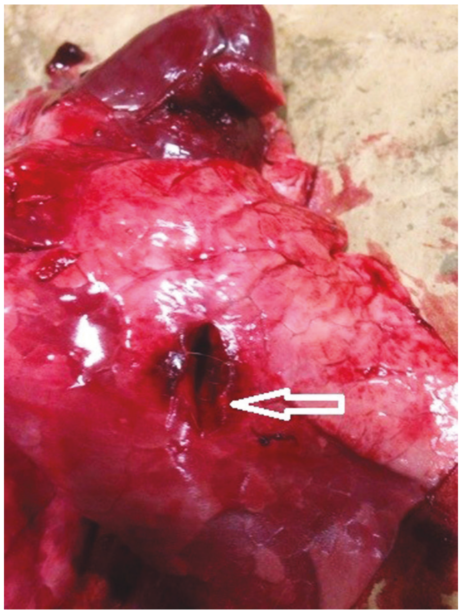

Figure 2 (left). Facsimile Upper Paleolithic composite point with two parallel backed bladelets slotted into reindeer antler, pine resin, charcoal and fiber adhesive, deer back sinew binding (arrowshaft is 8 mm in diameter, early winter 2018).
Figure 3 (center). Composite point entry wound at white-tailed deer rib cage, which dislodged one of the backed bladelets as the arrow passed through, but nonetheless proved fatal (Christopher Bergman and Johnny Lamb, autumn 2017).
Figure 4 (right). Composite point passed through lung, single bladelet edge visible at bottom of the wound channel, and reached the heart (Christopher Bergman and Johnny Lamb, autumn 2017).

Upper Palaeolithic composite points (reindeer antler/stone) and generic bifacial side-notched forms that are common during the Late Archaic Period (beginning ca. 5000 years BP) of the eastern United States. In the case of the composite points (Figure 2), I consider them to be "facsimiles," due to the fact that the overall point width must be at least 2.2 cm in order to comply with local bow hunting regulations. I think the backed bladelets on Upper Palaeolithic points were generally narrower, which may minimize a tendency for the experimental bladelets to be displaced on impact. Second, there is the question of the delivery system, atlatl dart or arrow, with my own belief that the bow is an earlier invention than we currently have evidence for. Regardless of these caveats, as well as many other factors, it can be confidently stated that the experimental composite points are extremely effective and possess considerable cutting power, creating a wide wound channel (Figures 3 and 4) causing an animal to drop within 30 m of a shot in some cases. Of course, fundamental to the effectiveness of any projectile is accurate targeting, which in the case of stone points can minimize characteristic impact damage.

Perhaps the most interesting observations concern the experimental bifacial projectile points, two of which are illustrated in Figure 5. Both were used in successful hunts, the example on the left displays impact damage which, in my opinion, is minor and atypical, while the example on the right displays no macroscopic damage at all and can be reused without sharpening. In the absence of identifiable microwear traces, the activities evidenced by these points would be archaeologically invisible, beyond mere guesswork. They are also relatively large and wide due to the requirements of hunting laws, meeting the size criteria of atlatl dart tips posited by some North American prehistorians, but they nonetheless can be hafted onto commercial 8 mm diameter wooden arrowshafts. It has always amazed me what is, and can be, placed at the end of an arrow, both in terms of morphological variation and size.

Tixier was always insightful in his thinking about prehistoric technology and, building upon his pioneering research, subsequent generations of flintknappers have shown increasing sophistication in their own work. Expanding our understanding of the behavior of prehistoric peoples, their material culture and lifeways, must be founded on the academic rigor that Tixier advocated and practiced throughout his distinguished career. This requires being able to look critically at our individual efforts, test our ideas repeatedly, and revise them as often as necessary over the years. In this manner, it is possible to successfully answer his challenge to "speak about what you know."

PS – In reading the Litikum Postcards and Tixier's lament of "less and less time" to work stone, I would add to his comments that as the years go by and eyesight begins to diminish, good lighting is essential!

Figure 5. Bifacial side-notched points, both used for successfully hunting white-tailed deer. The example on the left has an atypical notch-like impact fracture at the tip, while the example on the right has no visible damage and can be hafted and used again without modification. (Christopher Bergman and Johnny Lamb, autumn 2016 and 2017).

Statements

Data availability statement. The authors confirm that the data supporting the findings of this study are available within the article.

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The Use of Bone in Stone Tool Technology: Retouchers from Veternica and Vindija (Croatia)

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Abstract

Bone retouchers are tools used for the tasks of retouching lithics and are usually made from long bone shaft fragments. They are a common feature of many Middle Palaeolithic assemblages throughout Europe and the Near East but are also found during the Late Lower Palaeolithic and the Upper Palaeolithic. This study presents the results of the analysis of bone retouchers from the Middle Palaeolithic contexts of Veternica (MIS 3-5) and the Middle and Upper Palaeolithic contexts of Vindija (MIS 3), Northwestern Croatia. The study is comprised of an examination of site information, taxonomic and anatomical determination, basic taphonomic analysis, morphometric analysis and analysis of the retoucher use traces.

The results reveal a fundamental difference between the two retoucher assemblages. In Veternica, the bone retouchers are an important part of stone tool technology, represented by the number of retouchers, preferential selection of faunal species, preparatory scraping, evidence of curation, the sometimes heavy intensity of use and shaping of the morphology through flaking. In Vindija, retouchers represent a more expedient technology, suggested by the low number of finds in individual layers, their small size, low intensity of use and lack of evidence for preparatory measures and curation. Exceptionally, the assemblage from Veternica has provided retouchers made from cave bear bones, which could suggest exploitation of this species by Neanderthals.

Kivonat

Csonthasználat kőpattintási technológiákban: retusőrök Veternica és Vindija lelőhelyekről (Horvátország)

A csont retusőrök pattintott kövek retusálására szolgáló eszközök, melyek általában hosszúcsontok töredékeiből készülnek. Jelenlétük általános Európa és a Közel-Kelet középső paleolitikus lelőhelyein, de késő alsó paleolit és felső paleolit példányaik is ismertek. Ebben a tanulmányban az északnyugat-horvátországi Veternica (MIS 3-5) középső paleolit, illetve Vindija középső és felső paleolit (MIS 3) kontextusaiból származó retusőröket vizsgáljuk. A tanulmányban tárgyaljuk a lelőhelyek tulajdonságait, a leletek nyersanyagának rendszertani és anatómiai meghatározását adjuk, illetve alapvető tafonómiai, morfometriai és használati nyomelemzést mutatunk be.

Az eredmények alapvető különbségeket tárnak fel a két eszközkészlet között. Veternicában a retusőrök a kőpattintási technológia fontos eszközei, amit az eszközök nagy száma, a nyersanyaghoz preferált állatfajok, a karbantartás nyomai, a sok esetben intenzív használat, és a pattintással történő formálás bizonyítanak. Vindijában a retusőrök használat ennél esetlegesebb, amit az ilyen leletek alacsony száma, kis méretük, kismértékű használatuk, illetve az elkészítésükre és karbantartásukra fordított kis figyelem bizonyítanak. A veternicai retusőrök között medvecsont példányok is tatlálhatók, amik arra utalnak, hogy a neandervölgyiek is hasznosították e fajt.

Keywords *Bone retouchers, Bone tool technology, Middle Palaeolithic, Vindija, Veternica*

Kulcsszavak *csont retusőr, csonteszköz technológia, középső paleolitikum, Vindija, Veternica*

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1. Introduction

The use of bone tools in the production and maintenance of stone tools is a long-recognized phenomenon. Earliest recognition of such artefacts had already been made in the 19th century, with the first inference of their use in stone technology made by L. Henri-Martin (1906; see Patou-Mathis, Schwab 2002 for a historical perspective). Bone retouchers are artefacts used in the maintenance or shaping of lithic tools. They are commonly made on fragments of long bone diaphyses, but examples on teeth, mandibles, long bone ends with articulations, mammoth tusks and other hard organic materials have been found. The artefacts display linear and deep scores of V-shaped cross-sections, sometimes associated with striations, pits and cortical bone exfoliation (Chase 1990; Mozota 2018). Such traces are occasionally concentrated and/or superimposed into distinct and relatively deep use-areas, but can also appear dispersed and isolated over a larger surface. Even though the anthropic origin of these tools has been previously questioned (Binford 1981), the connection of the traces to the activities of retouching lithics is firmly supported by experimental and taphonomic studies (Armand, Delagnes 1998; Chase 1990; Daujeard et al. 2014; Giacobini, Patou-Mathis 2002; Mallye et al. 2012; Mozota 2013; 2018 and references within) and even by the occasional find of lithic chips imbedded in such artefacts (Abrams et al. 2014; Hutson et al. 2018; van Klofschoten et al. 2015; see Bello et al. 2013 for a study on an experimental piece). However, some documented examples resulting from carnivore gnawing can be misidentified as retouchers (Castel 2004: Photo 4).

The earliest known bone tools used in stone tool production and retouching have been documented in Boxgrove, UK, dated to some 500 ka BP (MIS 13) (Roberts, Parfitt 1999; Smith 2010; Smith 2013). After that, bone retouchers appear from MIS 12 to MIS 9 in several Late Acheulean and post-Acheulean technocomplexes in Europe and the Levant, but are generally poor in number in individual sites (Blasco et al. 2013; Daujeard et al. 2018; Moigne et al. 2016; Rosell et al. 2011; 2015; 2018; Tourloukis et al. 2018), except Schöningen 13II-4 (Hutson et al. 2018; van Klofschoten et al. 2015). It has been suggested that the phenomenon of retouchers occurs in the context of wider behavioural changes (Davidson 2018; Moigne et al. 2016; Rosell et al. 2018; van Klofschoten et al. 2015).

From the end of MIS 9 and the development of the Middle Palaeolithic, bone retouchers become widespread and their frequency increases, at given sites numbering in the hundreds (Auguste 2002; Daujeard et al. 2018; Mozota 2015; Moigne et al. 2016; Rosell et al. 2015; Tourloukis et al. 2018). During this period, retouchers have been found in France (Costamagno et al. 2018; Daujeard et al. 2014; 2018; Mallye et al. 2012; Sévêque, Auguste 2018; Verna, d'Errico 2011), Spain (Barandiarán 1987; Mateo-Lomba et al. 2019; Mozota 2009; 2012; 2015; Pérez et al. 2019), Belgium (Abrams 2018; Abrams et al. 2014; Rougier et al. 2016), Northern Italy (Jéquier et al. 2012; 2018; Leonardi 1979; Thun Hohstein et al. 2018), Germany (Conrad, Bolus 2006; Taute 1965; Toniato et al 2018), Czech Republic (Auguste 2002; Neruda et al. 2011; Neruda, Lázničková-Galetová 2018), Slovakia (Neruda, Kaminská 2013); Hungary (Bordes 1968), Slovenia (Turk, Dirjec 1989), Croatia (Ahern et al. 2004; Karavanić, Šokec 2003; Malez 1958; 1981; Patou-Mathis 1997), Montenegro (Morin, Soulier 2017), Greece (ref. in Tourloukis et al. 2018), Crimea (Veselsky 2008), the Russian Altai Mountains (Kolobova et al. 2016) and Syria (Griggo et al. 2011), among others. Middle Palaeolithic retouchers are mostly made from long bone shaft fragments and display no or very marginal shaping of the fragment morphology (Patou-Mathis, Schwab 2002). Generally, in this period, traces resulting from use are perpendicular or slightly oblique to the long axis of the piece (Abrams 2014). An exceptional feature of the Middle Palaeolithic is retouchers made on Neanderthal bones in Krapina (Patou-Mathis 1997), Les Pradelles (Mussini 2011), La Quina (Verna, d'Errico 2011) and Troisième Caverne of Goyet (Rougier et al. 2016).

Oldest-to-date bone retouchers in East Asia have also recently been recognized at Lingjing in China, in an MIS 5 context comparable to the Eurasian Middle Palaeolithic (Doyon et al. 2018; Doyon et al. 2019). Furthermore, rare finds of bone retouchers are also known from Middle Stone Age contexts in Africa (Campmas 2012; d'Errico, Henshilwood 2007; Henshilwood et al. 2001).

In Eurasia, bone retouchers are also found in Upper Palaeolithic contexts, and sometimes present a change in choice of support (most notably, the use of large carnivore canines) and use with regards to the Middle Palaeolithic (Castel et al. 2003; Conrad, Bolus 2006; Leroy-Prost 2002; Schwab 2002; Soulier 2014; Tartar 2012; Toniato et al. 2018). Certain diachronic differences in retoucher use can also appear between different Upper Palaeolithic industries on the same site (Schwab 2002).

In this paper, we present the results of an analysis of bone retouchers from the Palaeolithic sites of Veternica and Vindija (Croatia) (Fig. 1a). This sample was previously partially published in several works (Ahern et al. 2004; Malez 1958; 1981; Karavanić, Šokec 2003; Karavanić, Patou-Mathis 2009). However, new analytical developments warrant a complete analysis and presentation of the Vindija and Veternica retouchers. Further below we also present pertinent site information, results of lithic and basic zooarchaeological studies to examine in more detail these bone tools. The paper aims to present the finds in a context of recent improvements in the study of such artefacts, to infer possible modes of procurement and use and to evaluate their role in subsistence strategies and technological systems.

2. Site information

2.1. Veternica

Veternica cave is a large karstic cavity system located northwest from Zagreb, on the mountain of Medvednica, 306 m.a.s.l. (Malez 1965). The site was excavated by Mirko Malez from 1951 to 1955 and again in 1971 (Malez 1981). Archaeological remains are located exclusively in the entrance part of the cave, with an entrance gallery from which a northwestern corridor branches off (Malez 1965). Today, the opening is more than 4 meters high and approximately 8 meters wide. The entrance gallery is some 15 meters long and more than

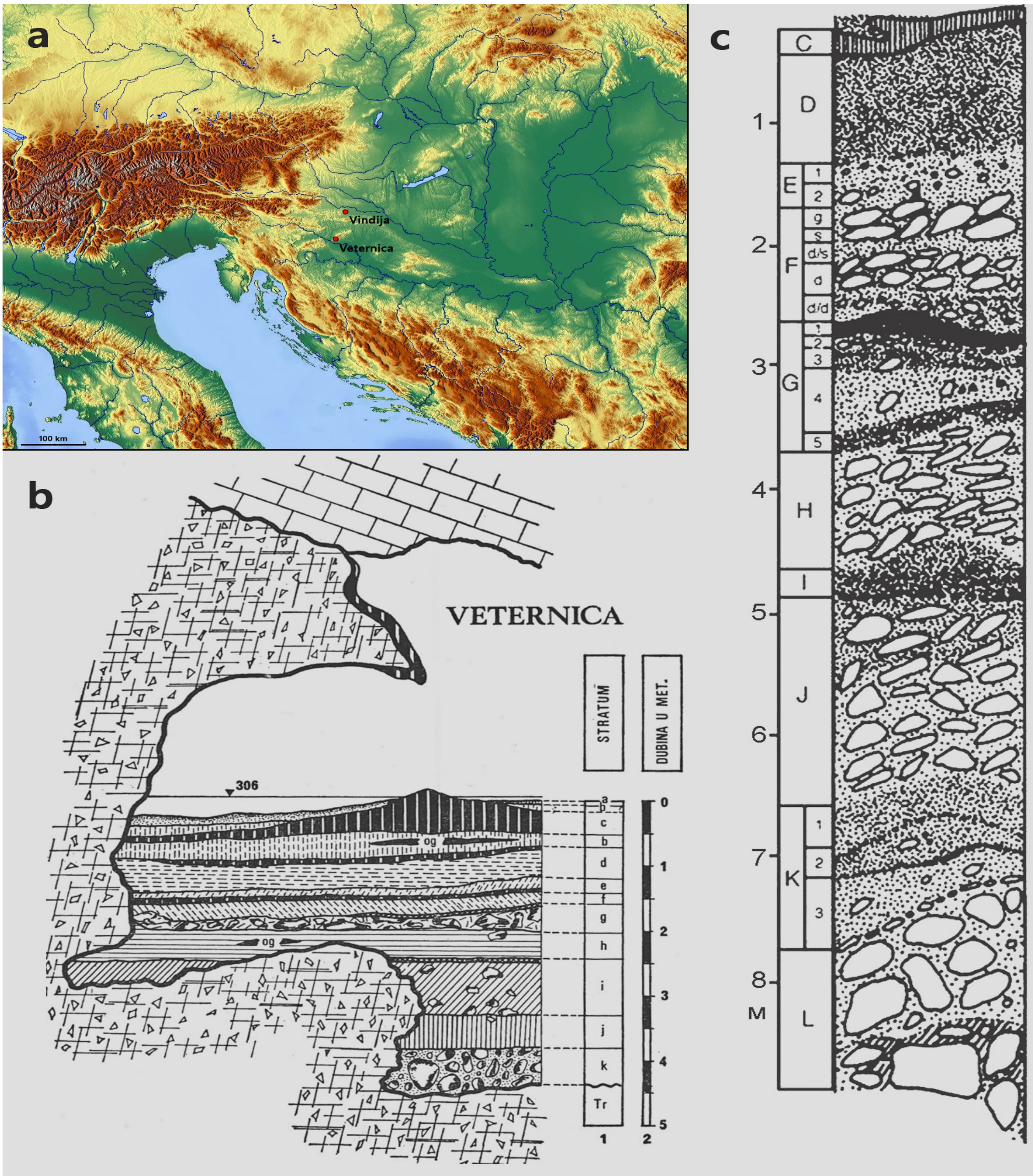

Figure 1. a) Map showing the location of Veternica and Vindija; b) stratigraphic profile of Veternica (after Malez 1981: Sl. 1); c) stratigraphic profile of Vindija (after Ahern et al. 2004: Fig. 1) (Edited by M. Banda).

8 meters wide in its widest part, with an average height of 5 meters. The smaller left corridor is 14 meters long, 3 to 7 meters wide and 4.5 to 6 meters tall (Malez 1965). The site has yielded archaeological remains from the Middle Palaeolithic to the Roman period (Malez 1981).

The stratigraphic sequence has revealed the presence of eleven Upper Pleistocene and Holocene geological layers laid atop of Triassic limestone bedrock, marked in alphabetical order from A to K (Fig. 1b) (Malez 1965). Layers J, I and H have yielded Mousterian lithic artefacts, along with faunal remains and traces of hearths. In layers I and H bone retouchers were also found, reportedly more than twenty pieces (Malez 1981). Layer J is dated to the last interglacial (MIS 5e), while layers I and H are broadly dated to MIS 5 or MIS 4/MIS 3 (Miracle, Brajković 2010; Miracle et al. 2010). Layer G atop of layer H is thought to represent a roof collapse or massive slope erosion, which buried the entrance almost completely, probably creating a hiatus in hominin and large mammal occupation of the cave. This event is thought to have occurred either during a colder phase of MIS 3 or during MIS 4 (Malez 1965; Miracle, Brajković 2010).

Among the faunal assemblages of layers H–J, cave bear (*Ursus spelaeus*) remains predominate with about 75%, but are less frequent (99%) than in Upper Pleistocene layers E and F, with rare evidence of hominin activity (Malez 1963; Miracle, Brajković 1992). This implies that the cave was interchangeably used by hominins and bears during the formation of layers H, I and J, and later almost exclusively by bears as a den (Banda, Karavanić 2019; Brajković 2005; Miracle 1991). About 82% of ungulate remains were found in layers H–J and 78.6% of that are remains of red deer (*Cervus elaphus*). These are followed by bovine remains (about 10% of all ungulate remains of layers H-J), mostly attributed at the genus level (*Bos/Bison*), but *Bison priscus* was more precisely recognized in layers I and J. Roe deer (*Capreolus capreolus*), elk (*Alces alces*) and chamois (*Rupicapra rupicapra*) remains are comparatively rare, about 3% each of all ungulates of layers H–J (Brajković 2005). The difference between the faunal spectrum of layers H–J and E–F suggests that hominins had an active role in the accumulation of cervid and bovine remains, which is supported by a basic taphonomic analysis and the almost exclusive (in the range of 90-95%) find of these species in layers H–J (Brajković 2005). These layers have also featured remains from *Canis lupus*, *Vulpes vulpes*, *Mustela erminea*, *Mustela putorius*, *Martes martes*, *Meles meles*, *Felis silvestris*, *Panthera spelaea*, *Panthera pardus* and *Lepus* sp. (Miracle, Brajković 2010). Paleoecological studies indicate that layer J was formed under warm and wet conditions and layers I and H under temperate conditions with some forest cover and wetlands in the regions, but this could be due to several factors (Miracle, Brajković 2010; Miracle et al. 2010).

The lithic assemblage from the three Mousterian-bearing layers was studied as a whole, in the absence of stratigraphical information for most of the lithic finds (Banda, Karavanić 2019). The inhabitants of Veternica made use of heterogeneous raw-material composition. Quartz is the dominant raw-material, followed by different varieties of chert, black eruptive and other less numerous raw-materials (Banda, Karavanić 2019; Blaser et al. 2002). The vast majority of raw materials were procured in the form of cobbles or pebbles, probably from secondary sources in the vicinity of the cave (Malez 1967). The mode of production is divided according to raw-materials. In raw-material group A (chert, black eruptive and other) centripetal cores predominate, with some irregular cores and one bidirectional core. On the other hand, in raw-material group B (quartz) the dominant method of production it that of cobble-wedge cores, i.e. cobbles flaked circularly around a cortical striking platform. Besides evidence of on-site production of lithic tools, there are pieces representing parts of a brought and curated tool-kit (Banda, Karavanić 2019). The tool composition of the site is dominated by various scrapers, followed by Upper Palaeolithic types, notches and denticulates, while other tool categories are not well represented. The assemblage as a whole is characterized as belonging to a *sensu lato* Charentian type of the Mousterian (Banda, Karavanić 2019), as defined in the literature that deals with the Middle Palaeolithic of Southeastern and South-Central Europe (Broglio, Kozłowski 1987; Kozłowski 1992; Mihailović 2014).

2.2. Vindija

The site of Vindija is a limestone cave located 2 km west of the village of Donja Voća, 20 km west of Varaždin. It is located in a narrow gorge, the entrance at 275 m.a.s.l. The cave is 50 meters long, 28 meters wide and higher than 10 m. The thickness of the sediments was about 9 meters and encompassed 20 strata dated from the Riss glaciation (MIS 6) to the Holocene (Fig. 1c) (Malez, Rukavina 1979). Complexes F, G and K are further subdivided into several sublayers (Malez, Rukavina 1979; Wolpoff et al. 1981). The site was intermittently excavated for thirty years by S. Vuković (1950), who first visited the cave in 1928. From 1974 to 1986 it was excavated by Mirko Malez, and most of the Palaeolithic artefacts, Pleistocene fauna and hominin remains come from these excavations. Neanderthal fossil remains were found in layers G1, G3 and I and ones from anatomically modern humans have been found in layer D and the F complex (Ahern et al. 2004; Cartmill, Smith 2009; Malez et al. 1980; Smith et al. 1985; Wolpoff 1999; Wolpoff et al. 1981).

Faunal assemblages from G3 and G1 are similar. Cave bear (*Ursus spelaeus*) is the most represented taxa (as in other Pleistocene layers), while among herbivores the Cervidae (*Megaloceros giganteus*, *Alces Alces*, *Cervus elaphus*) are dominant (see Patou-Mathis et al. 2018). Aurochs (*Bos primigenius*) is present in both layers, while roe deer (*Capreolus capreolus*) and Merck's rhinoceros (*Stephanorhinus kirchbergensis*) are present only in G1. Among carnivores, besides the already mentioned cave bears, the cave hyena (*Crocuta spelaea*) and the fox (*Vulpes vulpes*) are present only in G3 and the wolf (*Canis lupus*) and the cave lion (*Panthera spelaea*) are found in both G1 and G3 (Pathou-Mathis et al. 2018). Cave bear remains constitute 86% of all large mammal remains in G1 and 97% in G3. All age groups of this species are present and the most likely factor for their accumulation is hibernation death, due to the absence of cut or percussion marks on their bones and consistency with natural causes of fracture, i.e. sediment pressure and trampling. Other carnivore remains likewise display no traces of anthropic manipulation (Pathou-Mathis et al. 2018). The assemblage of herbivore remains, on the other hand, shows evidence of anthropic exploitation in the form of fresh fractures, cut marks and percussion notches. The near absence of carnivore gnawing on ungulate bones also reinforces the idea that they were mainly accumulated by hominins (Pathou-Mathis et al. 2018). Layer G3 also contains Neanderthal fossil remains with evidence of manipulation, suggesting a possibility of cannibalism (Patou-Mathis et al. 2018). A general overview of ungulate remains from the G complex as a whole shows a similar taxonomic composition and evidence of anthropic traces as mentioned above (Brajković 2005).

Ungulate remains from complex F are likewise dominated by cervid (*Alces alces*, *Cervus elaphus* and *Megaloceros giganteus*) and bovine remains, mainly *Bos/Bison*, but some more precisely designated as *Bos primigenius* and *Bison priscus* (Brajković 2005). *Capra ibex* and *Rupicapra rupicapra* are also present among ungulates. Among carnivores of complex F and the predominant cave bears, *Canis lupus*, *Vulpes vulpes*, *Panthera spelaea* and various Mustelidae are present (Miracle et al. 2010). There is also an assemblage of faunal remains designated as E/F but is not presented in more detail in the framework of this study, given that it contains remains from several different layers with different depositional conditions (Miracle et al. 2010).

Most of the archaeological material from the G complex, in particular layers G1 and G3, has been thoroughly analyzed. The G3 lithic assemblage was mainly produced by a non-Levallois flake technology but has additional evidence of bifacial and blade technology (Karavanić, Smith 1998). The industry is Mousterian, dominated by retouched flakes, notches, denticulates and scrapers, with the addition of some Upper Palaeolithic tools such as endscrapers (Ahern et al. 2004; Karavanić, Smith 1998). The technology of the G1 lithic assemblage is the same as in G3. Furthermore, the lithic tool composition is very similar, with endscrapers on flakes and blades, scrapers, denticulates and a bifacial point (Karavanić, Smith 1998). However, this typological classification has been challenged by Zilhão (2009), as he has recognized that a part of the tool assemblage belongs to pseudo-tools. Another striking feature of layer G1 is the presence of characteristically Aurignacian bone points, both Mladeč and split-base types, and their association with Neanderthal fossil remains. This has led researches to either characterize the G1 assemblage as a transitional culture with possible evidence of acculturation with anatomically modern humans (Karavanić, Smith 1998; Montet-White 1996) or a mixed assemblage due to post-depositional processes (Bruner 2009; Kozłowski 1996; Zilhão 2009; see Karavanić, Smith 2013 for a review of interpretations of G1). The most recent direct radiocarbon AMS dating, based on the extraction of hydroxyproline amino acid, of the G1 Neanderthals suggest they are older than 44 cal. ka BP and thus do not overlap with anatomically modern humans in this part of Europe (Devièse et al. 2017), but confirmation of this requires the dating of early modern human remains from Europe with the same technique.

The layers above the G complex are thought either to represent a sequence of Aurignacian (Fd/d), unknown (F/d), Gravettian (Fd/s; F/s; E/F) and Epigravettian (D) industries (Karavanić 1995) or Aurignacian (from Fd/d to E/F) and Epigravettian (D) with a major hiatus in between (Zilhão 2009). Karavanić and Smith (2013) have more recently accepted the possibility of the Aurignacian character of layers Fd/d and F/d, but have cautioned against the Western European subdivision of the Aurignacian in Vindija as proposed by Zilhão (2009).

On the other hand, Middle Palaeolithic assemblages from lower layers (i.e. from G4 onwards) have not been published in detail, except from the perspective of raw-material procurement (Blaser et al. 2002; Kurtanjek, Marci 1990). Generally, the Middle Palaeolithic lithic assemblages are predominantly made on quartz (50-80%), followed by variable quantities of tuff and chert in different layers. On the other hand, Upper Palaeolithic industries display a more balanced ratio of chert and quartz and even a predominance of chert in the Late Upper Palaeolithic (Blaser et al. 2002). Interestingly, the raw-material composition of the industry in layer G1 is intermediate between the Middle and Upper Palaeolithic industries (Ahern et al. 2004).

3. Materials and methods

3.1. Materials

The sample in question comprises of 33 bone retouchers from Veternica and 4 from Vindija. The entire sample is stored in the Institute for Quaternary Paleontology and Geology of the Croatian Academy of Sciences and Arts in Zagreb.

During the examination of faunal remains from Veternica, we found more retouchers than the approximately twenty pieces reported by Malez (1981). By his account (Malez 1981), all retouchers from Veternica were found in layers H and I. All of the pieces we found during our examination had no labels with stratigraphic provenience information, but we assumed that they belong to the mentioned layers (see Banda, Karavanić 2019 for the absence of stratigraphic information in Veternica). Furthermore, two photographs from Malez's publications (Malez 1958, Tabla 1; 1981, Sl. 19) directly associate seven of the retouchers with layers H and I. In his works, Malez (1958; 1981) had interpreted these artefacts as percussion retouchers and anvils.

In most recent studies, three retouchers have been recognized in Vindija, yielding from layers G3 and F/d and complex G in general (Karavanić, Patou-Mathis 2009). Other pieces previously described as retouchers (Ahern et al. 2004; Karavanić, Šokec 2003) have been reinterpreted as not resulting from hominin activity (Karavanić, Patou-Mathis 2009). The retouchers from Vindija are all labelled with the layer from which they come from and the year in which they were found. For this study we have distinguished four pieces as retouchers, coming from layers G/d (probably G4 or G5), F/d and the G complex. Thus, we have excluded from the analysis one piece previously considered to be and included one previously considered not to be a retoucher (Patou-Mathis, Karavanić 2009). Three of the selected retouchers come from Middle Palaeolithic contexts, and the one remaining comes from an Aurignacian context.

Additionally, three ambiguous specimens from Vindija are recognized and presented lower in the text (Fig. 6). All of these pieces were previously considered to be retouchers, some either by Karavanić and Šokec (2003), Karavanić and Patou-Mathis (2009), or both. Although these specimens present surface damage resembling retoucher use traces, it is not possible, beyond a reasonable doubt, to exclude other taphonomic agents possibly responsible for their origin. Thus, they are completely excluded from the analysis.

3.2. Methods

Traces on the bone surface were first examined macroscopically and with a ×10 and ×15 hand lens. When necessary, certain traces were further examined with a stereomicroscope.

If possible, the bone fragments were taxonomically and anatomically determined and indeterminate pieces were classified according to size groups according to Miracle and Pugsley (2006). When it was not possible to distinguish between different species of the same genus, the designation "sp." was used. Furthermore, we also used the designation "cf.", when the determination, either taxonomical or anatomical, was not completely secure (Reitz, Wing 1999). The assemblages were further examined for the presence of taphonomic traces (anthropic and non-anthropic) not related to the use of fragments in the modification of lithics. It was done to assess the sequence of events and activities which left their traces on the bone surfaces and to understand the timing of the use of fragments as retouchers. This is related to interpreting how the technology of bone retouchers is positioned in the overall mobility and settlement patterns, subsistence strategies, and likewise, whether the technology is essentially opportunistic or a planned aspect to such artefacts exists. Conventional referential literature for taphonomic classification of surface traces was used (Fernández-Jalvo, Andrews 2016; Lyman 1994). Furthermore, we examined the types of fractures (Villa, Mahieu 1991) as related to bone freshness. Based on the types of fractures present and other selected criteria we classified the bone fragments as either complete (all green fractures, fractures do not interrupt retoucher use-areas), almost complete (a mixture of green and dry fractures, has at least two use-areas on opposite sides which are not interrupted by fractures) and fragmented (a mixture of green and dry fractures with only one use-area, or at least one use-area terminated by a fracture, no matter the type of fracture).

Measurement of bone fragments used as retouchers followed that of Malerba and Giacobini (2002). The largest distance of the piece was measured as its length (L) and designated as the long axis. Width (W) is measured as the widest distance perpendicular to the long axis. Thickness (T) of the cortical bone was measured near the use-area of the piece, usually within 10 mm from it. Length (Lua) and width (Wua) of the use-areas were also measured, as was the distance of the last trace in a use-area to the nearest apical fracture surface (Dua-e). Pieces which are recorded as fragmented were measured but excluded from the morphometric analysis of supports, as they can introduce a bias. Two pieces were not measured as their morphology has been substantially altered by post-depositional breakage (VTR 6/R) or rodent gnawing (VTR 18/R).

The types of observed traces resulting from the use in the tasks of retouching lithics were classified according to Mallye et al. (2012) and Daujeard et al. (2014).

- Scores are linear and more or less deep marks of rectilinear, sinuous, concave and convex shape, and can have smooth or rough internal surfaces. They are made by a sharp lithic edge penetrating the bone surface. They sometimes have internal microstriations which are perpendicular to the overall orientation of the score (Abrams 2018; Malerba, Giacobini 2002) and indicate the direction of the movement which produced them (Daujeard et al. 2014).
- Pits are of triangular or ovoid form, produced by the protrusions on a lithic edge during contact with the bone.
- Scaled areas are created when external bone plaques are detached from the bone surfaces. This can result from intense use of the retoucher or if a dry bone or that of intermediate freshness is used.

However, we have not recorded systematically the presence of sliding striations, commonly referred to in other studies (Daujeard et al. 2014; Mozota 2013). This is because such traces can be mistaken for scraping marks or trampling striae, which are both not uncommon in the studied assemblages.

The orientation of bone blanks also followed that of Mallye et al. (2012). In this method, the pieces are always placed on their medullar surface and oriented along the long axis, with the use-area on the distal end (opposite from the observer). If the piece has other use-areas on the opposite end, it is reoriented for the analysis of that use-area.

The location of use-areas was determined as central, apical, lateral or covering (after Mallye et al. 2012). The shape and orientation of the overall use-area with regards to the long axis were classified into one of two categories: subcircular and oval. With that, we also recorded the orientation of the long axis of the oval use-areas in relation to the long axis of the bone blank. Use-areas were also classified according to the pattern formed by individual superposed traces as either hatched (predominantly scores), pitted (predominantly pits) or scaled areas (superficial detachment of bone plaques) (after Mallye et al. 2012). Finally, we classified the use-areas as either lightly (1), moderately (2) or heavily (3) utilized.

Additionally, we also recorded the presence of anthropic scrape marks, as well as their spatial and temporal relation to the retoucher use traces. In the spatial sense, they are either localized/confined to the use-areas, associated (but not confined) with the use-areas or not associated with the use-areas.

No experiments were conducted in the course of this study. Thus, in our comparative efforts, we relied on our earlier experimental results (Karavanić, Šokec 2003) and those of other researchers (e.g. Armand, Delagnes 1998; Daujeard et al. 2014; Mallye et al. 2012; Mateo-Lomba et al. 2019; Mozota 2013).

4. Results

4.1. Veternica

The retouchers from Veternica are all made from diaphyses fragments of limb bones. Of the 33 retouchers from this site (Tab. 1), 13 are made from ursid bones, seven of which undoubtedly came from cave bear (*Ursus spelaeus*) remains, two are tentatively attributed to cave bears (*Ursus* cf. *spelaeus*), three are attributed to bears on a genus level (*Ursus sp.)* as well as only one tentative piece (cf. *Ursus spelaeus*). Retouchers made from bovine (*Bos/Bison*) bones are present in five specimens. Only two pieces are undoubtedly attributed to red deer (*Cervus elaphus*), while three more pieces are classified as coming from a large cervid and two other are only recognized on a family level (Cervidae). The remaining pieces have not been determined on a taxon level, and are classified as belonging to a large (6) or medium (2) sized ungulate. The retouchers made from ursid bone are mostly pieces of femurs (11), but there is also one piece from an ulna and one from a humerus. On the contrary, four Cervid bone retouchers (including both *Cervus elaphus* specimens) are made from

VTR	Anatomical element	Taxa	Fractures	Length	Width	L/W ratio	Thickness	Num of UA	Scraping marks
VTR 1/R	femur	*Ursus* cf. *spelaeus*	Mix	95.47	34.15	2.80	6.38	2	-
VTR 2/R	metacarpus	*Bos/Bison*	Mix	80.50*	39.37*	2.04*	8.38	1	-
VTR 3/R	cf. femur	large ungulate	Mix	104.32*	58.79*	1.77*	9.78	2	-
VTR 4/R	femur	*Ursus spelaeus*	Mix	98.21	44.95	2.18	9.18	3	-
VTR 5/R	femur	*Ursus* sp.	Mix	103.10*	34.78*	2.96*	13.03	1	-
VTR 6/R	ulna	*Ursus* sp.	Mix	n/a*	n/a*	n/a*	9.50	1	-
VTR 7/R	femur	*Ursus spelaeus*	Mix	119.34	41.07	2.91	9.70	2	-
VTR 8/R	radius	*Bos/Bison*	Mix	131.76	43.52	3.03	11.46	1	-
VTR 9/R	femur	large ungulate	Mix	78.81*	43.43*	1.81*	7.70	2	-
VTR 10/R	metacarpus	*Bos/Bison*	Green	88.74	40.22	2.21	7.97	1	+
VTR 11/R	humerus	*Bos/Bison*	Mix	116.84*	50.89*	2.30*	4.86	1	-
VTR 12/R	femur	*Ursus spelaeus*	Mix	88.66*	33.51*	2.65*	6.25	1	+
VTR 13/R	cf. femur	large ungulate	Mix	92.19*	42.68*	2.16*	10.94	1	-
VTR 14/R	indeterminate long bone	large ungulate	Indet.	92.48*	49.04*	1.89*	8.28	1	-
VTR 15/R	indeterminate long bone	large ungulate	Mix	n/a*	n/a*	n/a*	8.71	1	-
VTR 16/R	indeterminate long bone	medium ungulate	Mix	80.74	32.38	2.49	6.64	2	+
VTR 17/R	tibia	*Cervus elaphus*	Green	75.17	23.51	3.20	5.91	1	+
VTR 18/R	femur	Cervidae	Mix	96.56	31.94	3.02	5.59	2	+
VTR 19/R	metatarsus	*Bos/Bison*	Green	85.36*	29.56*	2.89*	7.94	2	-
VTR 20/R	humerus	*Ursus spelaeus*	Green	88.67	53.75	1.65	10.78	1	+
VTR 21/R	radius	large cervid	Mix	102.86*	31.04*	3.31*	8.93	1	+
VTR 22/R	indeterminate long bone	medium ungulate	Mix	67.55*	22.51*	3.00*	8.01	2	+
VTR 23/R	femur	*Ursus* cf. *spelaeus*	Mix	75.83	31.45	2.41	13.22	2	+
VTR 24/R	indeterminate long bone	large ungulate	Mix	80.62*	30.95*	2.60*	10.08	1	-
VTR 25/R	femur	*Ursus spelaeus*	Mix	103.71*	28.52*	3.64*	6.68	1	-
VTR 26/R	cf. femur	cf. *Ursus* sp.	Green	85.37	32.83	2.60	6.61	2	-
VTR 27/R	tibia	*Cervus elaphus*	Mix	84.50*	29.23*	2.89*	7.05	1	+
VTR 28/R	femur	*Ursus spelaeus*	Green	110.35	33.94	3.25	7.65	2	+
VTR 29/R	tibia	large cervid	Mix	100.18*	33.10*	3.03*	5.67	2	+
VTR 30/R	tibia	large cervid	Mix	58.38*	32.65*	1.79*	8.65	2	+
VTR 31/R	femur	Cervidae	Green	79.54	30.69	2.59	5.58	2	+
VTR 32/R	femur	*Ursus* sp.	Green	65.91	25.71	2.56	6.91	3	+
VTR 33/R	femur	*Ursus spelaeus*	Mix	110.18*	32.09*	3.43*	7.53	1	-

Table 1. Retouchers from Veternica: Anatomical and taxonomical determination; type of fractures; length, width, L/W ratio and thickness of the bone blank; number of use-areas and presence of scraping marks. * - Piece is incomplete and not included in the morphometric analysis.

tibia fragments, two from femurs and one from a radius. Bovine retouchers come from two metacarpal, a metatarsal, a humerus and a radius fragment. The anatomical elements of the ungulate bones classified according to size are mostly indeterminate (5) or come from femurs (3).

Out of the 33 retouchers from Veternica (Tab. 1), 23 present a mix of green and dry fractures. On the other hand, eight pieces have only green fractures and two pieces are indeterminate. The absence of pieces with exclusive dry fractures indicates that all of the bones in the assemblage have been initially broken in a more or less fresh state, either by anthropic or non-anthropic agents. In some cases, the dry fractures are a result of post-depositional damage to the bone and it is evident that such pieces are not complete. On that point, more than half of the assemblage with mixed fractures present green fractures everywhere except on the proximal end of the piece, indicating that some retouchers

VTR	Length					Width					L/W					Thickness				
	N	Min	Max	Mean	S.D.	N	Min	Max	Mean	S.D.	N	Min	Max	Mean	S.D.	N	Min	Max	Mean	S.D.
	14	65.91	131.76	92.26	18.21	14	23.51	53.75	35.72	8.10	14	1.65	3.25	2.64	0.44	33	4.86	13.22	8.23	2.09

Table 2. Morphometric results of the Veternica retouchers.

VTR		Length			Width			Thickness		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Number of UA	1	96.09	75.17	131.76	40.25	23.51	53.75	9.03	5.91	11.46
	2	92.90	75.83	119.34	33.56	30.69	41.07	7.67	5.58	13.22
	3	82.06	65.91	98.21	35.33	25.71	44.95	8.05	6.91	9.18

Table 3. Morphometric results of the Veternica retouchers with different numbers of use-areas.

Veternica N=43	Length UA				Width UA				Distance to edge			
	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.
	9.26	43.89	21.87	8.53	5.56	26.17	14.34	4.73	0.00	23.12	6.79	4.58

Table 4. Morphometric results of the retoucher use-areas (UA) from Veternica.

were originally longer. However, the presence of only green fractures is not necessarily an indication that a retoucher is complete, which is exemplified by two (VTR 19/R, VTR 31/R) pieces on which green fractures terminate a use-area.

Only 14 retouchers from Veternica were recorded as complete or almost complete and selected for further morphometric analysis (Tab. 1). Mean values are presented in Tab 2. The length of the selected pieces ranges from 131.8 mm to 65.9 mm, with a mean of 92.3 mm. Width of the pieces ranges from 53.8 mm to 23.5 mm, with a mean of 35.7 mm. Thus, the ratio of length and width ranges from 3.25 to 1.65, with a mean of 2.6. The thickness of the pieces near the use-area was calculated on both the complete and incomplete pieces and ranges from 13.2 mm to 4.86 mm, with a mean of 8.2 mm.

The bones from Veternica generally present a wide variability in the state of surface preservation, owing to different conditions in the cave and complex post-depositional processes. During taphonomic analysis, 19 pieces (57%) were found to have trampling striae. Mineral staining, possibly manganese and iron oxide, was present on 7 pieces (21%). Only two pieces had traces of carnivore gnawing and only one had traces of rodent gnawing, which completely altered the morphology of the bone blank. Several traces of anthropic origin were present on the bones. Cut marks occur on eight pieces (24%) and, when discernable, seem to indicate meat removal. Percussion notches aimed at marrow extraction are present on only two pieces. Traces of burning are present on at least two pieces (6%), both attributed to secondary exposure.

Anthropic scraping marks are present on at least 15 pieces (45.5%) (Tab. 1). On all of the pieces, the scraping precedes the retoucher use traces, except perhaps one specimen (VTR 17/R) where scrape marks possibly cover the use traces (Fig. 9a). In all cases of scrape mark presence, they are associated with retoucher traces, two-thirds of them being confined to the surface of the use-areas. The scrape marks are usually associated with all of the use-areas on a piece, but there are two specimens (VTR 4/R, VTR 29/R) where some of the use-areas are and some are not associated with scrape marks. Additionally, there are also two examples of shaping a blank morphology on a lateral side of a bone fragment, which is seen as a sequence of continuous flake scars on the medullar side (VTR 13/R; VTR 18/R) (Fig. 2).

In Veternica, 17 retouchers have a single, 14 pieces have a second and two pieces have a third use-area (Tab. 1). The number of use-areas on a single piece is not proportional to the size of the bone blank, as the mean values of length, width and thickness are all smaller for retouchers with more than one use-areas. (Tab. 3) All in all, 51 use-areas have been identified in the Veternica assemblage.

The position of the use-areas is most often (56.9%) central on the bone blanks (Fig. 4a). This is followed by use-areas positioned on the right (21.6%) and left lateral (9.8%) side. Covering, apical and indeterminate (due to the fragmented nature of the blank) positions are very rare. The shape of use-areas is generally oval, followed by subcircular forms (Fig. 4b). The long axis of oval use-areas tends to be oriented more-or-less in parallel with the long axis of the bone fragment.

There is variability in the distribution of traces in individual use-areas (Fig. 4c). Most traces appear concentrated (45.1%) and concentrated and superimposed (41.2%). Dispersed distribution appears on only 13.7% of the use-areas and there are three retouchers with occurrences of isolated traces outside

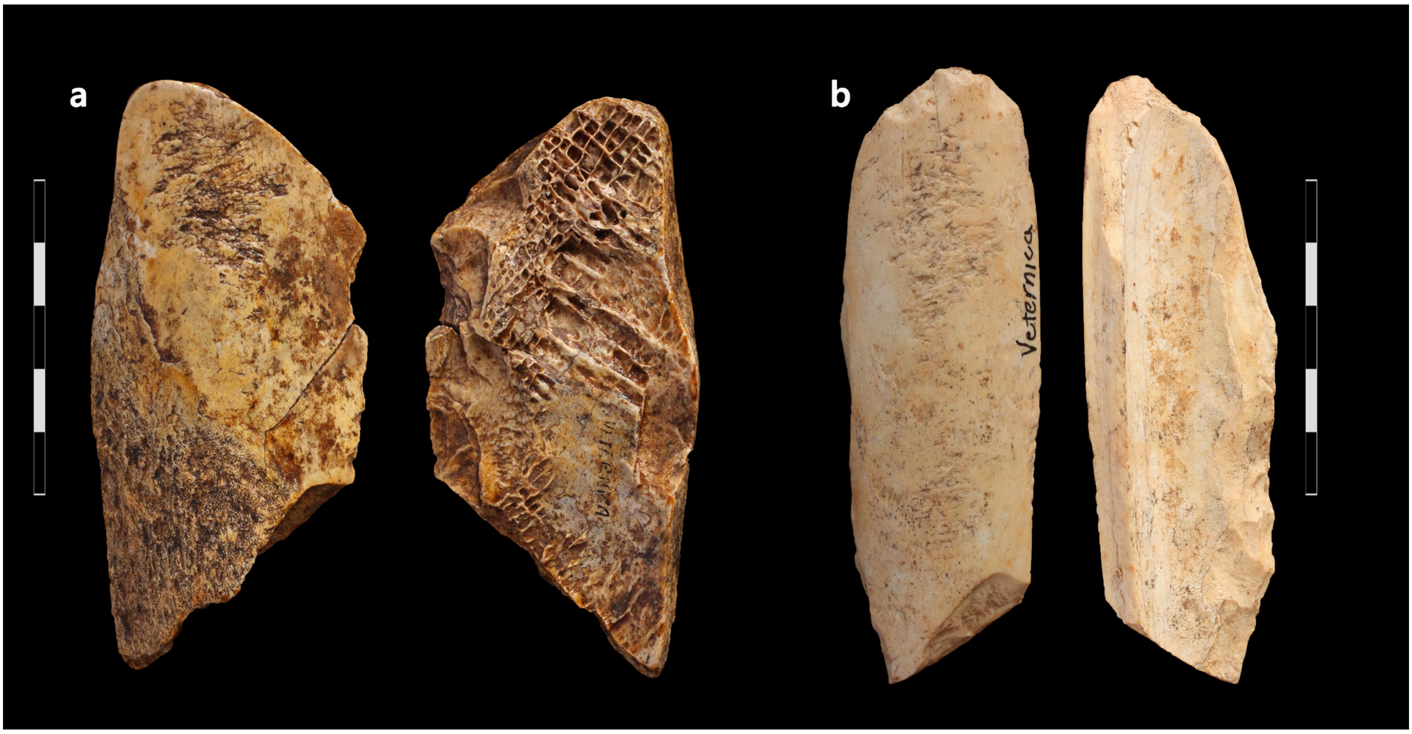

Figure 2. a) Retoucher VTR 13/R (large ungulate; cf. femur) with a single use-area and continuous flake scars on the medullar side, indicating shaping of the morphology; b) Retoucher VTR 18/R (Cervidae; femur) with two use-areas on opposite sides, scraping marks and continuous flake scars on the medullar side (shaping of the morphology). Scale = 5 cm (Photographed and edited by M. Banda).

designated use-areas. On pieces that have multiple use-areas, one zone usually displays fewer traces and damage than the rest. The orientation of the traces within the use-areas ranges from perpendicular to oblique in relation to the long axis of the tool (Fig. 4d). However, most use-areas present a continuum of variability in the orientation of traces. There are no pieces with traces oriented parallel to the long axis of the bone fragment.

Morphometric analysis of the use-areas included only 43 specimens (Tab. 4), the rest being excluded due to their fragmentation. The mean use-area length is 21.9 mm and the mean width is 14.3 mm. Distance from the apical edge varies from 23.1 to 0 mm, but in 83% of cases is located within 10 mm.

In about two thirds (62.7%) of the use-areas, the traces form a hatched pattern (Fig. 4e). Scaled surfaces appear on 17.6% of use-areas and the same percentage belongs to indeterminate patterns due to fragmentation, dispersal or not enough traces to form a discernable pattern. There are no predominantly pitted surfaces, but there is one with a combined hatched and pitted pattern. A depression produced by the intensity of use is present within 12 use-areas (23.5%). Approximately every third of the studied use-areas is lightly (1), moderately (2) or heavily (3) utilized (Fig. 4f).

The sample displays a wide variability in the number, shape, depth and size of retoucher traces. In the majority of cases, linear scores are much more numerous than pits, although there are 6 specimens (12%) where the number of pits vs. linear scores is comparable or even greater. The shape of linear scores varies greatly and most use-areas (39%) have a mix of linear scores with rough and smooth internal surfaces and rectilinear and curved forms. Exclusively smooth or rough linear traces occur respectively on 25% and 23% of the use-areas. Oval pits occur on 37% and triangular ones on 14% of use-areas. A variety of both types of pits occurs on 31% of all use-areas and 12% have no traces of pits at all. Scaling is present on 43% of use-areas and most commonly occurs with heavily utilized use-areas. This heavy utilization, or rather a superposition of traces, generally prevents detailed quantification of the use traces.

A couple of specimens (VTR 3/R, VTR 9/R, VTR 28/R) with a difference in retouch traces in two use-areas on the same apical part of the bone fragment or between two clusters in a single use-area testify that some of the retouchers were used in at least two separate retouching tasks (Fig. 3, Fig. 8a). Two of these specimens, VTR 3/R and VTR 9/R (Fig. 3), may even indicate a utilization in two different states of bone freshness, based on the difference of depth of traces, their surface features and presence the of scaled areas (Mozota 2015; Pérez et al. 2019; Rosell et al. 2011).

4.2. Vindija

The Vindija retouchers (Tab. 5, Fig. 5) are also made exclusively from diaphyses of long bones. Vi 75 G a (Fig. 5a) is made from a metacarpal of a Cervidae, Vi 78 G (Fig. 5b) from a metatarsus of a large cervid, while Vi 79 G/d (Fig. 5d) probably comes from a tibia of a large cervid. The only retoucher from an Upper Palaeolithic level, Vi 78 F/d (Fig. 5c), is made from a tibia of a large-sized ungulate.

Figure 3. Retoucher VTR 9/R (large ungulate; femur) with two use-areas (a and b) on the same apical side of the bone blank (proximal side is fragmented). The qualitative difference in the traces could point to use in a fresh (b) and dry (a) state. Scale = 5 cm (Photographed and edited by M. Banda).

Of the four retouchers (Tab. 5), three present a mix of dry and green fractures and one displays only green fractures. When present, dry fractures almost exclusively occur on proximal and distal edges of the bone fragments, indicating that post-depositional damage to the bone fragments primarily influenced their length. Because all of the pieces have at least partially green fractures, it is safe to assume that all of the bones were initially broken in a fresh state.

According to the presence and position of the dry fractures and locations of the use-areas, one specimen is considered as fragmented and the remainder as complete or almost complete (Tab. 5). The mean length of the complete retouchers is 73 mm (minimum 72.4 and maximum 74) and mean width is 28.7 mm (minimum 26.3 and maximum 31.3), the length/width ratio ranges from 2.3 to 2.8, with a mean of 2.6. If the length and width values of the fragmented pieces are included in the morphometric analysis, the means do not change significantly. The thickness of the bone fragments near the use-areas was calculated on both the complete and fragmented pieces and ranges from 7.3 to 9.1 mm, with a mean of 8.5 mm.

The number and characteristic of taphonomic traces on different bone fragments are variable. Trampling traces occur on two specimens, post-depositional exfoliation (which had terminated a use-area) is present on one piece and there is some indeterminate damage to the bone surface of two specimens that may be due to carnivore gnawing. On the other hand, traces of anthropic origin, i.e. cut marks, percussion notches and evidence of heat exposure are not present, except for scraping marks.

Anthropic scraping traces are present on at least two specimens (Tab. 5; Fig. 5b, c), in both cases associated but not strictly confined to the use-areas of the retoucher as they extend over a significant part of the bone surface. The scraping marks are always terminated by the use-traces, indicating that they occurred before the use of the piece as a retoucher.

Three out of four retouchers have one and a single retoucher has two use-areas (Tab. 5; Fig. 5d). Therefore, five use-areas were recorded. The number of the use-areas on a piece is not dependant on the size of the piece as most pieces have similar dimensions.

The use-areas are mostly in a central position (4/5), followed by one apical position (Fig. 4a). In terms of shape, two use-areas are subcircular and three are oval. The long axis of the oval use-areas is always more or less parallel to the long axis of the bone blank (Fig. 4b).

Use-areas have either concentrated (3/5) or concentrated and superimposed traces (2/5) (Fig. 4c). There are no dispersed or isolated traces. On the piece with two use-areas, one displays fewer traces and damage than the other one. The traces in use-areas are oriented perpendicularly or slightly oblique with regard to the long axis of the piece (Fig. 4d), and even though there is a slight variability of orientation in some use-areas, the traces are generally uniformly oriented.

The morphometric analysis included all five recorded use-areas (Tab. 7). The mean length of the use-areas is 15.3 mm and the mean width is 11.6 mm. Distance from the apical edge varies from 0 to 9.7 mm.

Almost all of the use-areas have a hatched pattern of traces (4/5), except one with a hatched and pitted pattern (Fig. 4e). No depressions resulting from intensity of use have been recorded. Two use-areas are considered to be lightly utilized, another two as moderately and one as heavily utilized (Fig. 4f).

Generally, in individual use-areas linear scores are more numerous that pits, but there is one use-area (Vi 79 G/d; Fig. 5d – proximal side) where the numerical relation of the two types of traces is comparable. Contrary to that, on one specimen (Vi 78 F/d; Fig. 5c) pits are not recorded. Although of different sizes, linear scores usually appear in two different shapes, either thin and deeper or wide and shallower. In both cases, they have rough internal surfaces. Pits, when present, are always oval. Scaling is present on half of the use-areas but is not predominant and none of the use-areas have a scaled appearance.

Vi	Anatomical element	Taxa	Fractures	Length	Width	L/W ratio	Thickness	Num of UA	Scraping marks
Vi 75 G a	metacarpal	Cervidae	Mix	81.3*	21.6*	3.76*	7.3	1	-
Vi 78 G	metatarsus	large cervid	Mix	72.6	31.3	2.32	9.1	1	+
Vi 78 F/d	tibia	large sized ungulate	Green	72.4	28.43	2.55	9.1	1	+
Vi 79 G/d	tibia	cf. large cervid	Mix	74	26.3	2.81	8.6	2	-

Table 5. Retouchers from Vindija: Anatomical and taxonomical determination; type of fractures; length, width, L/W ratio and thickness of the bone blank; number of use-areas and presence of scraping marks. * - Piece is incomplete and not included in the morphometric analysis.

Vi	Length					Width					L/W					Thickness				
	N	Min	Max	Mean	S.D.	N	Min	Max	Mean	S.D.	N	Min	Max	Mean	S.D.	N	Min	Max	Mean	S.D.
	3	72.40	74.00	73.00	0.87	3	26.30	31.30	28.68	2.51	3	2.32	2.81	2.56	0.25	4	7.30	9.10	8.54	0.74

Table 6. Morphometric results of the Vindija retouchers.

Vindija N=5	Length UA				Width UA				Distance to edge			
	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.
	9.91	18.90	15.32	3.54	8.60	15.80	11.63	2.99	0.00	9.70	5.86	3.61

Table 7. Morphometric results of the use-areas (UA) from Vindija.

As already mentioned, another three specimens from Vindija are ambiguous, even though their surface damage resembles retoucher use traces. Specimen Vi 75 G b (Fig. 6a) presents a cluster of surface damage on its distal end resembling retoucher use traces, but because of the colour difference (patina) of these traces and the cortical surface of the bone, combined with the presence of other types of damage (trampling striae and cortical bone detachment), it is not possible to the rule out the post-depositional origin of these traces. The variable and dispersed damage on specimen Vi 80 G3 (Fig. 6b), extending from the center to the apical part of the bone fragment, could also be due to carnivore gnawing. Finally, for specimen Vi 78 G3 IIP (Fig. 6c) it is not possible to distinguish if the clustered, shallow and uniformly oriented traces in the central-distal part of the fragment resulted from trampling or use as a retoucher. Given these uncertainties, the pieces are excluded from the analysis, but even in the event of their inclusion the results would not be significantly altered, as they are morphometrically and qualitatively similar to the unambiguously determined retouchers from Vindija, except Vi 80 G3 concerning the characteristics of the possible use traces.

5. Discussion

In various sites, the basic selection of blanks according to morphometric criteria is suggested by the larger average dimensions, especially length, of retoucher blanks than of unutilized bone fragments (Costamagno et al. 2018, Jéquier et al., 2012; Mallye et al. 2012; Rosell et al. 2015; 2018; Veselsky 2008). This, however, is not a rule, as sites with comparable dimensions of utilized and unutilized fragments have been documented (Armand, Delagnes 1998; Daujeard et al. 2014; Auguste 2002). Furthermore, Mozota (2009) has suggested that less heterogeneity in morphometric values of retouchers when compared to non-utilized bones also indicates a selection of blanks used for retouching. As of now, we cannot infer anything about the existence or non-existence of such a selection in the Vindija and Veternica retouchers, primarily because detailed morphometric data of non-utilized bone fragments have not been published. Although the relatively uniform dimensions of the Vindija retouchers may seem as a compelling argument in favour of selection and standardization, the small assemblage size and the distribution among different layers could indicate that this is fortuitous.

When it comes to the comparison of the morphometric characteristics of the two sites, the assemblage from Veternica presents longer and wider blanks on average, but there is a slight overlap with the Vindija retouchers, without (Fig. 7a) or with (Fig. 7b) the fragmented pieces included. Furthermore, although the Veternica retouchers are larger on average, the length-to-width ratio is very similar to that Vindija. Thus, the retouchers from both sites tend to be longer than wider in relatively consistent mode. The average bone thickness of the two assemblages is almost equal, though it is much more variable in the retouchers from Veternica, reflecting the generally greater morphometrical heterogeneity of that assemblage.

Another aspect in the selection of blanks relates to the taxonomic representation in the retoucher assemblage and the overall representation of species in the assemblage from which they come from. At some sites, the faunal spectrum of blanks used as retouchers more or less mirrors that of the parent assemblage (Armand, Delagnes 1998; Auguste 2002; Daujeard et al. 2014; Jécquier et al. 2012; Moigne et al. 2016;

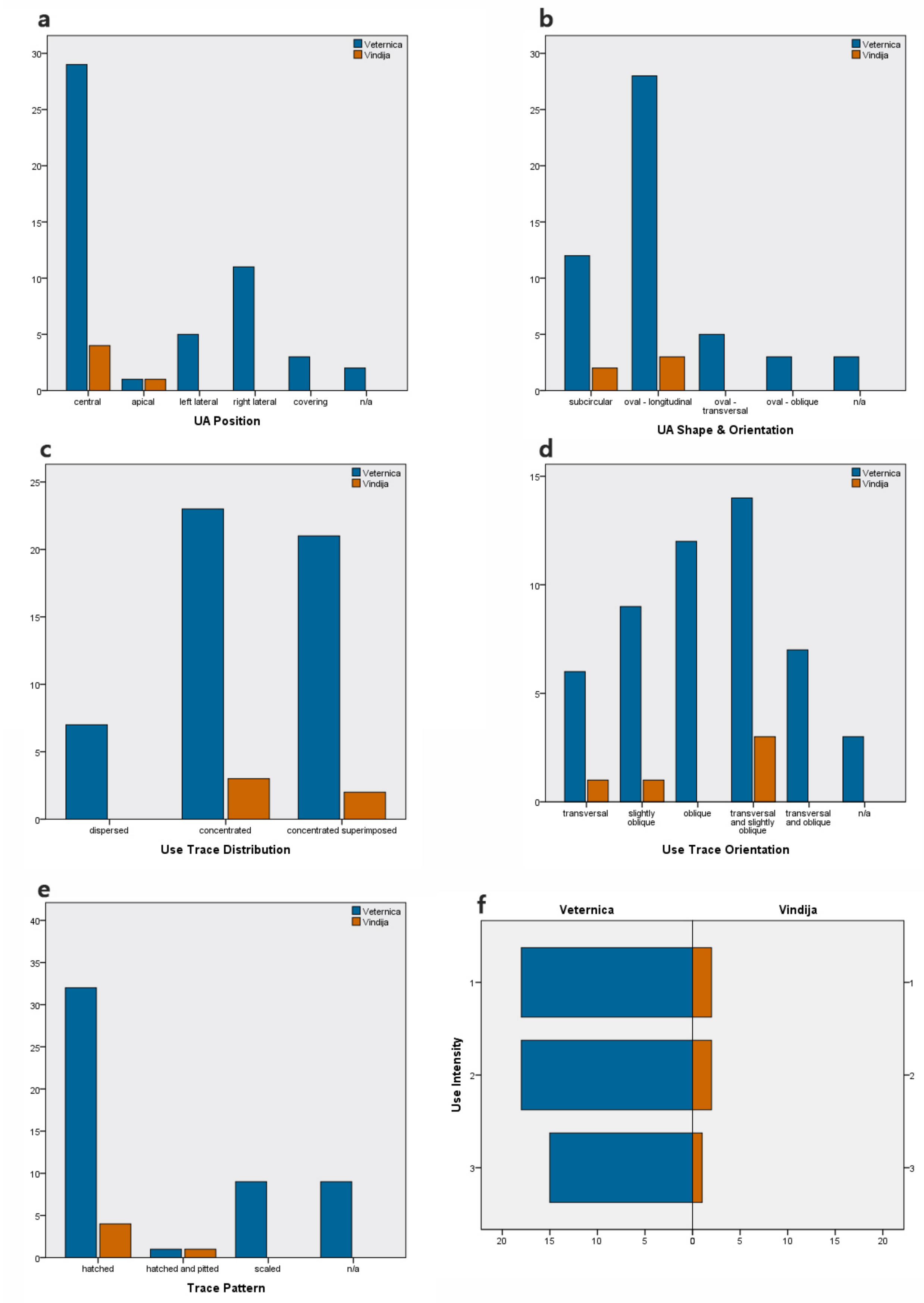

Figure 4. a) Frequency of use-area position classes; b) Frequency of use-area shapes and orientation; c) Frequency of use trace distribution classes; d) Frequency of use traces orientation types; e) Frequency of different patterns formed by use traces; f) Intensity of use (Edited by M. Banda).

Pérez et al. 2019; van Kolfschoten et al. 2015). On the other hand, some sites present a taxonomic spectrum of retouchers partially or substantially different from the remaining faunal assemblage, which is evident from a clear preference for the utilization of some species which are not as common in the remaining assemblage or the underrepresentation of blanks from species which are common or prevalent in certain assemblages (Mallye et al. 2012; Mozota 2009; Neruda et al. 2011; Rosell et al. 2015). The supposed selection is probably a result of a difference in cortical bone thickness between species and technical requirements of size and robustness for retouchers (Costamagno et al. 2018; Jéquier et al. 2018; Neruda et al. 2011). To Mozota (2009), the selection according to species, along with a lesser morphometrical heterogeneity of retouchers, indicates that there is no random procurement of blanks after the exploitation of the animal carcasses, but that the selection is conducted during the fracture of the bones for marrow procurement.

In Veternica, bear bones are prevalent in the retoucher assemblage, with about 40%. As there are only two remains of brown bear (*Ursus arctos*) at that site, and both come from layer J (Malez 1963), it is most likely that the bone retouchers determined at the genus level (*Ursus* sp.) belong to cave bears. Although the cave bear remains, at some 75%, are dominant in the entire assemblage of layers H, I and J (Malez 1963), most of the cave bear bones are probably the result of natural death during the use of the site as a den (Miracle 1991). Furthermore, bovine remains are rare and, as noted, make only about 10% of all ungulate remains from layers H-J, but at least 15% of retouchers are made from their remains. Even though the red deer is the most common ungulate species in the assemblage and the main species exploited by hominins, only two retouchers are undoubtedly made from its bones. There is a possibility that at most four more retouchers are made from red deer remains (two designated as Cervidae and two as a medium ungulate), but regardless if that were so, red deer remains would still be underrepresented in the retoucher assemblage with regards to the complete faunal assemblage, as they are the main exploited taxa. The three large cervid retouchers may belong to elk (*Alces alces*), as this is the only recognized large cervid in the entire site, and its remains are found only in layer H. Finally, the remaining retouchers are all made from large ungulate remains. Thus, a clear preference for large-sized mammals is evident in Veternica and we infer that the primary reason for this is cortical bone thickness and robustness as a defining criterion in the selection. The small retoucher assemblage from Vindija relating to each specific layer precludes such an assessment based on the present taxa. However, because most of the retouchers of that site are made from cervid bones, it can be suggested that the faunal spectrum of the retouchers broadly corresponds to the faunal spectrum of the species exploited by hominins.

Neither the Veternica nor the Vindija retouchers display evidence of a complex *chaîne opératoire* and thus no form of intentional production can be distinguished for these artefacts, as has been proposed for the refitted retouchers from Scladina (Abrams 2018; Abrams et al. 2014) or the retouchers with continuous percussion notches in Peña Miel (Mozota 2015) and Les Abeilles (Soulier 2014). However, VTR 13/R and VTR

Figure 5. Retouchers from Vindija: a) Vi 75 G a; b) Vi 78 G; c) Vi 78 F/d; d) V 79 G/d. Scale = 5 cm (Photographed and edited by M. Banda).

18/R from Veternica bear evidence of shaping the bone blank morphology by flaking, a phenomenon also observed at other Lower and Middle Palaeolithic sites (Abrams 2018; Doyon et al. 2018; Rosell et al. 2015).

The use of cave bear bones as retouchers in Veternica opens another topic. Coupled with the use of the cave bear bones as retouchers is the presence of other anthropic marks, mainly scrape and cut marks, and only VTR 7/R has neither of these traces. On two specimens (VTR 20/R and VTR 28/R) scrape marks occur together with cut marks, which in both instances point to meat removal (Fig. 8b). Furthermore, on VTR 28/R, a percussion notch is also present. There is also a virtual absence of carnivore gnawing, as only one piece has tenuous gnawing marks. We hypothesize that all of the stated indirectly implies the exploitation of cave bears by Neanderthals in Veternica, probably as a food and raw-material source. At the Middle Palaeolithic sites of Rio Secco, Grotta di Fumane (Romandini et al. 2018) and Caverna della Fate (Valensi, Psathi 2004) in Italy, Biache-Saint-Vaast (Auguste 2002; Sévêque, Auguste 2018) in France and Scladina in Belgium (Abrams 2018; Abrams et al. 2014) exploitation of bears is associated with the utilization of their bones as retouchers. However,

Figure 6. Ambiguous specimens from Vindija: a) Vi 75 G b; b) Vi 80 G3; c) Vi 78 G3 IIP. Scale= 5 cm (Photographed and edited by M. Banda).

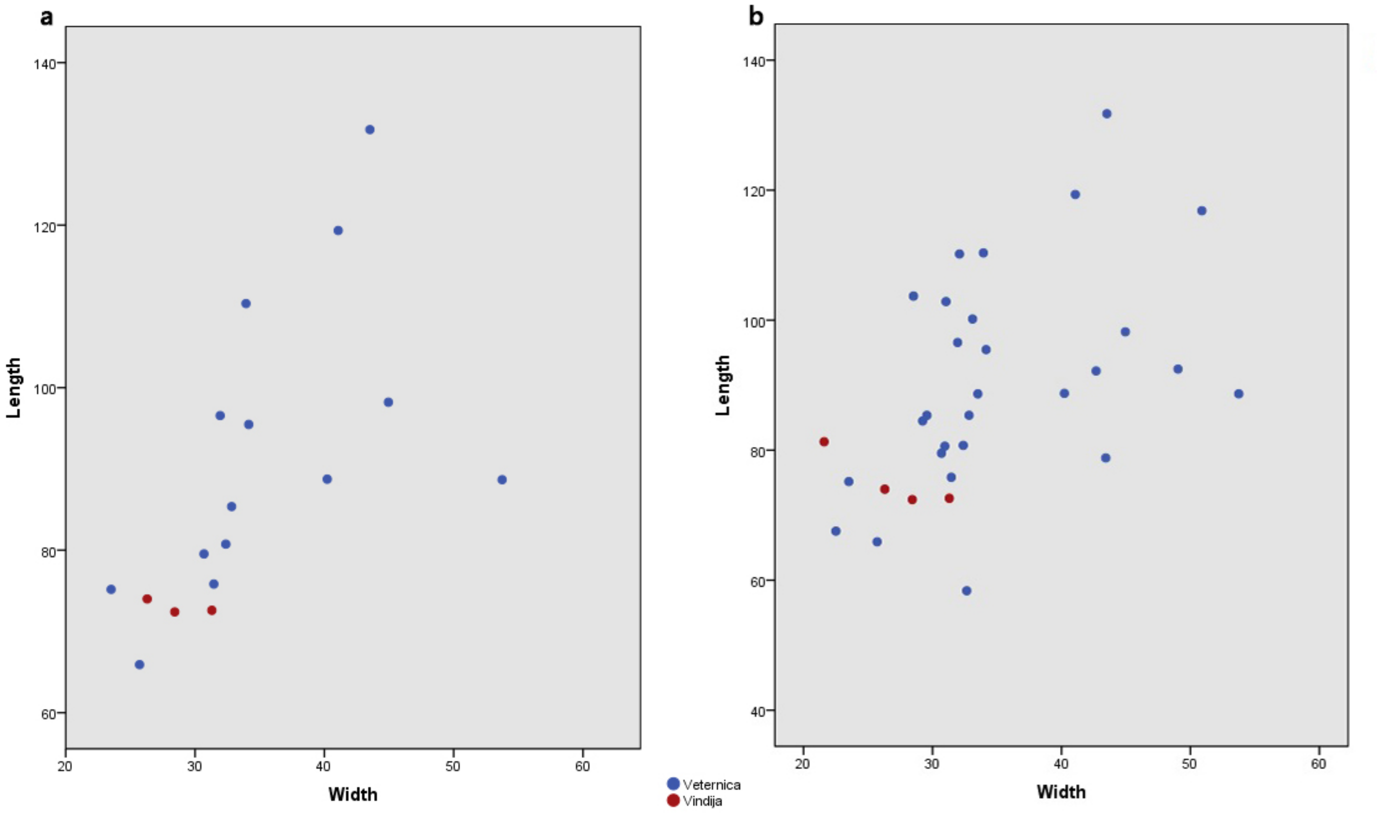

Figure 7. Scatter plot by length and width of the retouchers from both sites without (a) and with (b) the fragmented pieces included. Scale in mm. (Edited by M. Banda).

only Caverna della Fate (Valensi, Psathi 2004), Rio Secco (Romandini et al. 2018) and Scladina (Abrams 2018; Abrams et al. 2014) have provided retouchers made specifically from cave bear remains.

Whether this indicates the hunting of cave bears or the access to recently deceased bears in the case of Veternica is unresolved and requires further detailed zooarchaeological and taphonomic studies of the entire assemblage of bear remains. The most likely scenario is that it represents opportunistic exploitation of cave bears in their dens, conditioned on a good knowledge of bear hibernation cycles (Romandini et al. 2018). In any case, the use of cave bear remains as retouchers in Veternica is added to the rare Middle Palaeolithic examples and currently represents the largest assemblage of retouchers made from the remains of this taxon.

Scrape marks are commonly found on Palaeolithic bone retouchers and are sometimes confined to the use-areas of the tool. Several authors have suggested that the function of the scraping was to remove the periosteum from the fresh bone to improve the efficiency of the retoucher (Abrams et al. 2014; Armand, Delagnes 1998; Blasco et al. 2013; Daujeard et al. 2014). However, it is also possible that the scraping was intended to renew heavily damaged use-areas (Daujeard et al. 2014; Mozota 2009). Furthermore, Jéquier et al. (2018) have proposed that it may also be a result of the preparation of a lithic edge prior to retouching. Interestingly, out of four retouchers belonging to the same refitted cave bear bone from Scladina, only two have scrape marks (Abrams 2018; Abrams et al. 2014). This indicates that the removal of the periosteum was not an obligatory step prior to the use of fresh bone and that the absence of scraping marks on a piece does not indicate that the bone was used in a dry state (Costamagno et al 2018).

Given that almost half of the retouchers from Veternica have scrape marks and that these scrape marks are usually confined to use-areas and almost always overlain by retoucher use traces, it is most likely that the bones were scraped before their use to remove the periosteum and clean the surface. This is reinforced by the fact that some scrape marks occur with only lightly damaged retoucher use-areas, effectively disqualifying maintenance and repair as an explanation. In Vindija, scraping marks are not exclusively confined to the use-areas but appear over a much larger surface. This may indicate that the scraping was a part of the butchery phase of the exploitation of the carcass and not the preparatory stage for the retouchers (see Mozota 2009). On the other hand, it may simply indicate a different way of preparing a bone blank when compared to the Veternica assemblage, in which the preparation was localized on the surface of the future use-areas.

The presence of localized scrape marks preceding retoucher traces and green fractures which terminate use-areas point to the use of fresh bone fragments as retouchers in Veternica. On the other hand, the use of bones in a dry or intermediate state is also hinted by the possible evidence of recycling (Mozota 2015; Rosell et al. 2011) and by the presence of scaled use-areas (Mallye et al. 2012). However, in the first case, it is not evident that the difference in retoucher traces is the result of reuse of a bone in a dry state, as opposed to reuse in a separate retouching activity with stronger gestures. Furthermore, scaled use-areas can also occur with intensive use or a superposition of traces on a small area (Mozota 2009; 2013; 2018). Thus, neither are clear evidence and the possibility of the utilization of dry bone remains tentative. On the other hand, in Vindija the indication of the state of the freshness of bone blanks during use is even less certain. Green fractures and widespread scraping marks only point that the bones were initially broken while fresh, but do not suggest the timing of the use. It is difficult to clarify if some of the dry fractures present on the pieces occurred before use or after discarding the retoucher. Moreover, even though scaling occurs on some use-areas, it is always small and associated with other more predominant types of use traces. However, even though large-scale scaling and true scaled use-areas do not occur in the sample, their absence is not an indication that the bones were used in a fresh state (Mallye et al. 2012). Therefore, we leave the question of bone freshness during use for Vindija open.

There is an ongoing debate on the duration of use and curation of bone retouchers in the Palaeolithic. Chase (1990) has argued that these are *ad hoc* tools which have been used in short term retouching activities, mainly for transforming a single lithic edge and then discarded. Others have pointed out that intensive use, either in terms of force or repetition, is required to significantly influence the cortical surface of the bone (Daujeard et al. 2014). Moreover, Armand and Delagnes (1998) have recorded that not all experimental retouchers have macroscopically recognizable use traces. Contrary to that, Mallye et al. (2012) have reported all of the experimental retouchers as having use traces, regardless of their freshness or number of conducted strikes. Recently, Doyon et al. (2018) have classified bone retouchers as either expedient or part of a curated tool-kit, based on the absence or presence of shaping of the artefact morphology, respectively.

The presence of intensively utilized retouchers and multiple use-areas on the same pieces seems to point to the possibility that the retouchers from Veternica are not only expedient tools but that at least some of them were part of a curated tool-kit. Multiple use-areas on a piece point to reuse of a retoucher after the previous use-area became ineffective due to extensive damage (Mozota 2015; Schwab 2002). Furthermore, prolonged use is supported by the presence of several grouped clusters of traces with different characteristics and orientation in the same use-areas, which suggests that the retouchers were used in separate retouching activities. Although there is some indication of recycling the retouchers in a different state of freshness, it is not certain that they were recycled.

The Vindija assemblage, however, seems to represent expedient tools. Most pieces only have a single use-area, with traces which are usually shallow, not numerous and not superimposed. The only exception comes from the lowest layer in the assemblage (Vi 79 G/d; Fig. 5e), but it is not comparable to intensively used pieces from Veternica. The few pieces in

Figure 8. Retoucher VTR 28/R (Ursus spelaeus, femur) with two use-areas on opposite sides. a) A single use-area with two distinct clusters of traces pointing to two separate retouching activities. b) Continuous cut marks indicating meat removal. Scale = 5 cm (Photographed and edited by M. Banda).

each specific layer also suggest that these tools do not have a predominant role in the retouching activities of stone tools within those industries.

The question of how the retouchers were used is present since the earliest studies of them. Broadly speaking, they have been considered as percussion, pressure or anvil retouchers (see Patou-Mathis, Schwab 2002 and Mozota 2018 for a historical perspective). Contemporary researchers generally consider them as percussion retouchers, especially when discussing Middle Palaeolithic artefacts (see Mozota 2015). Recent experiments conducted by Mozota (2013; 2018) have focused on the qualitative difference of use traces between pressure and percussion retouchers. His findings have suggested that percussion, when compared to pressure retouching, leaves longer linear scores, less scaling of the use-areas and a higher amount of pits. Furthermore, it was also stated that percussion retouching generally creates oval use-areas that are longitudinal with the long axis of the bone blank and that pressure retouching leaves circular use-areas (Mozota 2015). Doyon et al. (2019) have reported on the presence of pressure retouchers from Lingjing in China, which they distinguish based on the lithic retouch flakes and distinct clustering of the use traces on the retouchers themselves.

When it comes to modes in which retouchers from Northwestern Croatian sites were used, the Veternica assemblage is consistent with the use as percussion retouchers. The use traces in this assemblage usually present variability of orientation, indicating changes in the position of the retoucher and/or lithic edge during the retouching activity, something that is consistent with percussion. Furthermore, the use traces in individual use-areas also display variability with regards to their shape and surface texture. On the other hand, one of us (I.K.) has previously (Karavanić, Šokec 2003), based on experimental results, suggested both active pressure and percussion flaking as the possible modes of use of the Vindija retouchers. Indeed, in this retoucher assemblage, the characteristics of use traces are more homogenous on individual pieces than in Veternica. Likewise, retouchers from Vindija are generally less utilized and in most cases present shallow traces that are concentrated but do not overlap and form depressions. Additionally, while more than half of the use-areas from Veternica are oval and longitudinal with the long axis of the bone blank, the retoucher use-areas from Vindija are divided in half by oval and subcircular shapes. However, we would currently advise caution upon determining pressure retouchers in Vindija. It is possible that a lower reliance on this type of tool in Vindija, i.e. a more expedient character of the technology influenced a shorter use period of the pieces and thus the noted differences in the use damage of both sites.

Another question concerns the recognition of lithic raw-materials retouched by these tools. In comparative experimental studies, retouchers have been used in retouching flint and quartzite (Karavanić, Šokec 2003; Mallye et al. 2012; Mozota 2013; Rosell et al. 2011) and flint and quartz (Mateo-Lomba et al. 2019). Because the dominant raw-materials in both Veternica and Vindija are quartz and flint, we have considered the findings of Mateo-Lomba et al. (2019) as the most pertinent for our study. However, they have not commented on any qualitative difference of the same types of use traces when different raw-materials are retouched but have found that there is a different quantitative representation of various use trace types. Unfortunately, because of the common occurrence of superimposed traces, we have found quantification to be difficult and thus unreliable for our assessment of which raw materials were retouched in Veternica. Also, as lithic tools from Veternica are made from a relatively heterogeneous raw material composition (Banda, Karavanić 2019), we are reluctant to use binary qualities of the use traces to differentiate the raw materials of the retouched tools (e.g. Mallye et al. 2012). This is further motivated by a noticeable overlap of use traces of different characteristics on the same use-areas. The only direct evidence of retouching a certain raw material comes from a possible quartz chip imbedded into a linear mark on VTR 17/R (Fig. 9b), but this must be further confirmed by EDX spectroscopy (see Bello et al. 2013). For Vindija, we can only assume that the retouchers were used on quartz and chert, the most common raw materials at the site (Blaser et al. 2002).

Figure 9. Retoucher VTR 17/R (*Cervus elaphus*, tibia) with a single use-area and scraping marks. a) Detail of the use area. b) Detail of a possible quartz chip imbedded in a linear mark. Scale = 5 cm (Photographed and edited by M. Banda).

Whether the presence of a single Upper Palaeolithic retoucher from Vindija represents continuity with the Mousterian in this region is currently difficult to confirm. Despite the similarity in dimensions with the Middle Palaeolithic retouchers from the lower layers, there is no unambiguous presence of retouchers in the upper layers of complex G, i.e. layers G2 and G1, the latter of which is the most recent level with Neanderthal remains and Mousterian lithics (Karavanić, Smith 2013). Coupled with the conclusion from the most recent dating results (Devièse et al. 2017), the current data leaves open the question of whether the retoucher technology was transferred from Neanderthals to anatomically modern humans in this region or more likely represents a reintroduction by modern humans after the disappearance of Neanderthals.

Finally, the above results point to significant differences between the Veternica and Vindija assemblages. These differences could point to diachronic changes in bone retoucher technology during MIS 4-3 in the regional setting of Northwestern Croatia. Interestingly, it seems this technology is also rare during the Last Interglacial (MIS 5e), as there are no reported retouchers from layer J in Veternica (Malez 1981) and there is only one retoucher from a Neanderthal bone in Krapina (Patou-Mathis 1997) and a couple of ambiguous retouchers from beaver (*Meles meles*) bones from the same site (Miracle 2007). The differences between Veternica and Vindija probably do not coincide with substantial changes in subsistence strategies, given that a similar faunal spectrum is present in both site contexts. Thus, it seems that certain societal practices and choices played a much more crucial role. To that one might add that lithic technology could be a driving factor in retoucher variability, in that the shapes and sizes of lithic supports in need of retouch determine the required morphological parameters of bone blanks and that the desired shape and extent of retouch determines the use mode of retouchers and its intensity.

6. Conclusion

The study of bone retouchers in Veternica and Vindija expands our knowledge on this technology during the Middle Palaeolithic and Early Upper Palaeolithic in South-Central Europe. Significant differences between the sites in terms of size, morphometrical uniformity, faunal selection, preparation and length and intensity of use may point to a different degree of importance of the bone retoucher technology in the two chronologically different contexts. As only two sites are taken into consideration, whether this difference represents a diachronic and regional change requires further data and future discoveries. All in all, bone retoucher technology links subsistence strategies to stone tool technology and the character of the lithic industry probably influenced the requirements and practices related to the retouchers themselves.

Despite our efforts, more can be done in the study of retouchers from Veternica and Vindija, and certain questions should in the future be addressed with the support of experimental studies and other methods.

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Technological features in the late Middle Paleolithic of the Côte Chalonnaise (Burgundy, France)

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Abstract

While former typological studies drew a heterogeneous image for the Middle Paleolithic record of the Côte Chalonnaise region in southern Burgundy (France), recent research, re-evaluation of old collections, and comparative analysis from several Middle Paleolithic sites in the area were able to highlight a homogeneous pattern of litho-technological features. The assemblages have been evaluated according to their general composition, the identifiable reduction concepts as well as their bifacial component. The concurrent results allow us to hypothesize a regional site cluster based on Levallois reduction and a common occurrence of Keilmesser (with tranchet blow). In chronological terms, dating attempts on stratified material from Grotte de la Verpillière I and II suggest a late Middle Paleolithic age of the sites around the end of MIS 4 or the beginning of MIS 3.

Kivonat

A Côte Chalonnaise régió (Burgundia, Franciaország) késő középső paleolitikumának technológiai jellemzői

A korábbi tipológiai vizsgálatok heterogén képet vázoltak fel a dél-burgundiai Côte Chalonnaise régió (Franciaország) középső paleolit leletanyagáról. Az újabb kutatások azonban a kőpattintási technológiai jellemzők homogenitását mutatták ki korábbi gyűjtemények revíziója, illetve középső paleolit lelőhelyek összehasonlító vizsgálata segítségével. A leletanyagokat általános összetételük, azonosított magkőredukciós koncepcióik, illetve a bifaciális darabok alapján értékelték. Az egybehangzó eredmények nyomán, a Levallois redukció és a tranchet blow technikával kialakított, Keilmesser típusú eszközök jelenléte alapján egy regionális megtelepedési csoportot feltételezünk. Az időrendet illetően, a Grotte de la Verpillière I és II rétegzett lelőhelyek datálási kísérletei a késői középső paleolitikumra, a MIS 4 végére vagy a MIS 3 kezdetére datálják ezt a csoportot.

Keywords *Late Middle Paleolithic, eastern France, Levallois, bifacial elements, Keilmesser*

Kulcsszavak *késő középső paleolitikum, Kelet-Franciaország, Levallois, bifaciális eszközök, Keilmesser*

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1. Introduction

The Paleolithic record in southern Burgundy is very dense, particularly for the Middle Paleolithic period. According to the DRAC's database (Fr. Directions régionales des affaires culturelles, cultural heritage of Bourgogne-Franche-Comté), there are 212 records in southern Burgundy (i.e. Saône-et-Loire department), including large open-air sites but also caves and rock shelters or dispersed single find spots (Fig. 1).

Paleolithic research has a long-lasting tradition in the region since the first excavations in the 1860s at sites like Solutré (Arcelin 1872), the Grotte de Germolles or de la Verpillière (Méray 1869) (now Grotte de la Verpillière I) or at Grotte de la Mère Grand (Combier 1956-1957). However, except for a few attempts (eg. Farizy 1995b; Gouédo 1999), no comprehensive comparative analysis of the assemblages took place. This absence may result from assemblages that are often decontextualized (e.g., lacking dates, sequence, or spatial data, see Frick 2016b; or Mackay et al. 2014), deriving either from old excavations with little or no recorded stratigraphical information or from surface collections (assigned vaugely to single locations without exact position data).

The lithic assemblage from stratified material from Grotte de la Verpillière II at Germolles, discovered in 2006 and excavated from 2006 to 2017, and its subsequent analysis (Frick 2016a; 2016b; Frick, Floss 2017), now provide a strong basis for further investigation and the assemblage serves as reference assemblage for the region.

The detailed analysis of the Verpillière II material, especially concerning the rich assemblage of horizon 3 (GH 3), provides first insights into a stratified Middle Paleolithic assemblage under modern excavation and research conditions for the southern Burgundy region in decades and reveals important data in terms of assemblage composition, site organization or litho-technological characteristics. Radiometric dating (IRSL, AMS 14C, and ESR/U-Th) places the GH 3 material from Verpillière II into a late Middle Paleolithic context between the end of MIS 4 and the beginning of MIS 3 (Heckel et al. 2016; Richard et al. 2016; Zöller, Schmidt 2016). In addition to excavation work, an intense re-examination of the available collections of major neighboring sites was and is still being conducted. This now allows a comparative view of the region's Middle Paleolithic record.

In contrast to previous work, which was based on typological criteria and thus suggested heterogeneous patterns of assignment, a fairly homogeneous picture of the assemblages can be drawn when technological criteria are used.

The recently re-investigated sites, including the Grottes de la Verpillière I and II in Germolles, La Roche in Saint-Martin-sous-Montaigu, Rue Cataux in Chenôves and La Clôsure in Bissy-sur-Fley will now be briefly introduced (Fig. 1). Then, an overview of our quantitative and technological comparative research, which favors the hypothesis of a linked Middle Paleolithic regional site cluster, is given.

2. Presentation of the sites

The following data of the assemblages are mainly based on our research (analysis of recent excavations and re-examination of old collections). To extract the Middle Paleolithic component from decontextualized assemblages, techno-typological criteria have been applied. If not indicated otherwise, we refer to material stored in the Musée Denon at Chalon-sur-Saône. In some cases, material from private collections has also been included in the analysis. In addition, a brief presentation of the sites and their Middle Paleolithic component concentrates on technologically and typologically relevant pieces, i.e., bifacially worked artifacts, and those revealing reduction concepts.

2.1. Grotte de la Verpillière I

The Grotte de la Verpillière I site in Germolles was first excavated in 1868 (Méray 1869; 1876). Since then, a multitude of test-pits and excavations were conducted at the site during the 19th and 20th centuries (Dutkiewicz 2011; Dutkiewicz, Floss 2015). The most recent activities have been undertaken between 2006 and 2016 (e.g., Floss 2007; Floss et al. 2013b; Floss et al. 2016). Nowadays, the site appears as a rock shelter with huge collapsed blocks in the entrance, which collapsed after the Paleolithic settlement. In addition to the well-known Middle Paleolithic lithic assemblage component (Desbrosse et al. 1976; Frick 2010; Frick, Floss 2017; Frick et al. 2017, 2018), the site yielded artifacts from the Châtelperronian (Floss et al. 2017; Würschem 2015), the Aurignacian (Floss et al. 2015) and, to a lesser extent, the Gravettian (Floss et al. 2013a), the Neolithic and Medieval times. The total lithic assemblage of the site is well over 20,000 lithics.

The assemblage to be assigned to the Middle Paleolithic has not yet been conclusively analyzed. However, we have reliable data on the assemblages from the old excavations below the rock shelter and on the forecourt (Dutkiewicz 2011; Frick 2010) and the GH 16 below the rock shelter (Litzenberg 2015). Within the lithic industry, which is dominated by Levallois reduction, we note an important number of bifacial objects like *Keilmesser* (hereafter: Keilmesser) with tranchet blow and corresponding blanks and a huge variety of other bifacial forms (Frick, Floss 2017). If the bifacial pieces of all known activities are combined, we arrive at a stock of n=121 pieces. Among them, there are n=13 asymmetric bifaces with small back, n=2 bifacially worked objects, n=10 double symmetric bifaces, n=5 small bifaces (*Fäustel*), n=16 bifacial Keilmesser without tranchet blow, n=40 bifacial Keilmesser with tranchet blow, as well as n=3 bifacial Keilmesser with a failed tranchet blow, one bifacial scraper with a tranchet blow and n=31 preforms of bifacial objects.

Blank production is dominated by Levallois, followed by opportunistic blank production, as will become evident for the surrounding sites, too. Other elaborate reduction concepts, such as Discoidal or Quina, are massively underrepresented. The tools are characterized by different side scraper variants, which are produced on different kinds of blanks (cortical, configuration, and target blanks).

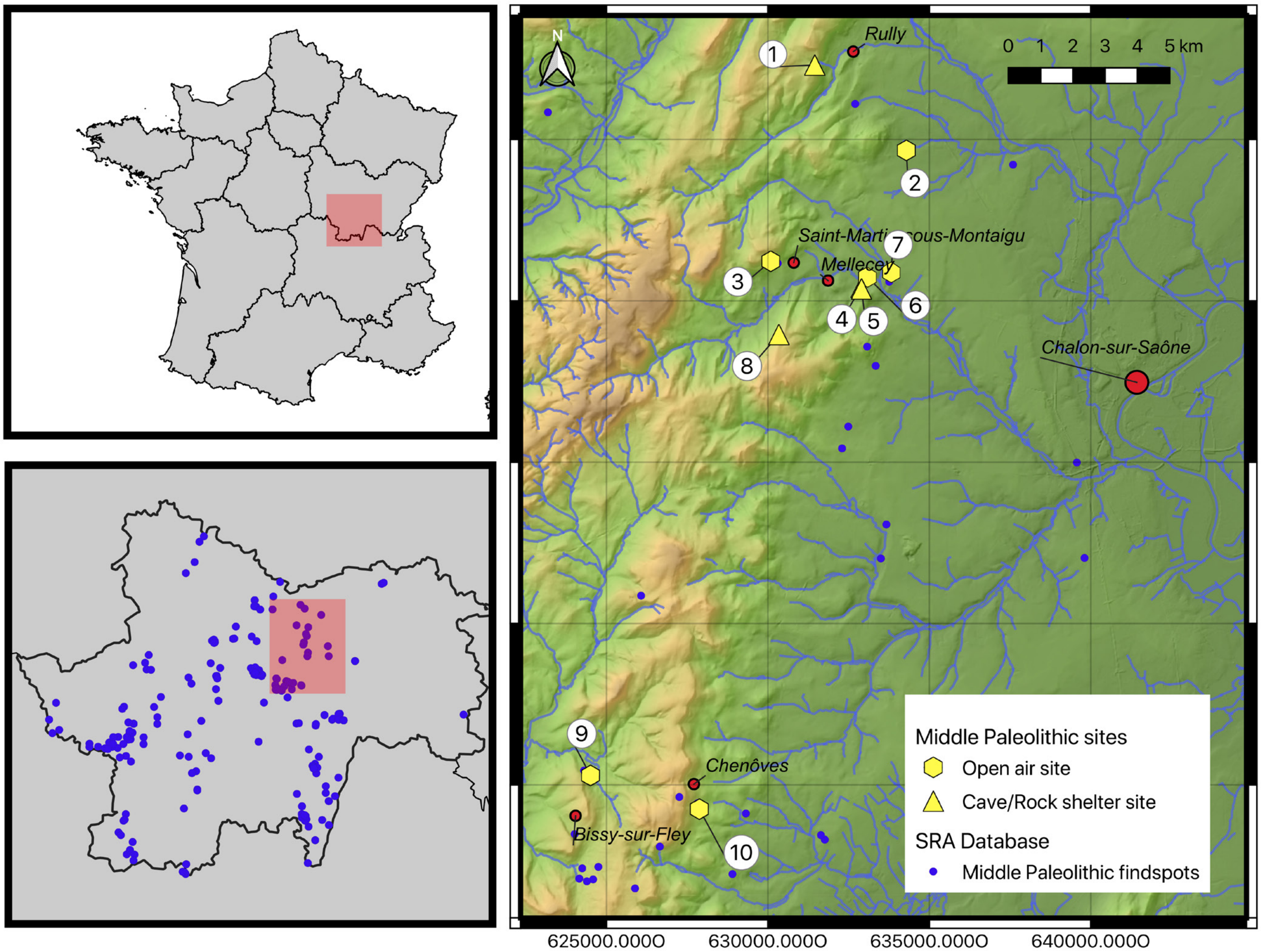

Figure 1. Upper left: Schematic map of France with location of the Saône-et-Loire department (red rectangle). Lower left: Saône-et-Loire department with its Middle Paleolithic record (blue dots) according to the DRAC-Bourgogne-Franche-Comté database and location of the Côte Chalonnaise research area (red rectangle). Right: Map of the Côte Chalonnaise research area with Middle Paleolithic record (blue dots) according to DRAC-Bourgogne-Franche-Comté database and important sites mentioned in the text: 1) Grotte de la Mère Grand in Rully; 2) Les Griffières in Fontaines; 3) La Roche in Saint-Martin-sous-Montaigu; 4) Grotte de la Verpillière I in Germolles; 5) Grotte de la Verpillière II in Germolles; 6) Saint-Sulpice in Germolles; 7) En Roche in Germolles; 8) Grotte des Teux-Blancs in Saint-Denis-de-Vaux; 9) La Clôsure in Bissy-sur-Fley; 10) La Rue Cataux in Chenôves. (Mapping: Herkert, topographic data: IGN France)

2.2. Grotte de la Verpillière II

The Grotte de la Verpillière II, discovered in 2006, about 50 m south of Grotte de la Verpillière I, was excavated by Floss between 2006 and 2017 (eg. Floss 2008; 2009a; 2009b; Floss et al. 2013c; Floss et al. 2016). So far, it is the only multilayered Middle Paleolithic site excavated under modern conditions in southern Burgundy. The excavated material is not as extensive as from the neighboring Grotte de la Verpillière I. However, the material from GH 3, 4x, and 4 was within an intact stratigraphy and allows correlations. Today, the site consists of a cave tunnel and a corresponding collapsed rock shelter. The excavation took place at the entrance of the cave tunnel. At the end of the excavation, GH 3 yielded *n*=4,247 lithics, GH 4x consists of *n*=27 lithics and GH 4 yielded *n*=413 lithic objects.

All three layers are dominated by Levallois reduction and yielded a huge variety of bifacial objects (including Keilmesser with tranchet blow, but there were no double symmetrical bifaces). From GH3, there are *n*=4 asymmetrical bifaces with a restricted back, *n*=5 bifacially worked objects, *n*=3 small bifaces (*Fäustel*), *n*=4 Keilmesser without tranchet blow, *n*=3 Keilmesser with tranchet blow, *n*=11 preforms of bifacial objects, and *n*=9 blanks of tranchet blow.

Other blank reduction concepts appear only in minor quantities, but there is a significant amount of opportunistic reduction. Ventral reduction on blanks was also used for Levallois core configuration. Blades are only incidentally present. Tools were mainly made on blanks (cortical, configuration, and target blanks), but cores were also retouched to tools. All three GHs yielded *n*=483 retouched objects, including side scrapers, objects with simple retouch, objects with multiple retouched parts or retouched points, whereas *n*=111 retouched objects are connected to Levallois reduction. On the one hand, *n*=73 of the retouched pieces are tool tips and clearly show that these pieces were used at this place and are broken. On the other hand, there are hafting rests, mostly basal fragments that were laterally retouched or show small fractures and most likely were sitting in the haft and were replaced on-site (retooling). Bulb reduction of tools on blanks is a common method for flattening and easier hafting of the pieces. *Groszaki*, dorsal reduction, and Janus flakes are present on a small scale. There are hardly any "Upper Paleolithic" tool types. The chronometric data from IRSL, ESR/U-Th and AMS 14C (Heckel et al. 2016; Richard et al. 2016; Zöller, Schmidt 2016) available so far indicate a late Middle Paleolithic context at the end of MIS 4 or beginning MIS 3 (Frick 2016b; Frick, Floss 2017).

2.3. La Roche

The La Roche open-air site appears in the literature with various names, e.g., *Vignes de la Roche*, *Vignes du Gros Theu*, or *Les vignes blanches* (Armand-Calliat 1928; Combier 1962). These names refer to the prominent rock above the vineyards where the site is located. In 1896, the first surface collections were made by Pierre (Jacquin 1896). However, it was not until 1926 that Lènez carried out systematic surveys and a test-pit excavation (Guillard 1947; Lènez 1926). From the 1950s onwards, Gros conducted numerous surveys (Gros 1964; Gros, Gros 2005). Since 2002, Donguy is conducting surveys and in the years 2009 and 2014, surveys were carried out by Floss's working group (Herkert 2014). There is no information of any further excavation at this site yet. The collection of Lènez was the subject of a master's thesis (Pouliquen 1982; 1983). All the site's known material is currently being analyzed and processed by Herkert (2020). To date, after intensive reevaluation of the known collections (Musée Denon and private ones), we know of about 1,800 lithic artifacts that can be associated with the Middle Paleolithic, wherein the Denon material comprises *n*=1,250 pieces. Of the *n*=66 cores from all the material, *n*=62 have been reduced according to the Levallois concept. So far, the Denon material alone provides a huge variety of *n*=145 bifacial objects, including *n*=93 bifaces as well as bifacial points and various bifacially worked objects, one of which shows a tranchet blow modification, *n*=10 Keilmesser without tranchet blow, *n*=9 Keilmesser with tranchet blow, *n*=21 bifacial side-scrapers, six of which also show a tranchet blow, *n*=3 bifacial pieces with failed tranchet blow, *n*=9 preforms and *n*=6 blanks of tranchet blow.

As over 600 pieces from the analyzed material can be associated with Levallois reduction, Levallois appears to be the main reduction concept, while the degree of other reduction concepts is quite low. The ventral reduction on blanks for the configuration of Levallois cores is visible. There is no noticeable blank selection for the manufacture of tools. Tools are made on a huge variety of blank types (cortical, configuration, and target blanks). Also, bulb reduction and other hafting evidence appear on tools.

2.4. Rue Cataux

The site was discovered by E. Guillard in 1934 near Chenôves, but he only published it 26 years later (Guillard 1960). Gros collected further surface finds in the 1950s and 1960s (Gros, Gros 2005). The spelling of the site varies between *Cataux*, *Cateux*, and *Catoux*, and sometimes even *station du Carrouge* is possible. In 1962, in a geological section caused by road construction, Gros recognized a clay layer separating two layers of pebbles containing finds (Gros, Gros 2005). But, as far as we know, no further excavations were carried out. Over 450 finds from the three surface collections (coll. Guillard, Salis, and Gros) of the site in Musée Denon can be assigned to the Middle Paleolithic.

The bifacial objects include *n*=7 Keilmesser, two of which were modified with a tranchet blow and two others show a failed attempt of a tranchet blow modification. Furthermore, there are *n*=20 bifacial pieces, at least one of which also shows a tranchet blow. In addition, *n*=1 blank of tranchet blow is present.

The assemblage from Rue Cataux fits into the morphological and technological habitus of the previous examples. In addition to Keilmesser with tranchet blow, high variability of the bifacial objects can also be observed. Levallois reduction occupies a leading position over other reduction concepts. Also, in these assemblages, blades occur only incidentally. Tools are made on cortical, configuration, and target blanks and are dominated by side scrapers, but points (retouched or not) are also important.

2.5. La Clôsure

The open-air site of La Clôsure (also La Clauzure or la Closure) near Bissy-sur-Fley was discovered by Méray in the 1870s (Parriat 1956). Its topological setting resembles that of La Roche in Saint-Martin-sous-Montaigu. Several collections exist from the site. The finds stored in the Musée Denon presumably come from various collection activities (based on what is written on the boxes), but it is not possible to determine exactly who collected them. In 1954-1955, Parriat and Pesce rediscovered the site, as Méray did not publish anything about it (Parriat 1956). Since the 1950s, Daudey has been collecting annually at the site and reported about it briefly (Daudey, Bonnot 1970). So far only the Daudey collection can be assigned to one collector. Recently, these finds were the subject of a bachelor's thesis (Schiller 2018). Two test pit surveys are known. The first was conducted by Blaise in 1990 and remains unpublished (to our knowledge). Farizy conducted the second survey in 1994 (Farizy 1995a). There, 11 small test pits were made (each of 1 to 2 m2) evaluating a find layer on marl (around 60 to 80 cm under the field surface). Unfortunately, the archeological artifacts are affected by solifluction and the artifacts rarely lay flat on the ground. Desbrosse and Texier (1973a) report that they are aware of 10 prospectors of the site. In total, they were able to analyze *n*=2,398 pieces from the site (of these, *n*=756 were tools and *n*=188 were cores). A review of the finds from Musée Denon revealed *n*=4,040 lithic artifacts assigned to La Clôsure in total. According to the latest review in March 2019, a total of over 900 finds can be assigned to the Middle Paleolithic.

The assemblage of La Clôsure differs only slightly from the previous ones. Again, there is a great variety of bifacial objects in addition to the pieces with tranchet blow. So far, the *n*=48 bifacial objects include 30 bifaces and bifacially worked objects, including one Micoquian biface. Furthermore, there are n=18 Keilmesser, three of which show a tranchet blow modification, and n=3 blanks of tranchet blow. Here, too, the Levallois concept for blank production is dominant, accompanied by ventral reduction. Other reduction concepts are present to a lesser extent, but the use of the discoidal concept is evidenced by 11 cores, in contrast to 85 Levallois cores. The tools are dominated by side scrapers. Within this assemblage, the high occurrence of edge-blanks (*éclats débordant* and *lame débordant*) is significant.

The widely spaced test pits by Farizy suggested that a new survey campaign (scientific surveys with georadar, etc., coring, and selected test pits) could potentially provide further results and material for radiometric dating.

2.6. Further sites

The previously mentioned sites seem most important in terms of assemblage quantity. Nevertheless, there are further sites in their vicinity: The Grotte de la Mère Grand in Rully, for example, first excavated in the 1860s and then again in the 1950s (Combier 1959; Combier, Ayroles 1976; Herkert 2020) yielded a small but Levallois based industry with a fairly large amount of Levallois blades. Scrapers dominate the tool spectrum, but there are some small bifacial pieces as well.

The open-air site of En Roche in Germolles is known for its "Aurignacoid" Upper Paleolithic but also comprises a Middle Paleolithic component (Gros, Gros 2005; Guillard 1954; Herkert 2017; 2020; Herkert, Floss 2019; Herkert et al. 2016). Within the collections, the Levallois affinities are evident, and the tool spectrum is dominated by different types of scrapers. Despite a low number of quite unspecific bifacial elements, recently conducted surveys could identify first indications for the execution of tranchet blows on site. A small test-pit excavation in 2017 and 2018 confirmed the Middle Paleolithic presence in stratigraphical position (Herkert, Floss 2019). Gros and Gros (2005) indicate the presence of a non-specific Mousterian for En Roche and stress the presence of a Levallois component and Quina type scrapers.

Finally, there is the open-air site of Saint-Sulpice in Germolles. Situated on a flint outcrop, the site appears to have been a workshop. Tools are quite rare, but the numerous cores and blanks reveal a very high component of Levallois production with a particular focus on elongated blanks (Colbère 1979; Herkert 2020). While there certainly are other smaller assemblages in the Côte Chalonnaise area, for further considerations we would like to limit ourselves to those mentioned above.

3. A comparative view

Since the first use of the terms Mousterian (âge du Moustier, Mortillet 1869; Moustiérien, Mortillet 1873), Micoquian (Hauser 1915, 1916) or Middle Paleolithic (Mittelpaläolithikum, Rademacher 1911; middle paleolithic, Sollas 1911), it has been discussed whether different units can be separated within these. For Western Europe, scholars defined a vast variety of cultures, facies, technocomplexes, or time-space-units, based on the approach of the research object (index fossils, qualitative or quantitative typology, technological features, etc.). The allocations, which were initially quite subjective (presence of index fossils or types), have been replaced over time by more objective, verifiable classifications (presence of technological features characterized by strictly defined criteria).

Since the 1950s, a high degree of diversification was noticed (Bordes 1961; 1968; Bordes, Bourgon 1951; Bosinski 1967; Grahmann, Müller-Beck 1967; Müller-Beck 1956) especially for the recent phase of the Middle Paleolithic (today MIS 4 and 3). The ascriptions were modified over time by changing the criteria of locally separated and technologically more or less divergent entities (Fig. 2).

As Figure 3 reveals, the Côte Chalonnaise region in Eastern France is actually situated at a marginal position in relation to the extension of several late Middle Paleolithic complexes (e.g. *Denticulés*, *Charentien à influence micoquienne*, Mousterian with bifacial tools, Mousterian of Micoquian influence, *Moustérien de tradition acheuléenne*).

When we look at the different chronological attributions that have been assigned to the different assemblages in the Côte Chalonnaise in 150 years of regional research history, they have been attributed through typological assessments and different emphasis of different scholars to a large variety of different entities (Tab. 1). There are many varying correspondences between the neighboring entities, thus suggesting a very heterogeneous pattern for the region's occupation during the late Middle Paleolithic.

Throughout the history of research, the Middle Paleolithic at Grotte de la Verpillière I has been assigned to a multitude of different techno complexes, such as MTA (Campy et al. 1989; Combier 1959; Desbrosse et al. 1976; Gros, Gros 2005), Charentian Mousterian (Desbrosse, Texier 1973b), Charentien with Micoquian influence (Farizy 1995b), Micoquian (Uthmeier 2004), Mousterian with Micoque-Option (Richter 1997), *Keilmessergruppen* (Jöris 2003; hereafter: Keilmessergruppen) or Mousterian with bifacial tools (Ruebens 2012), mostly in reference to the presence of different forms of handaxes and other bifacial pieces.

For the material of La Roche, Pouliquen (1982; 1983) discussed an MTA affiliation because of the presence of some cordiform bifaces but prefers to see a local variety of the Rhodanian Quina Mousterian due to scrapers with bifacial retouch, convergent scrapers, and other scrapers showing a Quina type retouch. Combier (1962) and Gros (1964) went into a similar direction by defining a Quina type Mousterian and stressing the presence of Limaces, alongside the scrapers with Quine-like retouch.

Former research placed the material from Rue Cataux into an MTA context, because of the presence of cordiform handaxes (Combier 1959). For Guillard (1960), however, the predominance of typological Levallois elements made it to a Mousterian of Levallois facies.

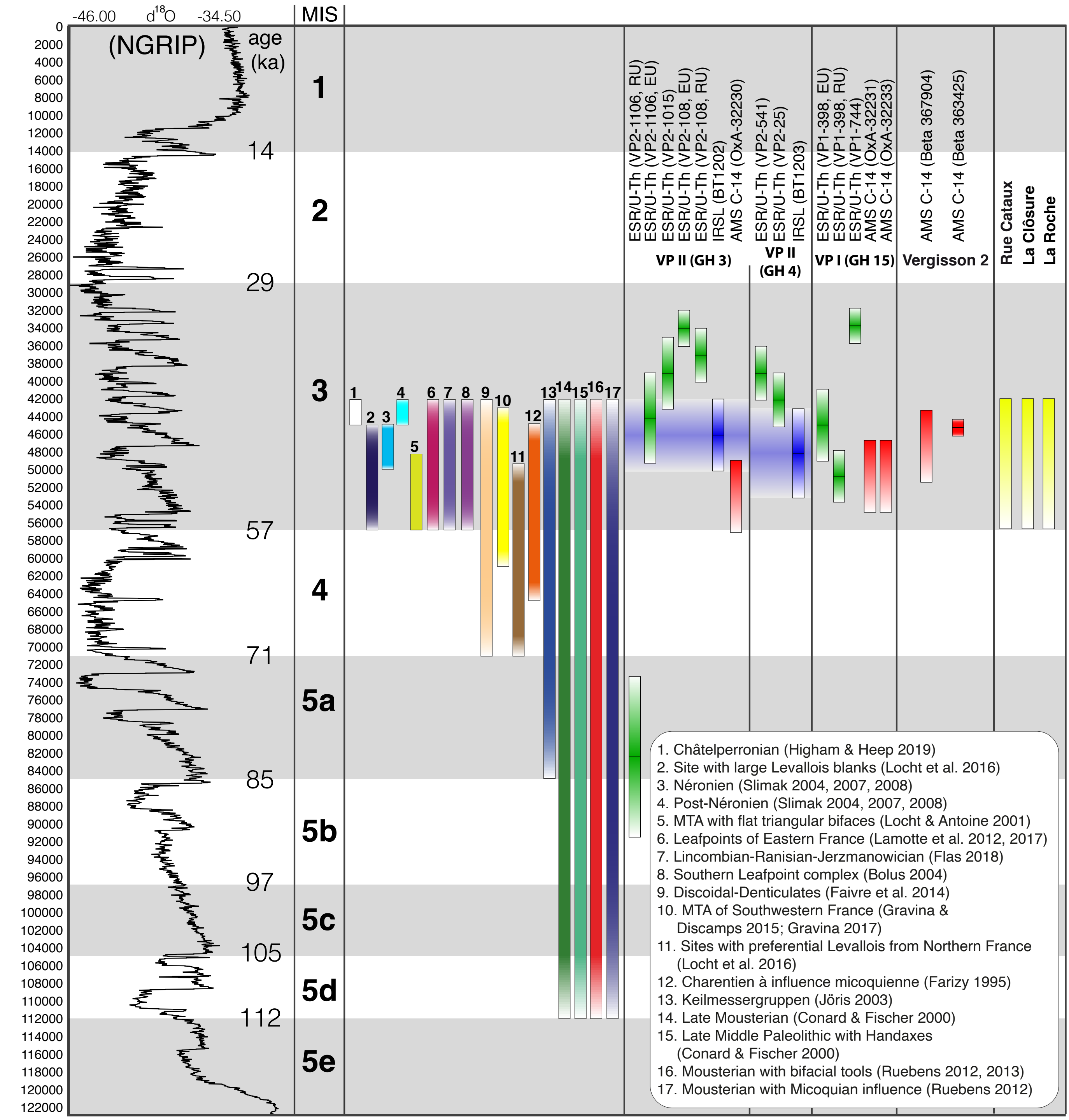

Figure 2. Chronological setting of late Middle Paleolithic entities and radiometric datings from Saône-et-Loire. The chronological setting of late Middle Paleolithic entities, based on Koehler (2009) and updated using the information provided by the following authors: Conard, Fischer 2000; Blaser, Chaussé 2016; Bolus 2004; Castel et al. 2017; Cliquet 2001; 2013; Faivre et al. 2014; Farizy 1995b; Flas 2018; Gouédo 1999; Gravina 2017; Gravina, Discamps 2015; Higham, Heep 2019; Jöris 2003; Koehler 2009; 2011; Lamotte et al. 2012; 2017; Locht, Antoine 2001; Locht et al. 2016; Ruebens 2012; 2013; Slimak 2004; 2007; 2008 and Soressi, Roussel 2014. For the radiometric data from Saône-et-Loire see: Frick 2016b; Heckel et al. 2016; Richard et al. 2016; Zöller, Schmidt 2016 and personal communication S. Quertelet and H. Floss. For Rue Cataux, La Clôsure and La Roche these are chronological assumptions. NGRIP record according to North Greenland Ice Core Project members (2004), Marine Isotope Stages according to Railsback et al. (2015). The chronological range relies on the literature cited above without strong stratigraphical correlation (especially for southwestern France, for example, the MTA (9) always predates the Chatelperronian (1), while there are sometimes other entities in between, see, e.g., Jaubert (2014)). (Composition: J. A. Frick)

At La Clôsure, Gros and Gros (2005) identified a simple Mousterian with bifaces. For Desbrosse and Texier (1973a) and Parriat (1956), the material showed affinities to a Charentien of Ferrassie type because of its predominance of Levallois elements and a high occurrence of scrapers and different bifacial forms. The presence of bifaces within the assemblage led Farizy (1995a) to a Charentian with Micoquian influence attribution.

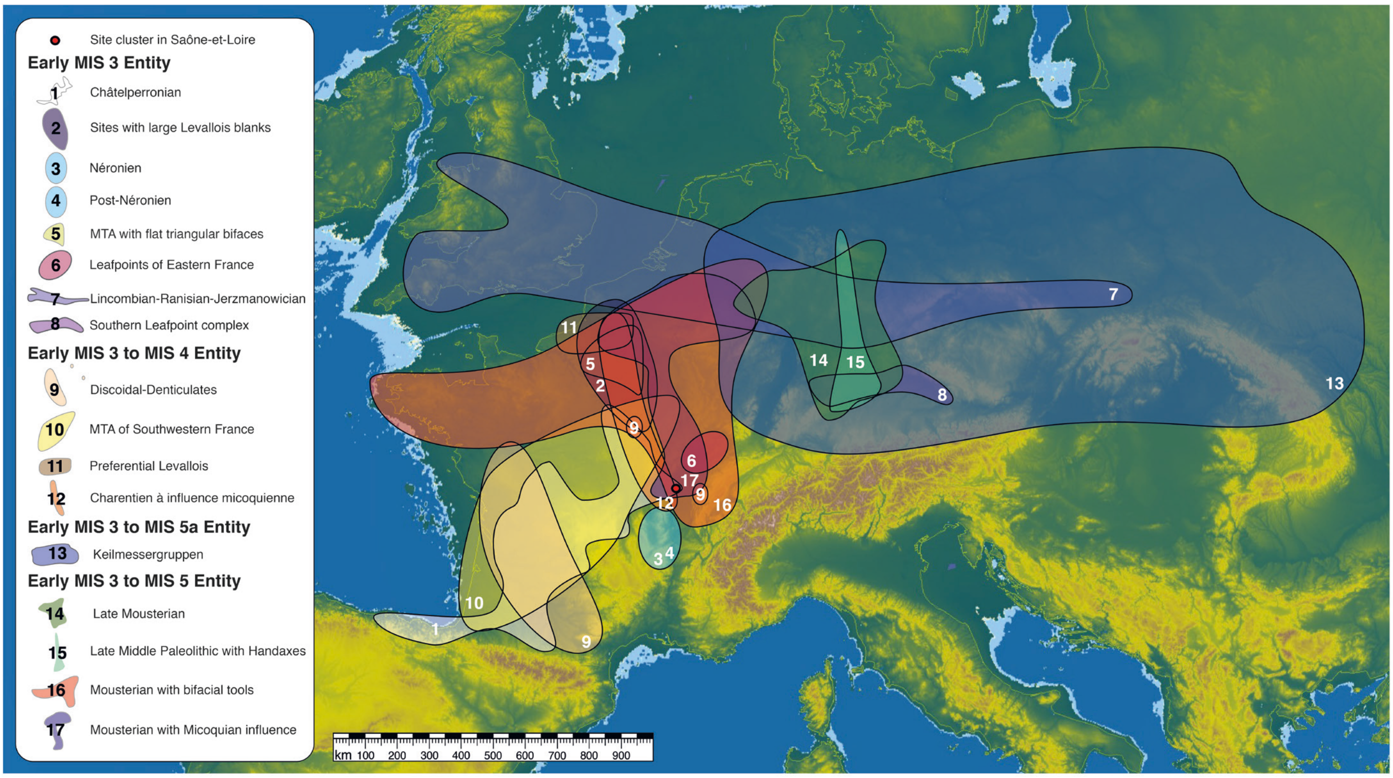

Figure 3. Spatial distribution of late Middle Paleolithic entities, based on Koehler (2009) and updated using the information provided by the following authors: Conard, Fischer 2000; Blaser, Chaussé 2016; Bolus 2004; Castel et al. 2017; Cliquet 2001; 2013; Faivre et al. 2014; Farizy 1995b; Flas 2018; Gouédo 1999; Gravina 2017; Gravina, Discamps 2015; Higham, Heep 2019; Jöris 2003; Koehler 2009; 2011; Lamotte et al. 2012; 2017; Locht, Antoine 2001; Locht et al. 2016; Ruebens 2012; 2013; Slimak 2004; 2007; 2008 and Soressi, Roussel 2014. The Côte Chalonnaise region is indicated (red dot), showing its marginal position within the different entities. The map is not exhaustive and only comprises entities defined for the early MIS 3 in central and western Europe. (Composition: J. A. Frick & K. Herkert; base map: temporalmapping.org layer at GoogleEarthPro, available via https://web.archive.org/web/20130723034936/http://www.temporalmapping.org/)

Based on sedimentological and typological issues (the presence of scrapers and bifaces and the absence of backed knives or Quina-type retouch), the assemblage of Mère Grand has previously been assigned to a final Micoquian (Combier 1959; Combier, Ayroles 1976). From a sedimentological point of view, Combier (1956-1957) compared the dominant find-layer with Vergisson II in the Mâconnais region, although he concluded a typical Quina industry there (Combier 2001).

For En Roche, the Middle Paleolithic component has been regarded as a simple Mousterian with Levallois elements. Additionally, the presence of Quina-like scrapers has been stressed (Gros, Gros 2005). Due to the observations from Saint-Sulpice, the predominance of the Levallois concept and the high occurrence of blades, Colbère (1979) classified the site as Mousterian of Levallois facies. The divergent chronological attributions for the Middle Paleolithic in the Côte Chalonnaise are summarized in Table 1.

In contrast to this and despite the contextual bias for some of the assemblages, our ongoing research was able to reveal several technological analogies between the assemblages, suggesting a much more homogeneous pattern than previously identified. Although the general quantitative composition of the five main sites already shows similarities (Fig. 4a & 4b), especially between La Clôsure and Rue Cataux, and, to a certain extent, also La Roche, there are differences as well. The differences concern the two cave sites, while the Verpillière II assemblage, deriving from modern excavation conditions, appears the most diverse. Nevertheless, based on characteristics identified by Frick (2016) in the analysis of the assemblages of Grotte de la Verpillière II, most of the following key features can also be observed within the other assemblages (Tab. 2):

- Presence of Keilmesser with and without tranchet blow
- Morphological diversity of bifacial objects
- Prevalent use of the Levallois reduction concept
- Almost no evidence of other elaborated reduction concepts
- Evidence of opportunistic reduction
- Ventral reduction on blanks used for the configuration of Levallois cores
- Incidental presence of blades
- Tools on blanks and cores
- Tools from cortical, configuration and target blanks
- Bulb reduction on tools
- Minor presence of *Groszaki*
- Minor presence of a dorsal reduction
- Minor presence of Janus flakes
- Hardly any „Upper Paleolithic“ tool types
- Evidence for hafting of tools

Site	Allocation	Criteria	Literature
Grotte de la Verpillière I - (Germolles)	Mousterian	presence of handaxes, points and scrapers	Chabas 1872; Gros 1958; Méray 1869, 1876
	MTA	presence of specific bifaces (cordiform handaxes)	Campy et al. 1989; Combier 1959; Desbrosse et al. 1976; Gros, Gros 2005
	Mousterian of Charentian type	presence of specific bifaces (pièce foliacée biface)presence of side scrapers and specific cores (discs and Levallois cores)	Desbrosse, Texier 1973
	Charentian with Micoquian influence	presence of specific bifaces (Keilmesser), backed side scrapers, side scrapers without bulb, bifacial side scrapers, plano-convexe bifacial objects, etc.	Farizy 1995
	Micoquian	presence of specific bifaces (Keilmesser)	Uthmeier 2004
	Middle Paleolithic		Slimak 2004
	KMG-B2	presence of specific bifaces (Keilmesser with tranchet blow in Western Europe)	Jöris 2003
	Mousterian with Micoque-Option	presence of specific bifaces (Ciemna knives with tranchet blow)	Richter 1997
	Mousterian with bifacial tools	presence of bifaces (classical and backed bifaces), scrapers, points, notches and denticulates	Ruebens 2012
En Roche - (Germolles)	Mousterian	Levallois component, presence of Quina type scrapers	Gros, Gros 2005
Saint Sulpice - (Germolles)	Mousterian, Levallois Facies	predominance of the Levallois concept, many blades	Colbère 1979
La Roche - (Saint-Martin-sous-Montaigu)	MTA (discussed)	some cordiform bifaces	Pouliquen 1982; 1983
	Quina Rhodanian (local variety)	presence of scrapers with bifacial retouch, convergent scrapers, Quina type retouch	Pouliquen 1982; 1983
	Mousterian Quina type	presence of Limaces and Quina type retouch	Combier 1962; Gros 1964
	Charentian with Micoquian influence	presence of specific bifaces (Keilmesser), backed side scrapers, side scrapers without bulb, bifacial side scrapers, plano-convexe bifacial objects, etc.	Farizy 1995
Grotte des Teux Blancs - (Saint-Denis-de-Vaux)	Upper Acheulian (discussed)Mousterian (rudimentary, archaic)	large cordiform bifaceLevallois flakes and points, scrapers, backed knives	Combier 1956
Grotte de la Mère Grand - (Rully)	Micoquian (final)	sedimentology, typology (presence of bifaces and scrapers), absence of backed knives or Quina type retouch	Combier 1959; Gros 1961; Gros, Gros 2005
La Clôsure - (Bissy-sur-Fley)	Charentian of Ferrassie type	predominance of Levallois concept, many scrapers, different bifacial objects	Desbrosse, Texier 1973; Parriat 1956
	Mousterian	presence of bifaces, Levallois flakes and points	Daudey, Bonnot (1970); Gros, Gros 2005
	Charentian with Micoquian influence	presence of specific bifaces (Keilmesser)	Farizy 1995
Rue Cataux - (Chonôves)	MTA	presence of specific bifaces (cordiform handaxes)	Combier 1959
	Mousterian, Levallois Facies	predominance of Levallois concept	Guillard 1960

Table 1. List of analyzed sites, highlighting the allocations given by different scholars according to their criteria used.

Accordingly, it seems worthwhile to examine these features in more detail, while the broad lines have already been sketched in a previous contribution (Herkert et al. 2020).

3.1. Blank production and reduction

In terms of blank production, for example, the Levallois concept is dominant (and in many cases the only elaborated blank production concept identified within the different assemblages). Where the archaeological context of the assemblages allows definite assignments, which appears difficult for surface collections, but can be demonstrated for the lithic industry from Verpillière II, there is also a high degree of opportunistic reduction. But in contrast to this, other specific reduction concepts, such as Quina or Discoid, only appear in very few examples, if they could have been identified at all.

Another common element related to the Levallois concept is the evidence of ventral cores on bigger flakes that show marginal (circumferential or semi-circumferential) Levallois-like configuration while profiting from the benefits of given convexities (like the bulb) for the anticipated production.

Furthermore, the analysis of the Levallois cores, in regards to the applied reduction mode (Boëda 1993; 1994; Boëda et al. 1990; Richter 1997), also demonstrates clear correspondences

	Grotte de la Verpillière II (Germolles)	Grotte de la Verpillière I (Germolles)	La Roche (Saint - Martinsous -Montaigu)	La Clôsure (Bissy-sur-Fley)	La Rue Cataux (Chenôves)	Saint-Sulpice (Germolles)	En Roche (Germolles)	La Mère Grand (Rully)
Presence of Keilmesser (with and without tranche! blow)	×	×	×	×	×	–	–	–
Morphological diversity of bifacial objects	×	×	×	×	×	×	×	×
Prevalent use of Levallois reduction	×	×	×	×	×	×	×	×
Almost no evidence for other reduction concepts	×	×	×	×	×	×	×	×
Evidence for opportunistic reduction	×	×	?	?	?	×	?	?
Ventral reduction on blanks for configuration of Levallois cores	×	×	×	×	–	?	×	–
Incidental presence of blades	×	×	×	×	×	×	×	×
Tools on blanks and cores	×	×	–	–	–	–	–	–
Tools from cortical, configuration and target blanks	×	×	×	×	×	×	×	×
Bulb reduction on tools	×	×	×	×	–	×	×	×
Minor presence of Groszaki	×	×	–	×	×	–	–	×
Minor presence of dorsal reduction	×	×	?	–	–	–	–	?
Minor presence of ventral flakes	×	×	×	×	–	–	–	–
Hardly any „Upper Paleolithic" tool types	×	?	?	?	?	?	?	?
Evidence for hafting of tools	×	×	×	×	×	?	×	×

Table 2. Cross table with the major assemblage characteristics according to Frick (2016b) (columns) and the different Middle Paleolithic assemblages (rows). Due to the decontextualized character of most of the assemblages, it is not always possible to determinate whether a criterion is fulfilled or not (e.g., presence of "Upper Paleolithic" tool types), but in most cases, a similar pattern is noticeable. Dark green: presence confirmed; Light green: present in small quantity; Dark red: absence confirmed; Light red: absence indicated after first overview; Yellow: (chronological) attribution unclear; Grey: no reliable data yet.

(Fig. 5). In total, several reduction modes are present, but the focus is clearly on a preferential or centripetal reduction, each comprising about one-third of the analyzed cores. In terms of size range when discarded, the Levallois cores form a very similar pattern, while only the two Verpillière sites provided fairly thick cores (Fig. 6).

In the same way, the blanks evince the prevalent use of Levallois reduction (Fig. 4a & b). For the stratified material from Verpillière II, for example, unretouched Levallois blanks (i.e., flakes, blades, and points) comprise over 20% of the assemblage. A similar amount has been identified for La Roche. The sites of Rue Cataux or La Clôsure show values of 36% and even 39%, respectively. The material from the ancient collections of Verpillière I contains the fewest amount of unretouched Levallois blanks, which could be related to the subjective bias of the ancient excavators.

The category of Levallois blanks contains Levallois flakes, Levallois blades, and Levallois points (according to Boëda's understanding, see also Frick, Herkert 2014). The quantitative composition of these three Levallois blank types shows that the spectrum is dominated by flakes, while blades and points differ slightly in their quantitative occurrence (Fig. 7).

3.2. Bifacial Elements

During their research history, bifacial elements have played an increasingly crucial role in the identification of Middle Paleolithic facies and thus its chronological attributions (e.g., Bordes 1961; 1984; Bosinski 1967; Valoch 1988). This is also noticeable for the Côte Chalonnaise assemblages (see Tab. 1). Despite the heterogeneous attributions, our recent research revealed strong similarities regarding the bifacial component. Concerning, for example, the Keilmesser as an emblematic bifacial tool, its presence at Verpillière I has long been considered as an isolated spot at the margins of the classical extension of the Central European Keilmessergruppen (e.g. Desbrosse et al. 1976; Jöris 2003). However, our recent investigation and re-examination of ancient collections from the

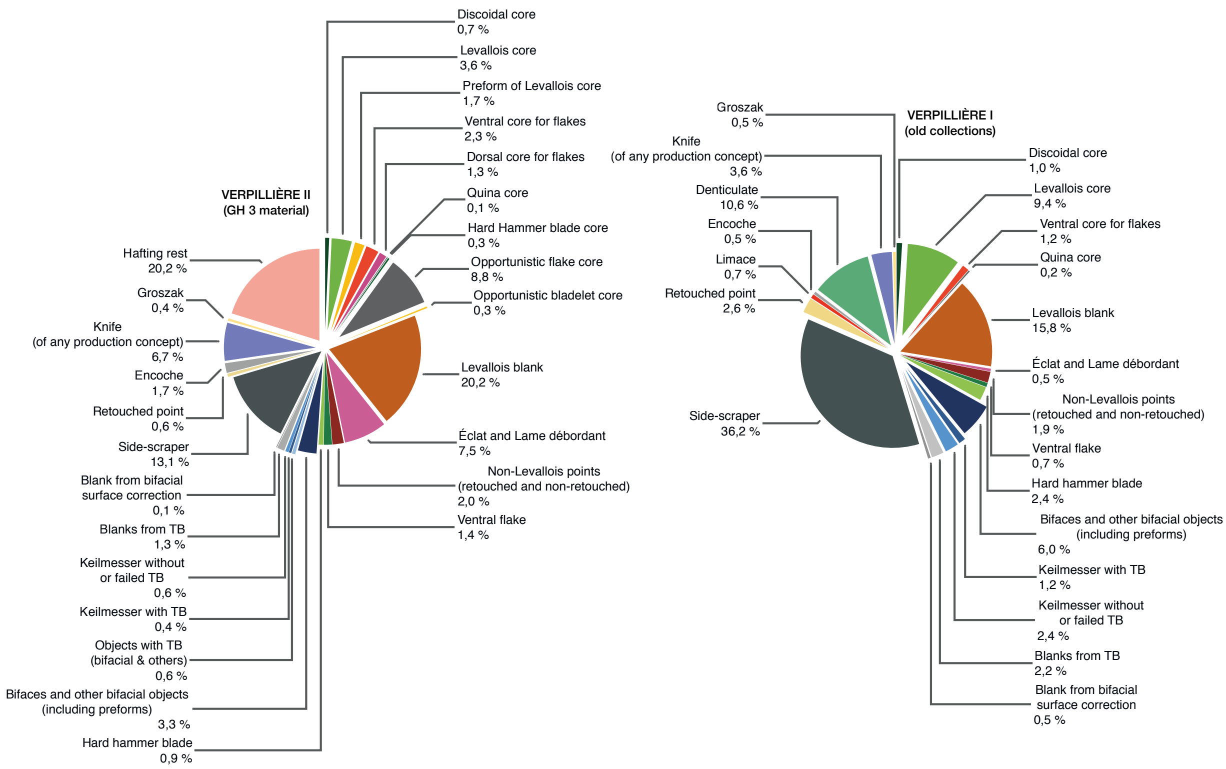

Figure 4a. Pie charts of the general assemblage composition of the two major Middle Paleolithic cave sites, the Grottes de la Verpillière I and II . The high diversification at Verpillière II is due to the modern excavation conditions.

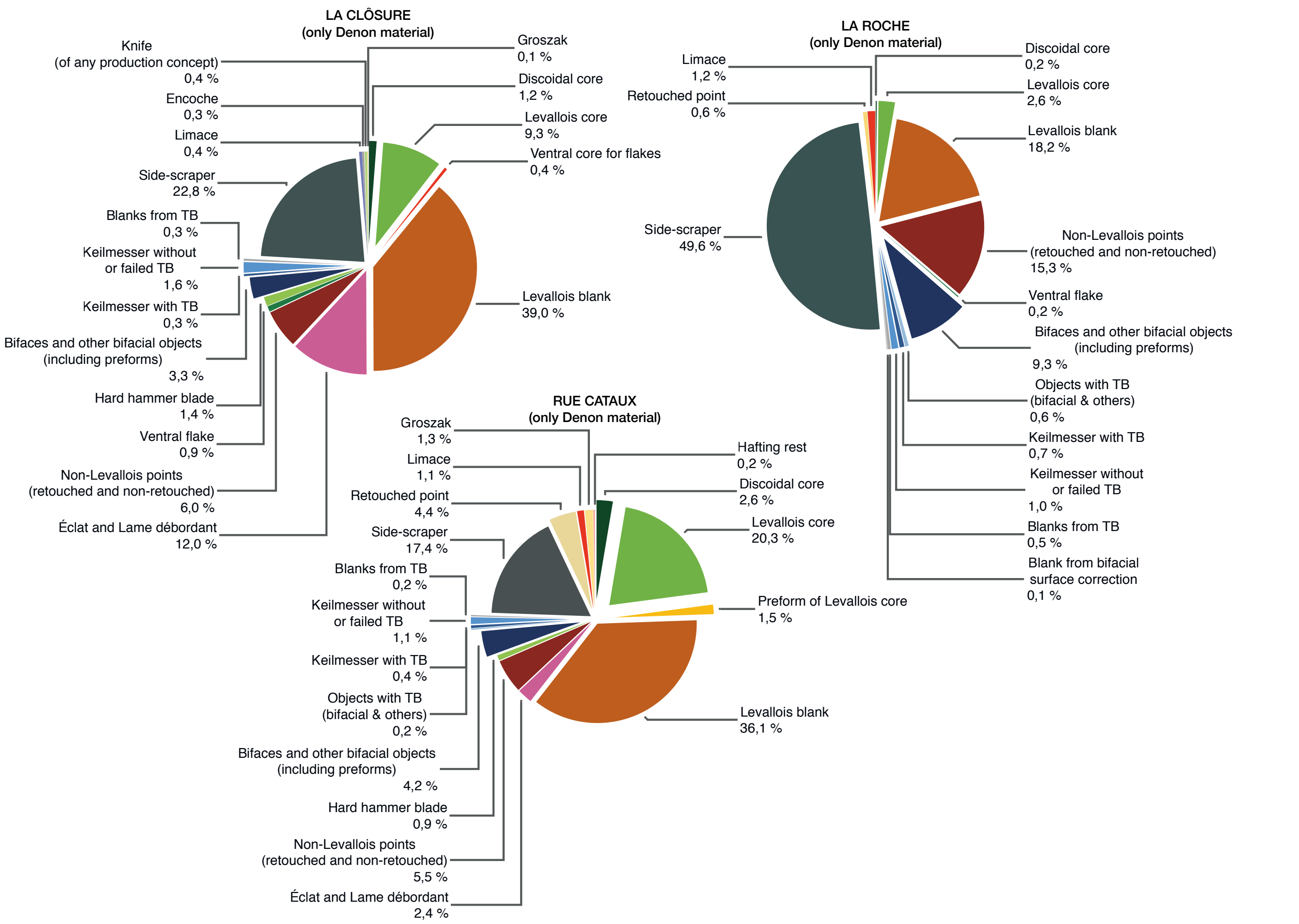

Figure 4b. Pie charts of the general assemblage composition of the three major Middle Paleolithic open air sites, La Roche, Rue Cataux and La Clôsure, where the similarities between the sites of Rue Cataux and La Clôsure and to a lesser extent of La Roche are worth noting.

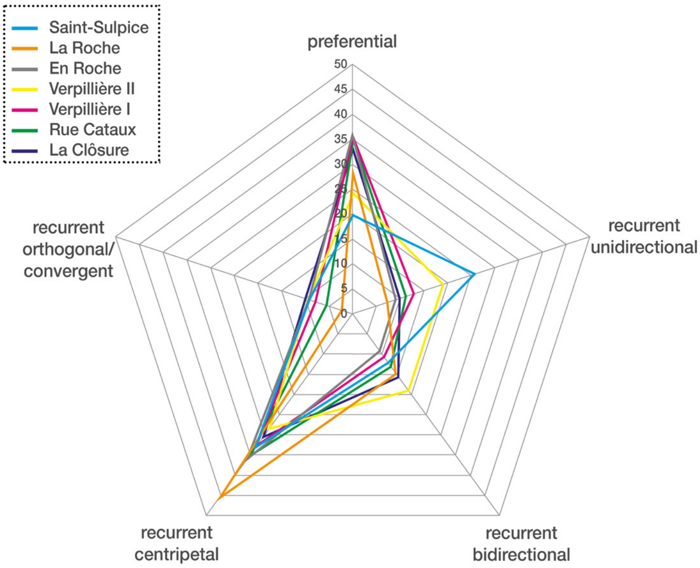

Figure 5. Net graph showing the percentage distribution of the different Levallois reduction modes observed at the analyzed sites. Total amount of analyzed cores: Saint-Sulpice *n*=66 (only Denon material), La Roche *n*=41 (Denon material and private collections from Donguy and Bonnotte), En Roche *n*=11 (Denon material and private collections from Donguy and Macioszczyk), Verpillière II *n*=21 (according to Frick (2016b)), Verpillière I *n*=39 (Denon material and private collection from Combier), Rue Cataux *n*=54 (only Denon material), La Clôsure *n*=71 (only Denon material).

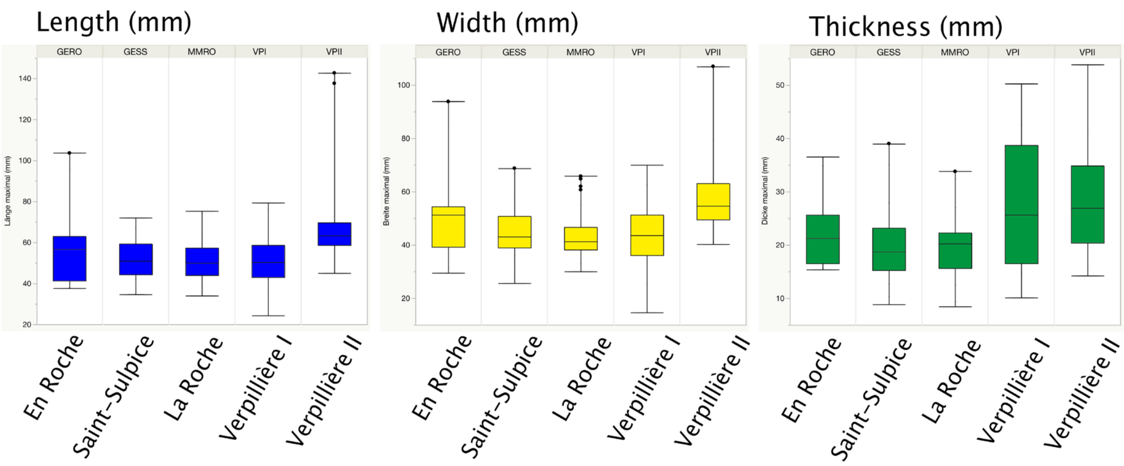

Figure 6. Comparative box plots of the maximum length, width and thickness of Levallois cores from different sites in the Côte Chalonnaise. Apart from the higher thickness values at the two cave sites, the size spectrum of the cores appears quite homogeneous.

Côte Chalonnaise could identify several additional sites containing Keilmesser, mostly even with a tranchet blow modification (Frick 2016b; Frick et al. 2020; Herkert et al. 2020; Herkert et al. 2015). The matrix for these pieces is highly variable and comprises either nodules, flakes, or frost shards. In addition to the mere existence of Keilmesser, it is above all the specific modification with a tranchet blow that must be emphasized and that links the different assemblages. On the one hand, the working stage analysis applied to the Keilmesser with tranchet blow from Grotte de la Verpillière I showed a high degree of variability and ramification, preceding the application of a tranchet blow. On the other hand, the results suggest a strong fidelity in the basal concept of the fabrication of these tools (Frick et al. 2017). For the neighboring sites, comparable analysis is in progress, but the morphological diversity already suggests a similar picture (Fig. 8).

Other bifacial elements that appear regularly within the assemblages are small Fäustel-type bifaces (Bosinski 1967). Like the Keilmesser, they are made from small nodules or flakes. Commonly, they have an asymmetrical, flat-convex cross-section, while the convex surface was shaped to a greater degree (Fig. 9). Overall, Fäustel have been observed at Verpillière I and II, at En Roche, La Roche, and at Mère Grand cave.

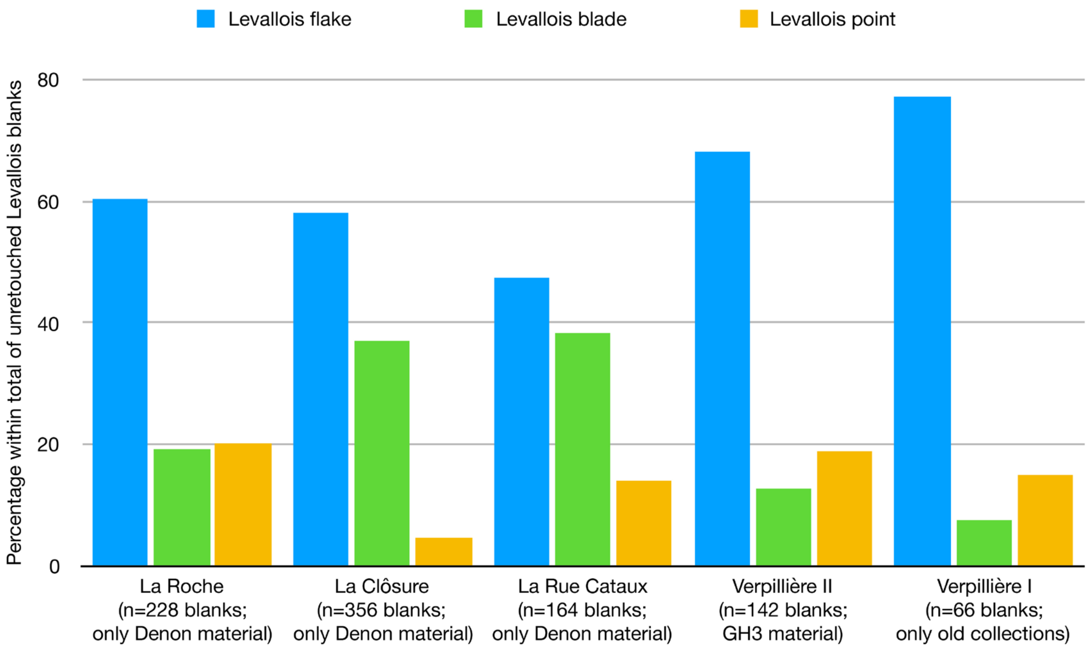

Figure 7. Bar graph showing the percentage distribution of unretouched Levallois blanks according to the blank-type.

In addition to these, other bifacially modified pieces are present in the assemblages. Among them, bifacial scrapers are quite common, which is especially true for La Roche, but also En Roche and Grotte de la Mère Grand.

Supplementing the bifacially worked elements, the assemblages also provide blanks that prove either on-site manufacturing or at least resharpening or reshaping activities, or the presence of specific blanks from tranchet blow evince the execution of tranchet blows. The latter is especially present in Verpillière I, and while some of these special finds already figure among the ancient collections, the majority derives from a recent excavation on the forecourt (Frick, Floss 2017; Frick et al. 2017). Figure 10 resumes the quantitative distribution of pieces related to bifacial tools or those that show evidence for the application of a tranchet blow. The high frequency of bifacial elements (in addition to Keilmesser) becomes evident. Furthermore, it is worth noting that the high number of blanks from tranchet blows, observable at Verpillière I and II, is mostly related to the recent excavation activities. Overall, the two cave sites provide a similar image, as do the open-air sites, respectively. Especially the presence of preforms becomes evident and could indicate their higher production rate at the cave sites and a higher discard rate of tools at the open-air sites.

3.3. Tools and other characteristics

It does not seem surprising that retouched tools are a very common feature within the assemblages. Therefore, the choice of blanks appears rather opportunistic, since blanks from different reduction stages (decortication, core configuration, core maintenance, blank production, target blanks, etc.) have been used for tool manufacture. This feature can be observed for all sites analyzed. Although tool quantity is high (but probably due to collection bias), the spectrum appears limited and is dominated by different forms of side-scrapers, which can compose up to half of the assemblages, as it is the case for the Musée Denon material of La Roche. The variety of side-scrapers comprises transversal, lateral, and bilateral edge modification.

Other common Middle Paleolithic tools such as Limaces (that have been used as descriptive elements, e. g., for La Roche), retouched points, notched pieces or denticulates only occur in small quantities. Only Verpillière I shows an elevated value of over 10% (with the highest number of denticulates), while the stratified material from Verpillière II comprises slightly more than 2%, and the other sites are within a spectrum of between almost 1% and slightly over 5%.

Concerning tool manufacture, bulb reduction is a further common characteristic that underlines the homogeneity of the assemblages. So far, it has been observed at six sites, while quantitative data is available only for La Roche, En Roche, and Verpillière II, where about 5% of the modified blanks evidence bulb reduction (Fig. 11).

This specific modification of ventral flattening is presumably linked to hafting purposes (Banks 2004; Rots 2010; 2016). Additionally, lateral notches or uni- or bilateral retouching can be observed on some of the tools as well as on tool fragments, indicating former hafting of tools, while the latter category (tool fragments) also suggests on-site retooling activities (Frick 2016b; Herkert et al. 2020).

4. Discussion

In the previous sections, we demonstrated the technologically coherent pattern of the Middle Paleolithic assemblages, which primarily relies on Levallois-focused blank production and various bifacial elements, whereby Keilmesser play a major role.

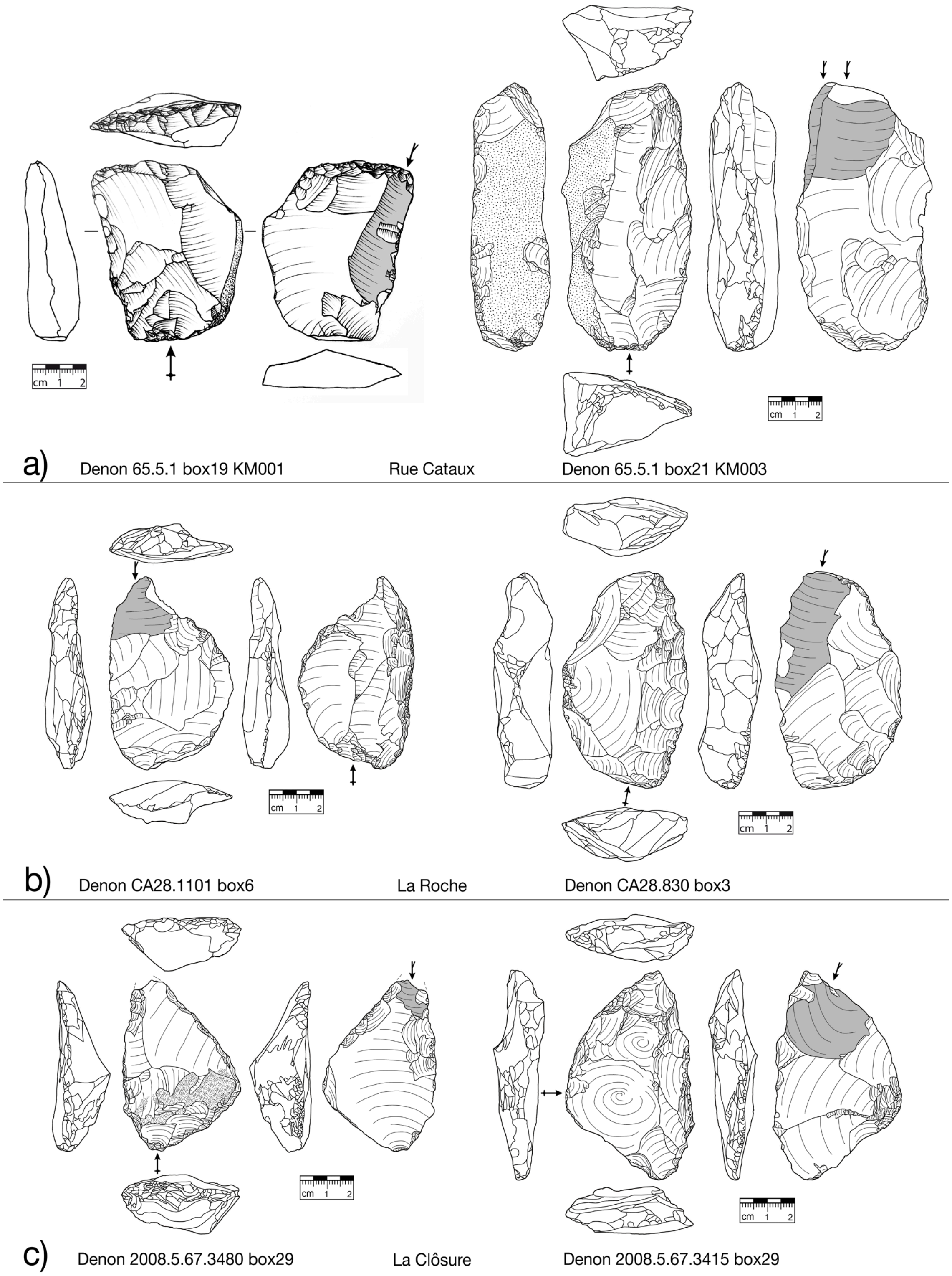

Figure 8. Keilmesser with tranchet blow (highlighted in gray) from a) Rue Cataux (Musée Denon Inv. No. 65.5.1 box 19 KM001 & 65.5.1 box 21 KM003); b) La Roche (Musée Denon Inv. No. CA28.1101 box 6 and CA28.830 box 3) and c) La Clôsure (Musée Denon Inv. No. 2008.5.67.3480 box 29 and 2008.5.67.3415 box 29). All pieces stored at Musée Denon in Chalon-our-Saône (drawings and composition: Frick, except 65.5.1.KM001 drawn by Rösch)

Detailed technological, morphometric, and metric analyses of the assemblages are in preparation and will contribute to the line of argument. A similar pattern shows the connection between various bifacial objects and the reduction utilizing the Levallois concept. Farizy (1995b) has already drawn attention to this connection. In her concept of the Charentien à influence micoquienne (Charentian with Micoquian influence, CIM), she highlighted the common occurrence of Levallois, bifaces, *Fäustel*, bifacial scrapers, and Pradniks, i.e. Keilmesser.

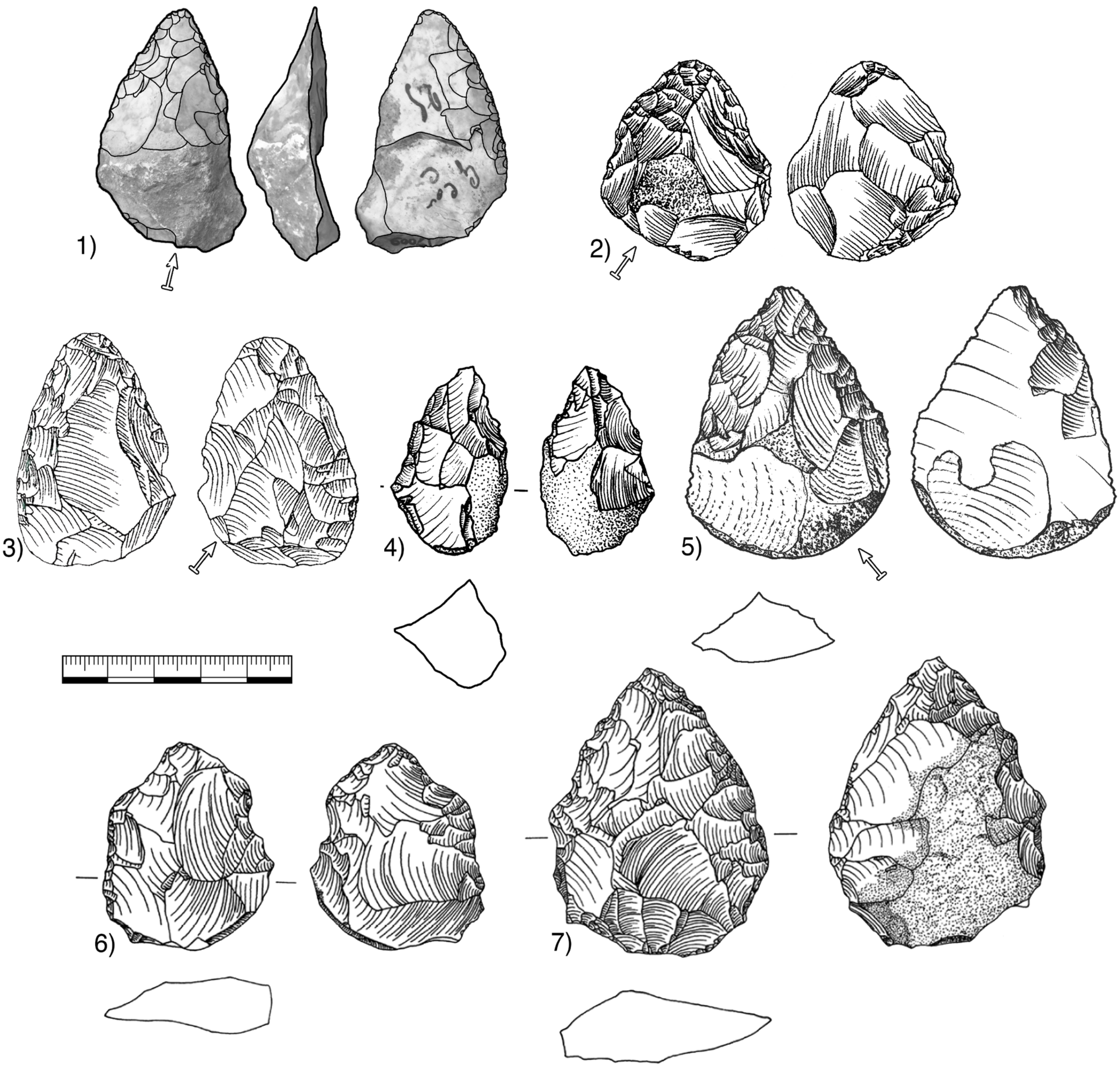

Figure 9. Small bifaces or *Fäustel* from different sites in the Côte Chalonnaise research area: 1) Grotte de la Mère Grand (MAN: Inv. No. 17.009; Drawing: Herkert); 2) En Roche (Denon: Inv.No. 02.23.345; Drawing: Gros 2005, p. 150 fig. 95.2); 3) La Roche (Denon: Inv. No. 02.7.1; Drawing: Gros 2005, p. 57 fig. 29.3); 4) Grotte de la Verpillière II (Inv.No. GER12.227-057.420, after Frick 2016, p. 461 fig. 269.a); 5) Grotte de la Verpillière II (Inv.No. GER13.227-057.1790 after Frick 2016, p. 461 fig. 269.b); 6) Grotte de la Verpillière I (Inv.No. GER07.197-110.18.1 after Floss (2008, p. 59 fig. 27.1)) 7) Grotte de la Verpillière I (Inv.No. GER07.195-094.52.1 after Floss 2008, p. 57 fig. 25.2).

In general, the co-occurrence of Keilmesser and other bifacial elements, especially Fäustel, has been stressed by other scholars (Bosinski 1967; Jöris 2003; Richter 1997; Veil et al. 1994) and underlines the chrono-technological coherence of the different assemblages.

Although it is not yet possible to chronologically fix the sites mentioned here, we would like to attempt listing chronological markers that already exist at this time (Fig. 2). In terms of absolute chronometric data, so far, the most reliable dates come from Grotte de la Verpillière II (via ESR/U-Th, IRSL, and AMS 14C), which point towards the early MIS 3. Dating of GH 15 material from Verpillière I (via ESR/U-Th and AMS 14C), which overlies the intact Middle Paleolithic in the cave, also points to the early MIS 3 (Heckel et al. 2016; Richard et al. 2016; Zöller, Schmidt 2016). In addition to the radiometric dating, the analysis of the micro-vertebrates by Jeannet (2014) provided evidence for a cool but humid climate setting during the deposition of the material forming GH 3 at Verpillière II. For the other sites in the Côte Chalonnaise, no chronometric data exists yet. Combier (1956-1957) correlated his sedimentological observations at Grotte de la Mère Grand at Rully with those of Vergisson II (Combier 2001), where recent 14C dating attempts on bone provided dates between 47 and 44 cal ka BP (BETA 367904 and BETA 363425; personal communication S. Quertelet and H. Floss).

In addition to these recent attempts to establish a chronological fixation based on radiometric data, other authors already attempted to at least include Verpillière I into their research. For example, Jöris (2002; 2003) included the site into his KMG B2, based on the presence of Keilmesser with

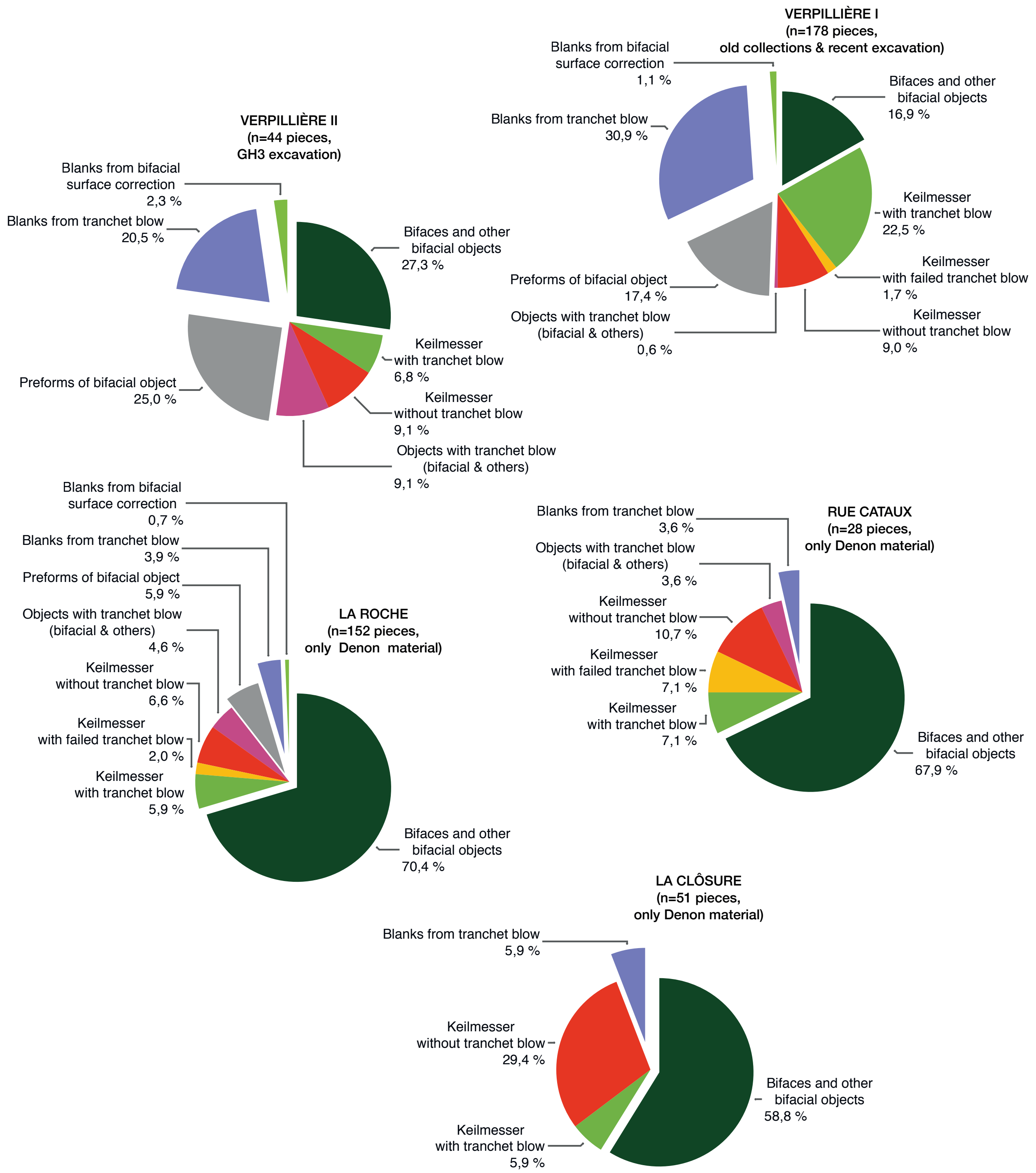

Figure 10. Pie charts showing the quantitative distribution of elements related to bifacial tools or the execution of tranchet blows.

tranchet blow and its spatial position in Western Europe. KMG B2 corresponds approximately to the second half of MIS 4 or the beginning of MIS 3. Nevertheless, further work on a firm chronological fixation for the presented site cluster is imperative.

As these attempts already demonstrate, it can be worthwhile to examine technological features. Rather than a mere fixation on discriminant morphotypes, analysis of the technological habitus, i.e. the identification of the techno-conceptual foundation, can help link assemblages. For the Middle Paleolithic of the Côte Chalonnaise, such a techno-conceptual basis is present, not only in the form of special reduction strategies but also in the manufacture of bifacial objects. Here, the focus is not on the morphological coherence of specific objects, such as Keilmesser, but on the final goal, the application of a tranchet blow, as could be demonstrated for Verpillière I (Frick et al. 2017; 2018). Thus, the sites are not explicitly linked via typology, but via a general litho-conceptual framework. Since no comprehensive working stage analysis has yet been carried out for pieces of the other sites, we can only present drawings of some of the Keilmesser

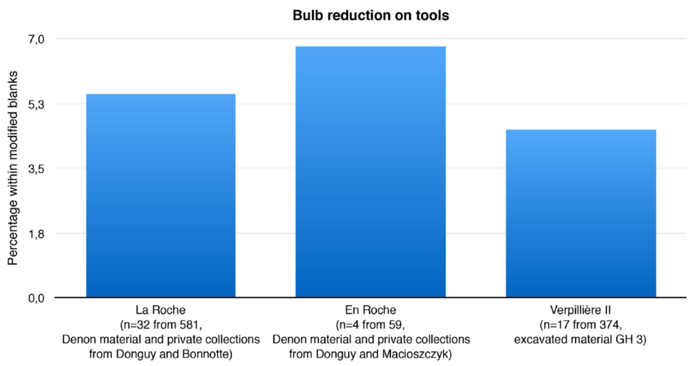

Figure 11. Bar graph showing the percentage of bulb reduction on modified blanks, i.e. tools, comprising the sites of La Roche, En Roche and Verpillière II.

with tranchet blow (Fig. 8). Nonetheless, as these simple illustrations already show, the pieces are quite different in terms of their morphology and their degree of shaping, although they evidence the tranchet blow application, something that Pouliquen (1982) did not recognize or mention in her work on the La Roche material.

If other known assemblages with evidence of tranchet blow are used as a basis, on a larger chronological scale, again, a striking accumulation is observed at the end of MIS 4 and the beginning of MIS 3 (Frick 2019). Verpillière I with its Keilmesser with tranchet blow assemblage has long been considered as an isolated spot of the Keilmessergruppen (Jöris 2003; Richter 1997). Our research was able to show that this phenomenon covers a whole region and is embedded in and linked to several other litho-technological characteristics, which could be interpreted as related to each other in a chrono-technological manner. So far, it is premature and not at all our intent to push the assemblages into an attribution to the Keilmessergruppen or the Charentien of Micoquian influence, into which they might seem to fit best. Thus far, our approach is to present the results in a more open context of considerations, that might better reflect the variability of late Neanderthal behavior and pave the way for new and fruitful discussion.

5. Conclusion

This paper is not an attempt to define a new techno-complex, nor do we try to force the different assemblages into one existing entity. Nevertheless, we find it worthwhile to reconsider the given traditional space-time units and their defining parameters. As the results show, there are several sites in the Côte Chalonnaise, whose assemblage composition comprises aspects which are or can be assigned to different geographically neighboring late Middle Paleolithic complexes, but which, as in the case of Verpillière II, form a coherent technological unit on their own. Therefore, the hypothesis of a technologically linked site cluster in the region seems appropriate to us. Therein, the major characteristics rely on homogeneous reduction strategies which are primarily based on Levallois, combined with the manufacture of morphological variable bifacial objects, which commonly evidence the presence of tranchet blow modifications, which, again, is a technically non-trivial feature. Further research and radiometric dating attempts could even strengthen this image and once again reveal the high flexibility and variability of late Neanderthal groups.

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Data availability statement. The authors confirm that the data supporting the findings of this study are available within the article. Further information is available from the authors upon request.

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The knapped stone assemblage from Boldogkőváralja in the light of a new statistical evaluation

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Abstract

One of the most famous knapped stone assemblages, the 566 intact blades found in a large vessel at Boldogkőváralja-Tekeres-patak, dated to the Bükk culture (5200–5000 BC) has been at the forefront of the research for decades. Our intention was three-fold when we decided to reevaluate this find. First, with the publication of the conjoining workshop material, we wanted to draw more attention to the whole assemblage and not just only to the depot. Second, the deliberate selection of the artefacts found in the jar has been suggested since the 1960s, which, in our opinion, can be tested by deep statistical analysis. Third, when Vértes applied parametric and non-parametric statistical analyses on knapped stone assemblages, he ventured into a brand new branch of archaeological investigation, not just in Hungary. Unfortunately, the pioneering attempts of Vértes were not followed for many decades. Our results suggest that the intact blades of the depot differed from each other significantly by their butt preparation because the pieces with dihedral butts are significantly wider than the others. On contrary, the length and the thickness of unbroken blades are homogenous, irrespective of preparation techniques. Concerning the different butt types across the whole assemblage, blades with plain butts are the most numerous in the depot and the workshops, but other, more thorough preparation occurred at a decreased rate in the workshops. At the same time, the different preparation types are evenly distributed in the four workshops, there are no significant differences between them.

Kivonat

A boldogkőváraljai pattintott kő leletegyüttes új statisztikai értékelése

A Bükk kultúrához (i.e. 5200–5000) tartozó Boldogkőváralja-Tekeres-patak lelőhelyen talált, 566 ép kőpengét rejtő edény lerakat hazánk egyik legismertebb pattintott kő leletegyüttese, mellyel sok korábbi kutatás foglalkozott már. Újraértékelésünk első célja, hogy a depóhoz csatlakozó műhelyek leletanyagára is felhívjuk a figyelmet. Második célunk volt, hogy az edényben talált tárgyak szándékos szelekciójának elméletét statisztikai módszerekkel vizsgáljuk. Ezzel összefüggésben harmadik célunk volt, hogy a kőpengéket korában egyedülálló módon statisztikai módszerekkel vizsgáló Vértes László munkásságát folytassuk hazánkban. Eredményeink szerint a depó ép pengéi között a kétlapú talonnal rendelkezők szignifikánsan szélesebbek voltak a többinél. Ezzel ellentétben az ép darabok hosszúsága és vastagsága hasonló, függetlenül a preparációs technikáktól. A depó és a műhelyek anyagában egyaránt a sima talonú darabok a leggyakoribbak, de az alaposabb előkészítés inkább a depóba helyezett pengéken figyelhető meg. Ezen felül a különféle preparációs típusok megoszlása egyenletes a négy műhely anyagában, vagyis ezek a leletcsoportok egymásra hasonlítanak.

Keywords *Neolithic, Bükk culture, lithics, statistics, structured deposition*

Kulcsszavak *neolitikum, Bükk kultúra, pattintott kövek, statisztika, strukturált depozitum*

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1. Introduction

Considering knapped stone tools, the larger part of the Middle Neolithic (5400–5000 BC), thus the later episodes of the Alföld Linear Pottery culture are underrepresented in the literature. Moreover, the known sites and assemblages are modest, sometimes containing only a handful of pieces (Biró 1987; Biró 1998; Kaczanowska 1985). However, the relatively high ratio of obsidian (more than 50% on average) testifies the continued importance of this raw material from the former periods in the Hungarian Plain. The last decade witnessed some modest results concerning new data from new sites, such as Polgár-Ferenci-hát (Site 31) (Kaczanowska *et al.* 2016; Kaczanowska & Kozłowski 2016), Polgár-Piócási-dűlő (Nagy *et al.* 2014; Kaczanowska & Kozłowski 2016) and Tiszaug-Vasútállomás (Füzesi *et al.* 2017). At the first mentioned site, dated to the latest phase of the Alföld Linear Pottery (ALP) culture, at least two obsidian core reduction strategy was recorded, one with flat debitage surface, and one with cylindrical debitage surface. In some cases, the pressure technique was hypothesized according to the analysis of the obsidian blades. The most numerous tools are end-scrapers, laterally retouched blades, and truncations. Polgár-Piócási dűlő yielded settlement features both from the early and the latest phase of this cultural unit, with almost exclusive utilization of obsidians. One interesting difference between the two chronological horizons is the length of the blades, as the earlier specimens are larger. At Tiszaug, in the southern part of the Hungarian Plain, only a handful of stone tools were collected, but one-quarter of the pieces were made on obsidian (Füzesi *et al.* 2017). This settlement, dated to the Szakálhát culture, displays important connections with Transdanubia in the form of radiolarite artefacts, and these connections became more intensive in the Late Neolithic period.

One of the most famous assemblages, Boldogkőváralja-Tekeres-patak, which is situated in the North Hungarian Range and belongs to the Bükk culture (5200–5000 BC) has been at the forefront of the research for decades (Fig. 1) (Biró 1998; Kaczanowska 1985; Mester & Tixier 2013; Vértes 1965). However, this assemblage is peculiar in many respects. First, the abundance of obsidian raw material characteristic of contemporaneous sites is not present here at all, as this raw material counts only 3% of the whole assemblage. Second, the 566 intact blades of a local raw material (limnosilicite) (Mester & Faragó 2016) and found in a large vessel at Boldogkőváralja, are particular in themselves. This find context has been the subject of several preceding studies. Among these, Vértes' statistical study was highly uncommon in the archaeological literature before (Vértes 1965). He argued that the metrical results following normal distribution around a specific size suggest standardized manufacturing for a special purpose, thus it can be a cultural marker for a specific industry. Later, the blade depot was discussed from a technological point of view in detail, with the conclusion that the similarity of these pieces is rather the result of specialist knapping activity. (Mester & Tixier 2013). According to the latter authors, these blades have been stored in a vessel accessible to the whole community. In another article, the intertwined relationship between ritual and domestic activities was emphasized through the case study of the blade depot of

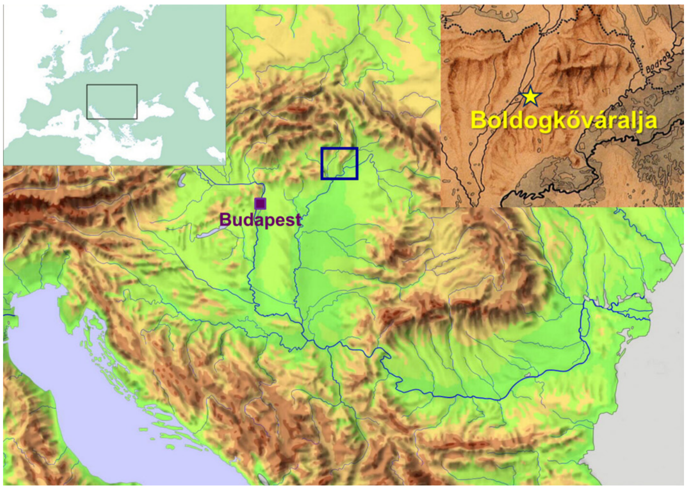

Figure 1. Location of the Boldogkőbáralja site in Hungary. Map: Zsolt Mester.

Boldogkőváralja. (Király *et al.* 2020). In this approach, the authors interpreted the knapping activity, the selection of the blades, and their deposition in the pot as possible elements of a complex ritual, which is difficult to distinguish from everyday practices. However, a detailed evaluation and publication of the lithic material from the workshops in the vicinity of the depot, never have been conducted. The only person, who investigated the material from the settlement features, only briefly mentioned the apparent metrical differences between the items from the depot and the other settlement features (Kaczanowska 1985, 52–53).

Our intention was three-fold when we decided to reconsider the analysis of the material of Boldogkőváralja-Tekeres-patak. First, with the thorough evaluation and publication of the conjoining workshop material, we wanted to draw attention to the entire assemblage from the site, not just the depot. Second, the deliberate selection of the pieces in the jar has been suggested since the 1960s (Király *et al.* 2020; Mester & Tixier 2013; Vértes 1964). At the same time, the intention of this act is obscure, and may not be ever clear, but in our opinion, it can be approached with the help of deep statistical analysis. Third, Vértes' parametric and non-parametric statistical analyses on knapped stone assemblages represent a brand new branch of archaeological investigation, not just in Hungary. At that time, natural scientific methods had just found their way into the research with the advent of new archaeology (Clarke 1968). Unfortunately, the pioneering attempts of Vértes had not been followed for many decades and statistics found their way into Hungarian Paleolithic archaeology only in the past few years (Lengyel 2018). Meanwhile, not just univariate or bivariate, but several multivariate statistical examples were introduced in the international literature already in the early years (Binford & Binford 1966; Dolukhanov *et al.* 1980; Hodson 1969). Seemingly, scholars interested in the Palaeolithic period and stone tools always have been more aware of such methods and investigations (Király 2018; Scerri *et al.* 2016).

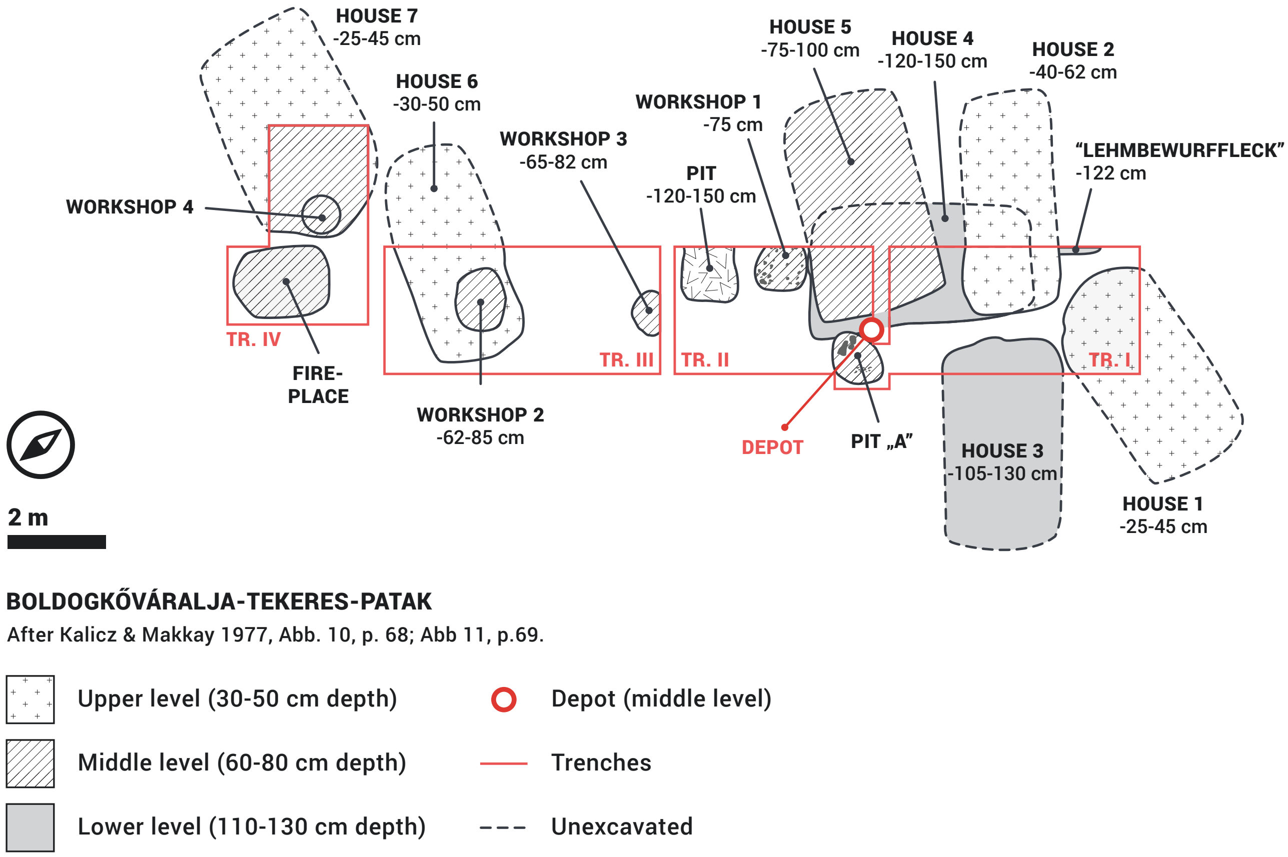

Figure 2. Excavation plan with the houses, workshops and other features belonging to the early (grey), middle (diagonal lines) and late (crosses) settlement phases, and the excavation trenches (red line). Assembled by Attila Király after Kalicz & Makkay 1977, Abb. 10 and 11.

2. Materials and methods

2.1. The archaeological site

Boldogkőváralja-Tekeres patak was discovered during road construction works by Tibor Kemenczei in 1963 (Kemenczei 1964). The site had been located near the Tekeres stream, where five trenches of 8–12.5 square meters were excavated (Fig. 2). During the excavation, 7 houses, 4 workshops, a pit, and a hearth were unearthed in four trenches. The settlement remains were dated exclusively to the Bükk culture according to the diagnostic ceramic material (Kalicz & Makkay 1977, 68–71). Based on the field observations, Kemenczei argued for two distinct settlement phases, situated between 20 and 160 cm below the topsoil. This idea was not confirmed by the ceramic analysis conducted later by Kalicz and Makkay (1977, 70), because all the sherds seemed to fit into the first phase of the Bükk culture. The famous depot in the standing vessel was found in Trench II, between House 5 and Pit 'A'.

Revising the observed depth of the different settlement features, we argue for three distinct settlement phases. The earliest part of the settlement was observed only in the southern zone in Trench I and II, represented by Houses 3 and 4 at 110–130 cm below the surface. The next level was situated in the central zone of the excavation between 60–80 cm. below the surface. Most of the activities, such as the erection of House 5, the establishment of the four workshops and Pit 'A', and the deposition of the vessel are dated to this period. Even Kemenczei associated these features with each other, representing one single settlement period. Finally, Houses 2, 6, and 7 at the level of 30–50 cm below the surface, in the distal part of the excavation area (Trench I, III, and IV) represent the last phase of occupation.

According to the examination of Piroska Csengeri, the jar containing the blades had been originally manufactured to store liquids, and after certain repairs, it ended up serving other purposes. Moreover, according to the remains cemented on the bottom and lower part of the outer wall, the lower half of the vessel was sunken into the soil while the upper half remained accessible above-ground.

2.2. Knapped stones

The excavation conducted at Boldogkőváralja yielded altogether 1083 knapped stone implements. Among them, the blade depot counted 566 pieces of intact and broken blades. Apart from that, four concentrations or workshops of knapped stones came to light with another 331 pieces of cores, flakes, and blades. 66 pieces were attributed to a feature named Pit 'A', but half of it were made of obsidian, so these pieces and further stray finds have been excluded from the present study.

Figure 3. Boldogkőváralja-Tekeres-patak, knapped stone implements and cores from Workshop 1. Photo: Norbert Faragó, courtesy of the Herman Ottó Museum in Miskolc.

Figure 4. Boldogkőváralja-Tekeres-patak, knapped stone implements and cores from Workshop 2. Photo: Norbert Faragó, courtesy of the Herman Ottó Museum in Miskolc.

Figure 5. Boldogkőváralja-Tekeres-patak, knapped stone implements and cores from Workshop 3. Photo: Norbert Faragó, courtesy of the Herman Ottó Museum in Miskolc.

The distribution of finds among the workshops is uneven; the most abundant is Workshop 2 with 111 knapped stones (Fig. 3–6). Among these, 93 pieces are blades or blade fragments, while the rest were cores, flakes, and debris. Workshops 1 and 4 contained 93 pieces each, from which 81 and 75 blades and blade fragments were chosen for the analysis respectively. Finally, Workshop 3 contained the least amount, 25 pieces suitable for study.

According to the database of Jacques Tixier and Zsolt Mester about the depot, we observed the following attributes on the pieces from the workshops: length, width, width at the mesial section, thickness, curvature, and butt type. To ensure compatibility and integrity with the depot dataset, we decided to include our measurements in the original database of the mentioned authors.

In our study, both parametric (ANOVA, Levene's, Welch) and non-parametric (Chi^2, Kruskal-Wallis, Mann-Whitney pairwise) tests were conducted with the application of the PaST 3.22 statistical software (Hammer *et al.* 2001). Every analysis was introduced by normality tests, which determined the method of comparison to follow. In the case of non-normal distribution, which was more frequent, Levene's test from median has been applied. If unequal variance occurred between the data series, the Welch test completed the evaluation. In parallel with the comparisons of the means, especially when non-normal distributions or unequal variances occurred, the medians were also compared with the help of Kruskal-Wallis and Mann-Whitney paired tests.

3. Results

3.1. Metric analysis

First, the metric attributes of the blades in the depot were investigated in more detail. The width of the intact blades was compared by the preparation technique of the blades (Fig. 7). According to the normality tests, the distribution of the butt types among blades is normal except for plain butts. In this case, the ANOVA test was run with the aid of Levene's test for homogeneity of variance from the median ($p = .910$). The result was a significant difference between the means of the blade widths ($F[4, 392]) = 3.10$; $p = .016$). To check the medians of the same data, the Kruskal-Wallis test was applied with similar results: they differed significantly ($H = 12.51$; $p = .014$). According to the Mann-Whitney pairwise test, the greatest distance occurred between the blades with dihedral and facetted, and dihedral and plain butts.

Blades lengths have been analysed in the same manner. First, normality tests were conducted, with similar results (Fig. 8). This time, blades with dihedral butts displayed non-normal distribution. Second, ANOVA and Levene's test have been run with the same results, both the variances ($p = .805$) and means were found to be the same ($F[4, 392] = 1.70$; $p = .178$). For the medians, the Kruskal-Wallis test showed strong similarity ($H = 6.63$; $p = .157$).

The analysis of blade thickness yielded similar results (Fig. 9). Except for atypical and crushed butts, all types followed

Figure 6. Boldogkőváralja-Tekeres-patak, knapped stone implements and cores from Workshop 4. Photo: Norbert Faragó, courtesy of the Herman Ottó Museum in Miskolc.

non-normal distribution. Levene's test from medians showed that the variances are the same (p = .551), so as the means (F[4, 392] = 1.80; p = .128) and the medians (H = 6.68; p = .136).

Next, the curvature of the intact blades with different butts has been compared with the same tests (Fig. 10). The normal distribution requirements of the ANOVA were strongly violated by the samples, only the blades with atypical butts followed a normal distribution. In this case, it was obvious that Levene's test from median has to be taken into consideration, which resulted in a very homogenous variance (p = .9488). Nevertheless, both means (F[4, 392] = 4.18; p = .003) and medians which were tested with the Kruskal-Wallis method (H = 16.28; p = .003) differed significantly. To identify the inherent relationships in the dataset, paired Mann-Whitney tests had been conducted again, which showed that the difference is the most significant between pieces with dihedral and facetted, and between pieces with dihedral and plain butts.

Lastly, the width of all pieces of the depot, broken or nonbroken were taken into consideration (Fig. 11). According to the normality tests, the distribution of pieces with dihedral and plain butts violated the normal distribution requirements. Again, Levene's test from median was applied to inspect the homogeneity of variances, which resulted in the same variance (p = .891). The ANOVA showed that the means differ significantly (F[4, 514] = 4.22; p = .002), while the Kruskal-Wallis test verified the same for the medians (H = 16.25; p = .003). The underlying cause behind these heterogeneous distributions is the distribution of blades with dihedral butts again. According to the paired Mann-Whitney test, those blades are significantly wider than the blades having crushed, facetted, or plain butts.

The statistical evaluation of the entire assemblage was started with the investigation of blade butts (Table 1). The question arose whether the same distribution can be recorded in the depot and the workshops or not. Atypical, dihedral, crushed, facetted, and plain butts together offered an adequate sample to analyse. According to the Chi^2 test, there is a significant difference between the different assemblages concerning the distribution of butt types (X^2 = 85.50; df = 16; p < .001). Having a closer look at the distribution, only one common attribute can be noted: the most frequent butt type is plain among the whole assemblage. The facetted type is the second most abundant in the depot, while the workshops contained only a minor quantity of them. Instead, atypical butts, together with the dihedral type in equal quantities were the second most frequent groups in the workshop samples, while the depot contained only a few atypical pieces. We ran a distinct Chi^2 test only on the workshops to see the degree of the difference between them. The result was striking: there is no significant difference between the butt type distribution of the four workshops. (X^2 = 10.92; df = 12; p = .536).

Beyond the apparent differences in the metric attributes of the blades from the depot and the workshops (Kaczanowska 1985, 52–53), we elaborated their relationship in more detail. First, the most obvious difference, the length of the whole blades were compared with each other (Fig. 12). This time, it seemed useless to run any tests, because the boxplot convincingly showed that the blades of the depot are much longer. However, we confronted the workshop assemblages with each other by ANOVA and Kruskal-Wallis tests. According to the results, the means and the medians are all the same throughout the four workshops (F[3, 53] = 0.53; p = .667; H = 2.70; p = .439), moreover, their distribution was normal.

At the same time, the width data seemed less different, so it was not futile to run statistical tests on them (Fig.13). According to the normality tests, the width of the depot blades are not following normal distribution, but the blades of the workshops do. According to Levene's test from medians, the variances are not homogenous (p < .001), so the Welch F-test was applied. The result was a definitive difference between the means (F = 6.77; df = 17.96; p < .001), reinforced by the Kruskal-Wallis test for medians (H = 24.12; p < .001). Mann-Whitney pairwise tests helped to clarify the inherent relationship between the five assemblages, which reported that Workshop 1 falls close to the depot, while Workshops 2 and 3 are the most different in this sense.

Analysing the blade thickness throughout all the assemblages, the depot seemed to be substantially different from the workshops again (Fig. 14). Blade thickness distributions are not normal, while the variances (p < .001), the means (F = 4.12; df = 17.52; p = .001), and the medians (H = 24.65; p < .001) are all heterogeneous. The Mann-Whitney pairwise test revealed that Workshop 1 stands close to the depot, while the rest of the workshops are more similar to each other again.

Theoretically, the curvature of the whole blades are closely related to the length of the blades (Fig. 15). As the blades of the depot are much larger, so one would expect more curved pieces in this assemblage as well. According to the boxplot, this claim is true, as the values of the depot are much higher than the workshops. Comparing again the four workshops with each other, non-normal distributions were experienced this time. However, Levene's test of variance from medians reinforced the homogeneity of these assemblages, and their means and medians were proved to be the same again (F[3, 53] = 0.37; p = .776; Kruskal-Wallis H = 3.35; p = .310).

The last aspect investigated is the width of all broken and unbroken blades from the depot and the workshops (Fig. 16). The normality tests resulted in a non-normal distribution in all cases, so Levene's test from medians was applied to test the variance (p < .001). The inhomogeneous variances allowed only the application of the Welch F-test, which showed that there is a significant difference between the medians of the different assemblages. (F=12.15; df[total] = 128.8; p < .001) The Kruskal-Wallis test reinforced this suggestion with the comparison of the medians (H = 65.30; p < .001), while the Mann-Whitney pairwise test shed light on the distance between the depot and the rest of the workshops.

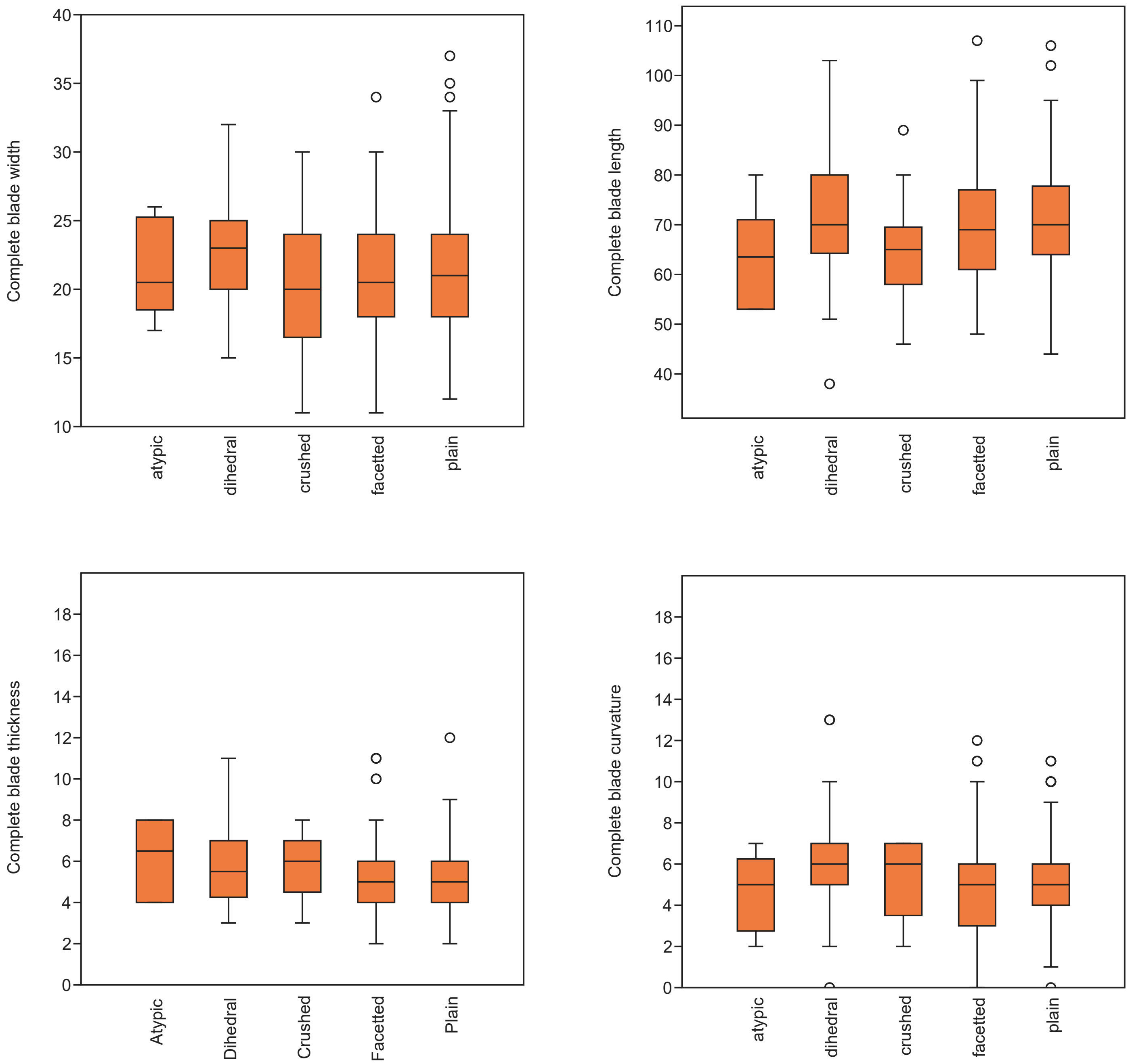

Figure 7–10. Boldogkőváralja-Tekeres-patak, metric attributes of the complete blades with different butts (atypic, dihedral, crushed, facetted, plain). Upper left (Figure 7) – width; upper right (Figure 8) – length; lower left (Figure 9) – thickness; lower right (Figure 10) – curvature. Scale is in millimeters. Assembled by Norbert Faragó.

4. Discussion

Although the Neolithic is more representative concerning the number of sites and the knapped stone tools than the Paleolithic, stone tools in obviously special deposits like the Boldogkőváralja example are very scarce in the territory of Hungary even in the former period. Apart from knapped stones deposited in graves (Faragó 2017; 2019; Siklósi 2013), our knowledge about the complex role of these artefacts in the one-time social life is extremely limited. A similar deposit from Early Neolithic times, in the context of the Körös culture, has been found at the site Endrőd 39 (Kaczanowska et al. 1981). Here, a 50 × 50 m area was excavated for about five seasons beginning in 1975, under the direction of János Makkay in connection with the fieldwork of the MRT (*Magyar Régészeti Topográfia* – Hungarian Archaeological Topography). A total of three houses and six pits were excavated, and the finds in question were recovered in the north-western half of the excavation area in 1976. To the west, near a partially excavated building, a stone hearth was found. Adjacent to the latter, an ash pit came to light, containing a rounded, cylindrical-necked jar covered with a fragment of a base, with 101 knapped artefacts inside. The stones all showed a southern origin, with raw material from the western Banat or the pre-Balkan plateau. Their technological characteristics were also fairly uniform, being exclusively flakes associated with a later stage of core reduction. The refitting analysis of a few pieces also provided an excellent sketch of the tool production process, with the authors assuming three cores.

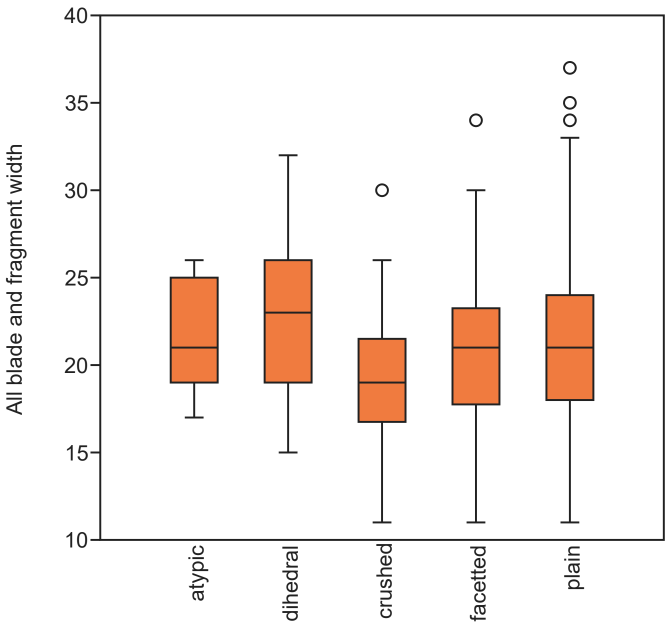

Figure 11. Boldogkőváralja-Tekeres-patak, width values of the complete and fragmentary blades with different butts (atypic, dihedral, crushed, facetted, plain). Scale is in millimeters. Assembled by Norbert Faragó.

Similar depositions are also known from the Late Neolithic period, the Hungarian example mentioned here is from Szegvár-Tűzköves (Biró 2009). The site itself is a multi-layered tell settlement, typical of the Hungarian Plain region and the period, and it is well known in Hungarian and even international research (Tálas 1987). Excavations had been carried out here for several decades, but for us, it is the work conducted in 1955 that is of interest, when a small cup-shaped vessel containing 37 stone blades was found on a building's floor during the excavation led by József Csalog. Of these finds, 33 have survived until now, except one limnosilicite item, all are radiolariates of the Úrkút-Eplény and Szentgál types from the Transdanubian region. The refitting tests were successful, almost half of the finds were (14) matching pieces (Biró 2009). The remaining blades also appeared to fit in some way into the same production processes, with a total of three different starting cores assumed. Although the blades are not retouched, the analysis of their use-wear showed their utilization, and they fit well into the general picture of the material of the tell.

Even from these rare examples, it can be stated, that the guiding principles in the establishment of these contexts vary from site to site. The only fixed element connecting these cases is the presence of a vessel as a container for the selected stone tools. Other aspects driving the selection depended on the local community and its traditions, general attributes are difficult to identify. The numerous and diverse theoretical branches of archaeology have already come to the same conclusion that the exact context of a given find assemblage is as important during the interpretation as the artefacts itself (Gosden & Malafouris 2015; McNiven 2013; Hodder 1991; Renfrew & Zubrow 1994; Robb 1998,). The introduction of the neutral term "structured deposition" came in handy where any "ritual" or "symbolic" interpretation might

	Atypic	Dihedral	Crushed	Facetted	Plain
Depot	6	80	13	138	160
Workshop 1	6	6	1	4	26
Workshop 2	4	7	1	4	31
Workshop 3	3	1	0	0	13
Workshop 4	2	7	4	2	31

Table 1. Boldogkőváralja-Tekeres-patak, distribution of butt types in the depot and the four workshop areas. Assembled by Norbert Faragó.

emerge (Richards & Thomas 1984). However, the excessive use of the term for almost every archaeological feature and phenomenon could result also in a misleading interpretation (Fogelin 2007; Garrow 2012).

During their analysis, Tixier and Mester emphasized the apparent differences between Endrőd, Boldogkőváralja and Szegvár, while they set foot in a strict material and functional domain during their interpretation (Mester & Tixier 2013, 181–183). Later, the possibility of a one-time ritual practice has been formulated during the analysis of the Boldogkőváralja blade assemblage, highlighting only some selected arguments (Király *et al.* 2020).

5. Conclusion

To sum up, the intact blades of the Boldogkőváralja depot differed from each other significantly by their butt preparation, because there is a correlation between butt types and width. The pieces with dihedral butts are significantly wider than the others, especially with facetted or plain butts. On the contrary, the length and the thickness of unbroken blades are very homogenous, irrespective of their preparation techniques. However, not length but width is in concordance with the angle of inclination in this sense, as pieces with dihedral butts are more curved than the others. Again, the differences between dihedral and facetted, and dihedral and plain butts are the largest. Taking into consideration the width of all pieces in the depot (broken and unbroken) the same observation was made, as pieces with dihedral butts are significantly wider than others.

Investigating the distribution of the different butt types across the whole assemblage, it was verified again that the depot stands out compared to the four workshops. While blades with plain butt are the most numerous in the depot and the workshops also, other, more thorough preparations occurred less frequently in the workshops. It has to be stressed, that the presence of the different preparation types is evenly distributed in the four workshops, there are no significant differences between them. It is possible, that careful butt preparation was more useful to get more suitable detachments for the depot, but in an everyday context, more simple methods were preferred. On the other side, the formation of dihedral butts also would have been inappropriate, if width and angle of inclination had been as important as length. Pieces with dihedral butts are significantly wider and more curved than the others.

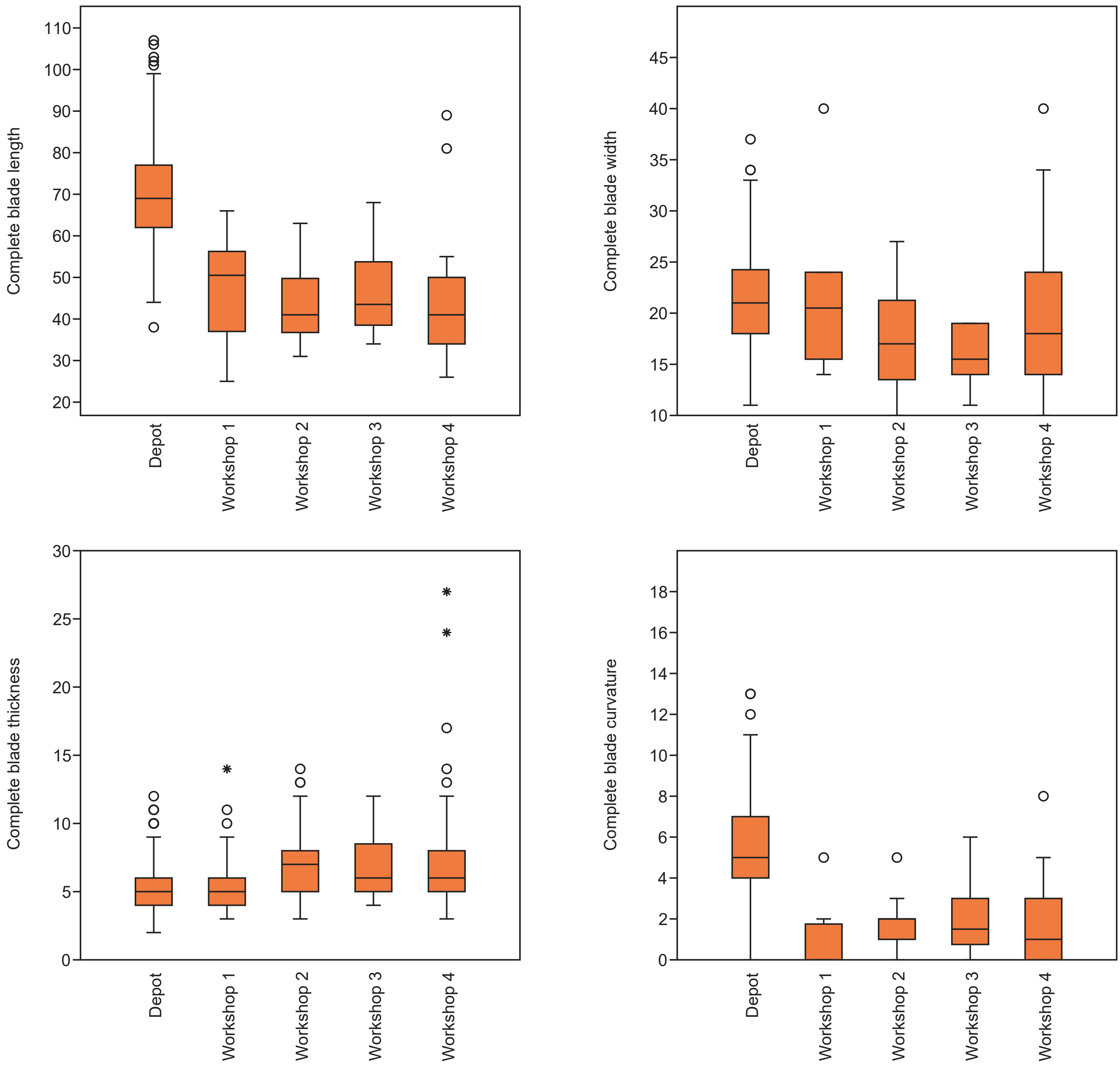

Figure 12–15. Boldogkőváralja-Tekeres-patak, metric attributes of the complete blades of the five assemblages (the depot and Workshops 1–4). Upper left (Figure 13) – width; upper right (Figure 14) – length; lower left (Figure 15) – thickness; lower right (Figure 16) – curvature. Scale is in millimeters. Assembled by Norbert Faragó.

The metric attributes of the workshops suggest the priority of the length and thickness above other measures when pieces were chosen for the depot. Whole blades left in the workshops are significantly smaller, thinner, and a bit narrower. Concerning the width of all blades and blade fragments in all assemblages from the site, this difference becomes more apparent, as the blades from the depot are much wider. The angle of inclination was in correspondence with these observations, as blades deposited in the jar are more curved than the others.

The concept of *chaîne opératoire* has been formulated in the 1960s thanks to the trailblazing work of André Lerhoi-Gourhan (Lerhoi-Gourhan 1964; 1965). Later on, several French scholars helped to transform it into a coherent theoretical framework about the complex relationship between technology and society (Pelegrin *et al.* 1988; Texier & Meignen 2012; Tixier 2012). According to this framework, the production process possesses a structure with phases and sub-phases. At certain points of this process, it is possible to deviate from a given course of events, but there are points at which it is critical to do so (Lemonnier 1989). So, tool-making itself is not only a process determined by natural laws and raw material constraints, but also has a strong human component that is culturally determined (Schlanger 1994). Moreover, the mind which encounters raw material constraints and technological possibilities is necessarily pragmatic and creative, but there is also an intellectual, theoretical aspect of thinking which views the whole process and the cultural choices it contains, from the inside out as a complex and reversible

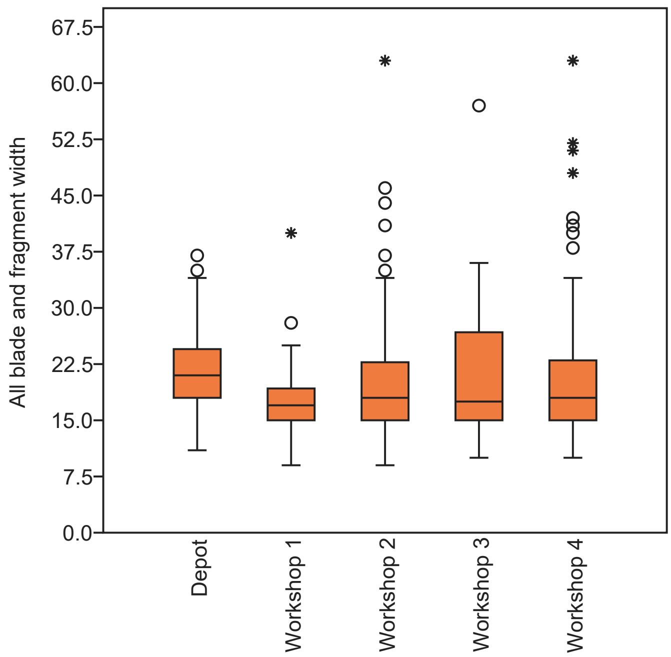

Figure 16. Boldogkőváralja-Tekeres-patak, width values of the complete and fragmentary blades of the five assemblages (the depot and Workshops 1–4).. Scale is in millimeters. Assembled by Norbert Faragó.

structure (van der Leeuw 1994). It is not surprising then when specific technological solutions are raised into a higher cognitive domain to serve as symbols. One example is the regular blade made by pressure technique, the know-how of which transferred a message during the spread of the European Neolithic into the Scandinavian region (Knuttson 2001). Another example is the manufacturing of bifacial daggers in the same region during the dawn of the Bronze Age. According to their study, the most spectacular and most skilful phases of their manufacture were not hidden at all but were performed near the places of the utilization of these tools (Apel 2008).

In conclusion, it is possible to associate all our results with the works dedicated to this blade depot. Vértes correctly emphasized the standardized nature of the metric attributes of these blades, while he mistakenly considered them as markers of a specific industry, or a cultural entity (Vértes 1965). Later, Mester and Tixier successfully argued for the technical reasons behind this standardization, advocating for technological choices over typological or metrical reasons as true cultural markers (Mester & Tixier 2013). Meanwhile, neither Vértes nor Mester and Tixier were concerned with the finds from the rest of the workshops; just Kaczanowska did (Kaczanowska 1985). However, she restricted her evaluation only to general and short statements, without a thorough evaluation and publication. Király, Faragó, and Mester later argued for the ritual aspect of assembling more than 500 very similar blades from the workshops into an accessible jar near a house, but the detailed comparison of the finds was still missing (Király *et al.* 2020). With our data and results presented here, we took one step forward to reconstruct a prehistoric act in its totality.

6. Appendices - descriptive statistics

	Depot complete blade length					Depot complete blade width				
Butt type	**atypic**	**dihedral**	**crushed**	**facetted**	**plain**	**atypic**	**dihedral**	**crushed**	**facetted**	**plain**
N	6	80	13	138	160	6	80	13	138	160
Min	53	38	46	48	44	17	15	11	11	12
Max	80	103	89	107	106	26	32	30	34	37
Sum	381	5760	846	9606	11279	128	1818	260	2854	3437
Mean	63.5	72	65.07692	69.6087	70.49375	21.33333	22.725	20	20.68116	21.48125
Std. error	4.23281	1.44235	3.07484	0.98295	0.88279	1.42984	0.45631	1.41421	0.36625	0.36103
Variance	107.50000	166.43040	122.91030	133.33480	124.69180	12.26667	16.65759	26.00000	18.51074	20.85499
Stand. dev	10.36822	12.90079	11.08649	11.54707	11.16655	3.50238	4.08137	5.09902	4.30241	4.56673
Median	63.5	70	65	69	70	20.5	23	20	20.5	21
25 prcntil	53	64.25	58	61	64	18.5	20	16.5	18	18
75 prcntil	71	80	69.5	77	77.75	25.25	25	24	24	24
Skewness	0.61045	0.38577	0.54572	0.39787	0.19619	0.38018	0.02470	0.29417	0.22973	0.61428
Kurtosis	-0.24474	0.05724	0.99597	-0.09034	0.23607	-1.40979	-0.62123	0.07203	-0.25986	0.74983
Geom. mean	62.81492	70.86329	64.22146	68.67191	69.60446	21.09733	22.35328	19.38583	20.23049	21.01127
Coeff. var	16.32791	17.91776	17.03598	16.58854	15.84048	16.41741	17.95983	25.49510	20.80353	21.25913

Appendix 1. Boldogkőváralja-Tekeres-patak. depot blade length and blade width descriptive statistics.

	Depot complete blade thickness					Depot complete blade curvature				
Butt type	**atypic**	**dihedral**	**crushed**	**facetted**	**plain**	**atypic**	**dihedral**	**crushed**	**facetted**	**plain**
N	6	80	13	138	160	6	80	13	138	160
Min	4	3	3	2	2	2	0	2	0	0
Max	8	11	8	11	12	7	13	7	12	11
Sum	37	461	75	732	851	28	485	71	688	791
Mean	6.166667	5.7625	5.769231	5.304348	5.31875	4.666667	6.0625	5.461538	4.985507	4.94375
Std. error	0.74907	0.18508	0.42598	0.13784	0.11641	0.76012	0.25492	0.51410	0.18484	0.16992
Variance	3.36667	2.74035	2.35897	2.62203	2.16820	3.46667	5.19858	3.43590	4.71512	4.61946
Stand. dev	1.83485	1.65540	1.53590	1.61927	1.47248	1.86190	2.28004	1.85362	2.17143	2.14929
Median	6.5	5.5	6	5	5	5	6	6	5	5
25 prcntil	4	4.25	4.5	4	4	2.75	5	3.5	3	4
75 prcntil	8	7	7	6	6	6.25	7	7	6	6
Skewness	-0.36154	0.90528	-0.19687	0.93875	0.94190	-0.39249	0.47973	-0.80978	0.38781	0.42785
Kurtosis	-2.10274	0.88363	-0.62615	1.69411	2.04846	-0.94305	1.23262	-0.94449	0.59394	0.40446
Geom. mean	5.91913	5.54505	5.56216	5.07041	5.12720	4.29758	0.00000	5.08627	0.00000	0.00000
Coeff. var	29.75429	28.72711	26.62219	30.52716	27.68472	39.89783	37.60888	33.93947	43.55489	43.47494

Appendix 2. Boldogkőváralja-Tekeres-patak. depot blade thickness and blade curvature descriptive statistics.

	Whole assemblage complete blade length					Whole assemblage complete blade width				
Assemblage	**Depot**	**Workshop 1**	**Workshop 2**	**Workshop 3**	**Workshop 4**	**Depot**	**Workshop 1**	**Workshop 2**	**Workshop 3**	**Workshop 4**
N	405	7	17	6	27	402	7	17	6	27
Min	38	37	31	34	26	11	14	10	11	10
Max	107	66	63	68	89	37	24	27	19	40
Sum	28407	352	741	278	1200	8604	135	287	95	538
Mean	70.14074	50.28571	43.58824	46.33333	44.44444	21.40299	19.28571	16.88235	15.83333	19.92593
Std. error	0.58025	3.99830	2.33273	4.86256	2.79159	0.21874	1.62882	1.18471	1.22248	1.38873
Variance	136.35890	111.90480	92.50735	141.86670	210.41030	19.23371	18.57143	23.86029	8.96667	52.07123
Stand. dev	11.67728	10.57850	9.61807	11.91078	14.50553	4.38563	4.30946	4.88470	2.99444	7.21604
Median	69	53	39	43.5	41	21	18	16	15.5	18
25 prcntil	62	37	36.5	38.5	34	18	15	13	14	14
75 prcntil	77	57	50.5	53.75	50	24.25	24	21	19	24
Skewness	0.35311	-0.08824	0.81670	1.38597	1.59715	0.28266	0.05926	0.31771	-0.56486	0.97823
Kurtosis	0.06704	-0.71962	-0.25837	2.33332	3.32169	0.00180	-2.25259	-0.52686	0.26078	0.95216
Geom. mean	69.17674	49.29683	42.65863	45.19256	42.53651	20.94988	18.86806	16.21022	15.57879	18.77916
Coeff. var	16.64835	21.03680	22.06576	25.70672	32.63743	20.49072	22.34534	28.93376	18.91225	36.21432

Appendix 3. Boldogkőváralja-Tekeres-patak. whole assemblage blade length and blade width descriptive statistics.

	Whole assemblage complete blade thickness					Whole assemblage complete blade curvature				
Assemblage	Depot	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Depot	Workshop 1	Workshop 2	Workshop 3	Workshop 4
N	7	17	6	27	405	7	17	6	27	87
Min	4	4	5	3	0	0	0	0	0	10
Max	14	11	9	27	13	5	5	6	8	63
Sum	58	103	37	243	2109	8	32	12	45	1835
Mean	8.28571	6.05882	6.16667	9.00000	5.20741	1.14286	1.88235	2.00000	1.66667	21.09195
Std. error	1.24813	0.43276	0.65405	1.11197	0.10941	0.70470	0.26956	0.85635	0.36980	1.07692
Variance	10.90476	3.18382	2.56667	33.38462	4.84797	3.47619	1.23529	4.40000	3.69231	100.89840
Stand. dev	3.30224	1.78433	1.60208	5.77794	2.20181	1.86445	1.11144	2.09762	1.92154	10.04482
Median	8	5	5.5	7	5	0	2	1.5	1	18
25 prcntil	5	5	5	6	4	0	1.5	0.75	0	15
75 prcntil	10	7	7.5	11	7	2	2	3	3	23
Skewness	0.50383	1.39656	1.35376	1.91612	0.40169	1.87355	0.87724	1.75524	1.63931	1.97368
Kurtosis	0.60060	2.37660	1.23967	3.77949	0.59782	3.43235	3.64534	3.65703	3.27438	4.34805
Geom. mean	7.70544	5.84559	6.01266	7.72392	0.00000	0.00000	0.00000	0.00000	0.00000	19.36898
Coeff. var	39.85457	29.45006	25.97971	64.19936	42.28226	163.13980	59.04514	104.88090	115.29230	47.62395

Appendix 4. Boldogkőváralja-Tekeres-patak. whole assemblage blade thickness and blade curvature descriptive statistics.

	Depot all blade and fragment width					Whole assemblage blade and fragment width				
	atypic	dihedral	crushed	facetted	plain	Depot	Workshop 1	Workshop 2	Workshop 3	Workshop 4
N	7	103	18	178	213	564	82	108	30	87
Min	17	15	11	11	11	11	9	9	10	10
Max	26	32	30	34	37	37	40	63	57	63
Sum	151	2326	351	3663	4549	11979	1443	2129	622	1835
Mean	21.57143	22.58252	19.5	20.57865	21.35681	21.23936	17.59756	19.71296	20.73333	21.09195
Std. error	1.23167	0.42179	1.05796	0.32026	0.30797	0.18452	0.51149	0.78506	1.73995	1.07692
Variance	10.61905	18.32401	20.14706	18.25649	20.20228	19.20193	21.45333	66.56170	90.82299	100.89840
Stand. dev	3.25869	4.28066	4.48855	4.27276	4.49469	4.38200	4.63177	8.15854	9.53011	10.04482
Median	21	23	19	21	21	21	17	18	17.5	18
25 prcntil	19	19	16.75	17.75	18	18	15	15	15	15
75 prcntil	25	26	21.5	23.25	24	24	19.25	22.75	26.75	23
Skewness	0.09082	-0.00518	0.56421	0.17777	0.53205	0.28108	1.54581	2.28811	2.10980	1.97368
Kurtosis	-1.20513	-0.87198	0.78497	-0.32454	0.64478	-0.11428	5.64225	7.87460	6.19409	4.34805
Geom. mean	21.35919	22.16857	19.01785	20.12836	20.89263	20.78375	17.06288	18.46851	19.15870	19.36898
Coeff. var	15.10650	18.95561	23.01819	20.76308	21.04572	20.63151	26.32054	41.38665	45.96516	47.62395

Appendix 5. Boldogkőváralja-Tekeres-patak. descriptive statistics of complete and fragmentary blade width values in the depot and in the whole assemblage.

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