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LEAFPOINTS OR RATHER "LEAFKNIVES"? A TECHNOLOGICAL ANALYSIS OF BIFACIALLY SHAPED ARTEFACTS FROM MAUERN, GERMANY

ABSTRACT: The article shows the results of a scar pattern analysis of 21 bifacially worked artefacts from the site Weinberghöhlen (Mauern) in the Altmühl Valley, Germany. A characteristic feature of the described tools is the significant asymmetry of one edge, which is much more convex than the other one. The results show that none of the analysed tools bear traces of an idea of creating a symmetric tool with two edges convergent at the exposed tip. A lot more effort was put on the retouch of the edge and its course than on exposing the tip and making the tool more symmetrical. The asymmetry appeared at the moment of shaping the edges, the retouch has slightly deepened it. There is no trace of sequences which eliminated the asymmetry and form the shape of the tool. Therefore, we may conclude that none of the analysed tools can be called leafpoints from a technological point of view. The raw material used to produce tools from Mauern certainly conditioned the form of the tools. The small thickness of flat flint slabs meant that in order to obtain a usable edge it was necessary to perform broad flat decorticating removals on both sides. Further knapping had to follow the same pattern, so as not to blunt the edge. At the same time the thickness of the material was too small to create tools in the type of Micoquian Keilmesser, but the raw material allowed for producing tools with long working edges. It was logical, therefore, to change the system of repair of one edge into a tool in which one could use subsequently fragments of edges and then abandon them. Therefore analysed tool should be rather called "leafknives" than leafpoints.

KEY WORDS: Middle/Upper Palaeolithic transition – Altmühlian – Leafpoints – Technology – Scar pattern analysis – Raw material

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INTRODUCTION

Leafpoints are often considered the "index fossils" for the Middle/Upper Palaeolithic transition in Central Europe (Allsworth-Jones 1986, Bosinski 1967, Freund 1952, Mester 2008, 2010), but also for several Middle Palaeolithic (MP) industries such as Altmühlian (Bohmers 1939, 1951), Babonyian (Ringer 1983, 2000, Ringer, Kordos 1995), Bohunician (Oliva 1984, Valoch 1976, 1982, 2008), Jankovichian (Gábori-Csánk 1990, 1993) or Moustero-Levalloisian of the Balkans (Dzambazov 1967, 1971, Haesaerts, Sirakova 1979, Kozłowski 2003, Sirakova, Ivanova 1988). The mentioned industries were considered as the early phase of later "transitional cultures" such as Szeletian, Ranisian, Jerzmanowician (Bosinski 1967, Chmielewski 1961, Freund 1954, 1987, Hillebrand 1935, Hülle 1977, Kadič 1916, Luttropp, Bosinski 1967, Prošek 1953).

If one takes into consideration the Middle Palaeolithic industries with leafpoints, it becomes clear that in many cases the occurrence of leafpoints is the only common element in the inventory of mentioned entities. Thus, it is essential that the attribution of these artefacts is conducted according to a definition that presents a coherent tool concept. Till now, leafpoints have been classified according to typological definition of a bifacially shaped, symmetric tool in the shape of a leaf, which is at least three times wider than ticker (Ginter, Kozłowski 1975).

The paper presents technological analyses of bifacial tools from Mauern, which are the most representative inventory of Altmühlian industry (Allsworth-Jones 1986, Bolus 2004, Bosinski 1967, Hopkinson 2007). The term "Altmühlian group" was introduced by Bohmers (1939: 156), who treated it as early phase of the later, e.g. Szeletian leafpoints industries (Bohmers 1951). Such assumption has been widely accepted and since then, the Altmühlian leafpoints were treated as a characteristic and distinctive element of late Middle Palaeolithic in Germany (Allsworth-Jones 1986, Bolus 2004, Bosinski 1967, Hopkinson 2007), and have their continuation in later Szeletian industries.

The objective of the paper is to check if in case of the most representative MP leafpoints from Germany a unified tool concept is represented. Recent analyses by Richter (1997) and Uthmeier (2004) advocated the possibility that one is dealing here not with leafpoints, but a kind of a bifacial double scraper concept (*Dopperschaber*) with very specific diagonal symmetry (*Drehsymmetrie*). This paper shows the results of technological analyses conducted on a sample of bifacial leafpoints from Mauern, which was aimed at checking those assumptions.

THE WEINBERHÖHLEN SITE (MAUERN)

The Weinberhöhlen site (Mauern) consists of several interconnected caves located on the western slope of the Weinberg hill in the Wellheimer Trockental valley, Germany, north of the modern Danube River valley.

Excavations on the site were carried out three times. The first systematic archaeological work began in 1937 with Schmidt and was later ran by Bohmers (1937–1939) (Bohmers 1939, 1951). Another study was undertaken by Zotz in 1947 and he led it until 1949 (Zotz 1955, 1959). Due to stratigraphy divergences obtained during the first two excavations, a re-exploration began in 1967 and was carried out by Müller-Beck and von Koenigswald (Koenigswald *et al.* 1974). The last excavations confirmed the general stratigraphical description made by Bohmers.

According to Bohmers, the artefacts were located in six out of 10 layers (*Figure 1*). In the F layer, Bohmers found 33 bifacially worked leafpoints. Apart from these, he also recovered two handaxes and 61 other tools, among them mainly: side scrapers (also with bifacial retouch), 15 cores and 210 non-retouched artefacts (Bohmers 1951). This inventory was described as Altmühlian by Bohmers. Bohmers correlated the subsequent weathering layers with the Vistulian Interstadials: the F layer was dated to Early Vistulian Interstadials (OIS 5c) (Bohmers 1939: 156).

Zotz, on the basis of his excavations, distinguished 10 layers (Zotz 1955). In two of them, F1 and F2, he found leafpoints. The F1 layer should be seen as an equivalent to the Altmühlian level (layer F) of Bohmers (*Figure 1*). Layer F2 can be correlated with layer G' by Bohmers, which he had called Mousterian. In total, Zotz's excavations yielded 18 leafpoints (of which six were from the F2 level and 12 from F1). Zotz believed in the evolutionary link between Acheulean, Central European leafpoint industries and Solutrean culture. Therefore, he defined the upper layers (F1 and F2) containing leafpoints as Presolutrean level II, and the industries found in the lower layers (G and H) as Presolutrean level I (Zotz 1955). Zotz (1955: 21) correlated the F1 layer with Würm 2 (Lower Pleniglacial), and the F2 layer with Würm 1–2 (Early Vistulian Interstadial).

Müller-Beck made the correlation of all three profiles (*Figure 1*). As a result, he agreed with the results obtained

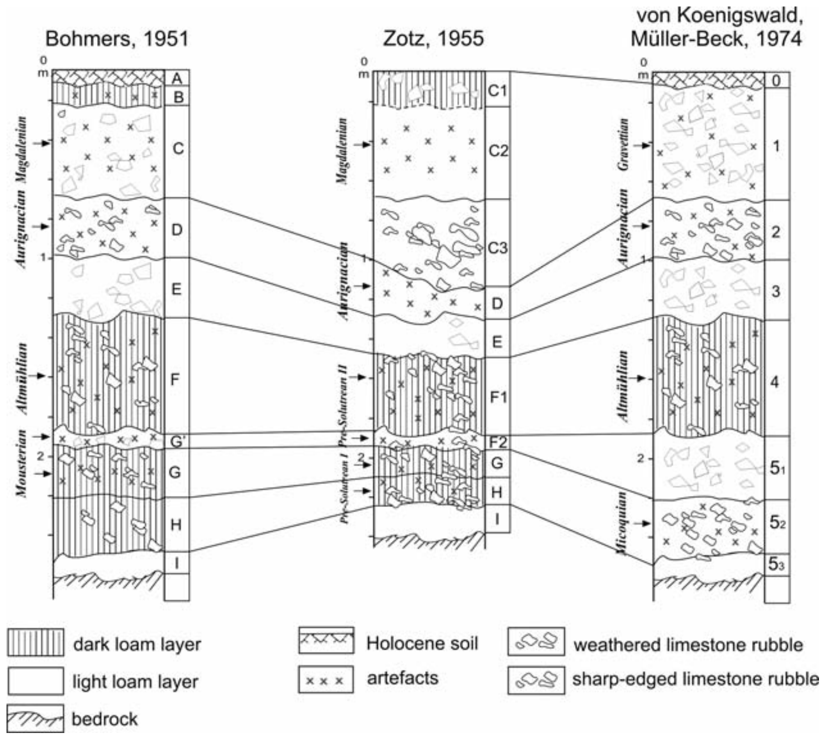

FIGURE 1. Collective profiles correlation from Bohmers, Zotz and von Koenigswald, Müller-Beck study.

by Bohmers (Koenigswald, Müller-Beck 1975, Koenigswald *et al.* 1974). A layer defined by Zotz as F2, and by Bohmers as G', which is characterised by the presence of sharp-edged limestone rubble and Middle Palaeolithic artefacts, was correlated by Müller-Beck with a temperate climate and dated to First Pleniglacial (OIS 4).

The Müller-Beck chronology has been criticised recently (Hopkinson 2007, Richter 1997, 2009, Uthmeier 2004), noting that in the region there are no sites with signs of settlement during the maximum of the First Pleniglacial (OIS 4). Owing to comparative analyses with Sesselfelsgrotte data, the Altmühlian levels were correlated with M.M.O-B3 dated to Oerel/Glinde (OIS 3) (Richter 1997). Uthmeier (2004: 274) suggested that layer G (by Bohmers), containing Micoquian artefacts, as well as G', should be dated to the early phase of OIS 3 by analogy to the layers of Sesselfelsgrotte (G-Complex) (Richter 1997). The layer F containing leafpoints (defined in the study of Zotz as F1), was described as a brown layer with weathered limestone rubble and should therefore also be dated to OIS 3. What is more, due to the comparative analyses of both inventories from Mauern and Sesselfelsgrotte, the Altmühlian has since been identified with the Micoquian assemblage of M.M.O.–BB3 cultural horizon (Richter 1997, Uthmeier 2004). Thus, it does not appear as a distinct cultural unit of "transitional character", but as a part of the latest standard Middle Palaeolithic industries in southern Germany. The following paper aims at testing the statement from the perspective of tool concept.

MATERIAL AND METHODS

Material

The technological analysis covered 21 artefacts from the Weinberghöhlen site, 13 of them come from Bohmers' collection and 7 from Zotz' collection. For the analyses, all the bifacial tools in a shape similar to a leafpoint which are currently stored in the Archaeological Museum in Munich were chosen. Of the analysed specimens, 20 are referred to as leafpoints or their fragments in the literature (Bohmers 1951, Zotz 1955, 1959). One form (1951_663) was defined as a type of knife (Bohmers 1951: Taf. 41).

The artefacts differ from one another in terms of morphology, mainly the size and shape. All the artefacts of Mauern are plano-convex and characterised by small thickness, which was caused by using very thin slabs (about 1 cm thick) of flint called Plattensilex (Bohmers 1951). The average thickness of Mauern tools is 0.93 cm.

Methods

In the Mauern collection mainly bifacial tools got preserved. The lack of debitage products did not allow to use the refitting method. Due to such limitations, the so-called scar-pattern analysis (working steps analysis) was used. This method has been used for a short time only (Bourguignon 1992, Richter 2001, Uthmeier 2004), and so far it was applied with success in the analysis of Middle Palaeolithic bifacial tools (Boëda 1995a, 1995b, 2001, Graßkamp 2001, Jöris 2006, Migal, Urbanowski 2006, Soressi *et al.* 2003, Soressi, Hays 2003, Urbanowski 2004).

A direct result of each examination is the reconstruction of single tool manufacturing scheme. However, it is the further comparative examination that allows to understand bifacial tool formation process, and reconstruct a general tool concept, which can be called a "mental template" (Migal, Urbanowski 2006) or an "ideal type" as defined by Cziesla (1989).

The analysis started from establishing the chronology of removal scars visible on the tool and combining single flake scars into flaking sequences which would, as a whole, reflect a particular action in the tool reduction sequence. The focus of the examination is placed on reconstructing the underlying idea of the knapper, and not only the sole sequence of flaking actions. For this reason, the analysis of the flaking sequences parameter was used to understand the function of each of them. What is more, it was observed that the diversity of removals derived from different parts of the tool. In most cases, different parts of the tool were treated consequently differently during the following manufacturing stages. Such parts of the tool were distinguished as separate techno-functional units (Boëda 2001, Kot 2013, in press), e.g. a cutting edge, a distal-posterior edge, a base, a back.

A crucial examination component was to establish the functions of all actions undertaken at consecutive manufacturing stages and correlate them with particular techno-functional units. Owing to this, it was possible to determine what the goal of forming certain part of the tool was, and consequently, following parameters significant to the knapper, which decided about the utility of a given form, or its abandonment.

Much as this outcome is informative in itself, it is the collective and comparative analysis of particular reduction sequence within a chosen sample that may bring the most interesting findings. It was based on dividing the manufacturing process into stages, and comparing artefacts among one another using particular tool formation stages with reference to then applied schemes. The approach adopted in this paper can be called a techno-functional approach (Boëda 1995a, 1995b, 2000, 2001, Boëda *et al.* 2013) because it was focused on understanding the technological function of certain flaking sequences.

RESULTS

All the analysed tools are characterised by significant technological cohesion. However, they can be divided into three major groups. The groups presented below were distinguished due to scar pattern analysis and do not correspond to the divisions described by Bohmers (1951: 71). One single tool (1951_663) does not fall into any of the groups and so it will be described separately.

Group I

The first group includes tools which are characterised by slight edge asymmetry (one edge is slightly more convex than the other one; *Figures 2, 3*). In two cases (1949_780, 1951_603), the asymmetry is more visible and the more convex edge even has a biangular profile.

In these tools one cannot see any difference in edge treatment due to removal types but subsequent removals were performed at a different angle in relation to each edge. One of the edges was formed with removal series perpendicular to the vertical axis. This led to the creation of a straight vertical edge. The other edge was formed by angular removal series in relation to the vertical axis, creating a convex edge (*Figure 2*). The difference in both edges treatment appears already at the stage of edge forming and is then continued at the stage of edge retouching. Both edges were formed in parallel at each production stage.

What appears to be also typical are the differences in the treatment of both surfaces. One face is flat and has no retouch, whereas the second is slightly convex and displays all the retouches.

Tool knapping proceeded in four stages (*Figure 2*):

I. Surface formation. Flat extensive removals were performed onto both tool faces. Their purpose was not only surface formation, but also nodule decortication. All of this was done on one and then on the second edge.

The convex edge was treated as the second, whereas the first to be knapped was the more vertical one.

II. Edge formation. At this stage, differences in the treatment of both edges are clearly visible. As already mentioned, one of the edges is formed with a series of perpendicular removals, which reinforces the formation of a vertical edge. The second edge is formed with angular removals which make it more convex (*Figures 2, 3*).

III. Edge retouches. The edges were retouched in a bottom-top edge scheme. A flat removal series applied onto the lower face preceded a marginal retouch series. The marginal retouch is semi-flat. After the marginal retouch, a series of small removals to correct edge profile were applied if necessary on the lower face.

IV. Notches. At the end of the manufacturing process, notches were formed. Some of them, made with a single semi-abrupt removals, could be treated as postdepositional damages; nonetheless, their identical location on a number of tools can indicate their intentional nature. The tools have at least three notches, of which one is located at its base/tip (*Figure 4*), the other two on the edges. The notches might have occurred either during use, or they might be traces of hafting. The second option is implied by their location.

The artefacts 1949_780 and 1949_791 had gypsum fillings at the edges which made it difficult to analyse

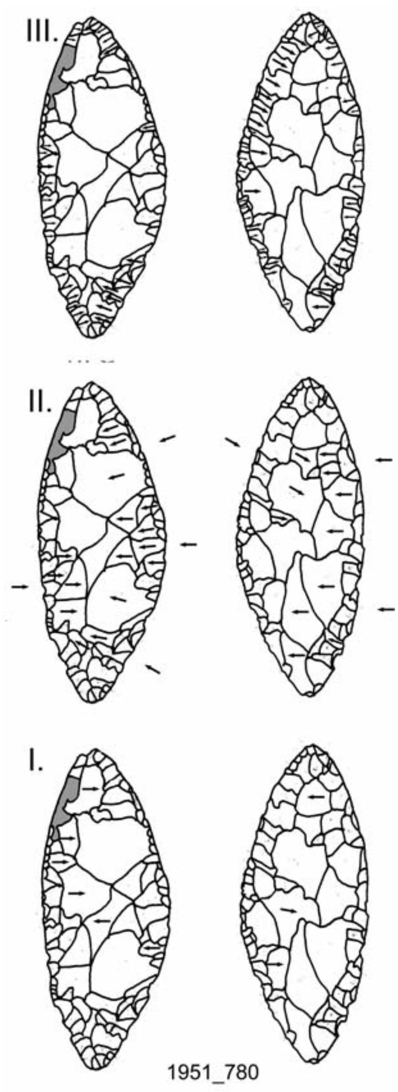

FIGURE 2. Removal directions and manufacturing scheme on group I tool. Phase I, surface formation; phases II, edge formation; phase III, edge retouches. The scheme shows different treatment of both edges already at edge formation stage (phase II).

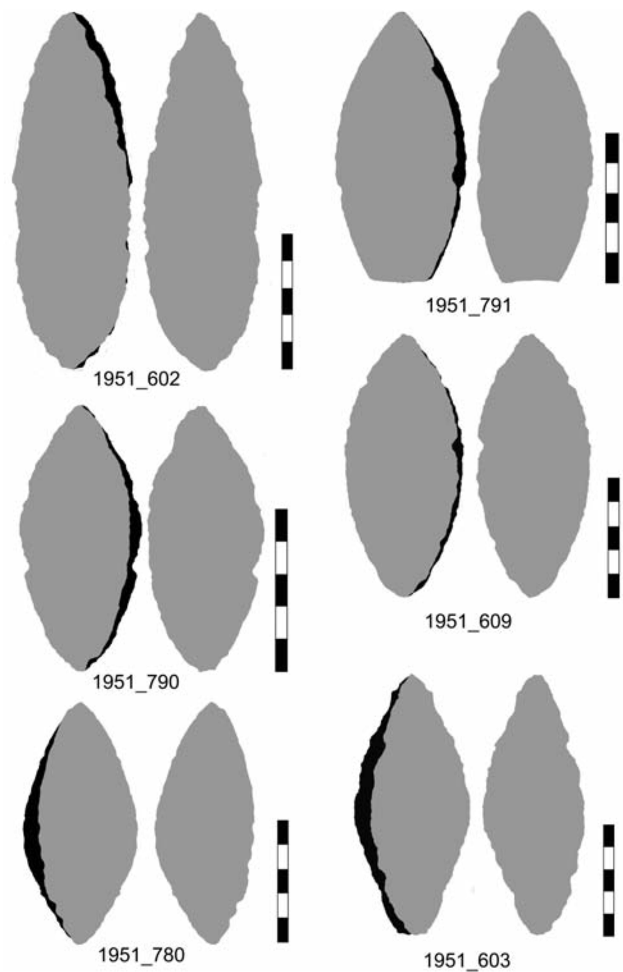

FIGURE 3. Group I tools shape classification with marked edge asymmetry in vertical axis.

them properly. Due to the courtesy of the Archaeological Museum in Munich, it was possible to remove the fillings. As revealed in the analysis, the fillings existed in the notches whose location corresponds well with the remaining notch system in the artefacts included in group I.

In case of the 1949_780 tool, one can be sure that though one of the percussions (which created a notch) is postdepositional, but earlier notch-creating percussions were derived during the manufacturing process. Thus, it can be assumed that in this case, part of the edge underwent postdepositional truncation at the existing notch. In case of the 1949_791 artefact, nothing indicates that the maintenance of the filled notch had a postdepositional nature.

The tools show no signs of intensive repairs, which may be due to the fact that the next retouch series would only cause total edges blunting. Small slabs thickness prevented any attempts to renew the edges angle by means of removals onto the lower face.

The tools display traits of care for their shape. The angular sequences at the very tips resulted in the creation of convex edges converging at the tip. However, greater strain was put on edge profile, even though tool symmetry could have been achieved at a very small expense. For example, in the 1949_780 or 1951_603 tools, additional retouch series could have led to a better tip exposure and its return to the vertical axis (*Figure 3*).

The tools of group I exhibit asymmetry in vertical axis, as well as a lack of care for the tip. At the same time, the tools were knapped very precisely. More attention was devoted to edge profiles than to their symmetry. Both edges were treated in a parallel manner. No traces of preference for any edge in particular are visible (except for a different removals angle, which creates bigger convexity on one of the edges; it is difficult, though, to find an explanation for such edge treatment). In addition, however, the tools are largely symmetrical along the horizontal axis – the tip was treated analogously to the base.

The construction of group I artefacts suggests that these tools were used in hafts. As a matter of fact, all their edges are sharp and the tools not only do not have the back, but also, in most cases, a base, which could have served as a handle. Therefore, the tools were most probably shaped with the idea of hafting. Hence, the notches and truncations, as it was already mentioned by

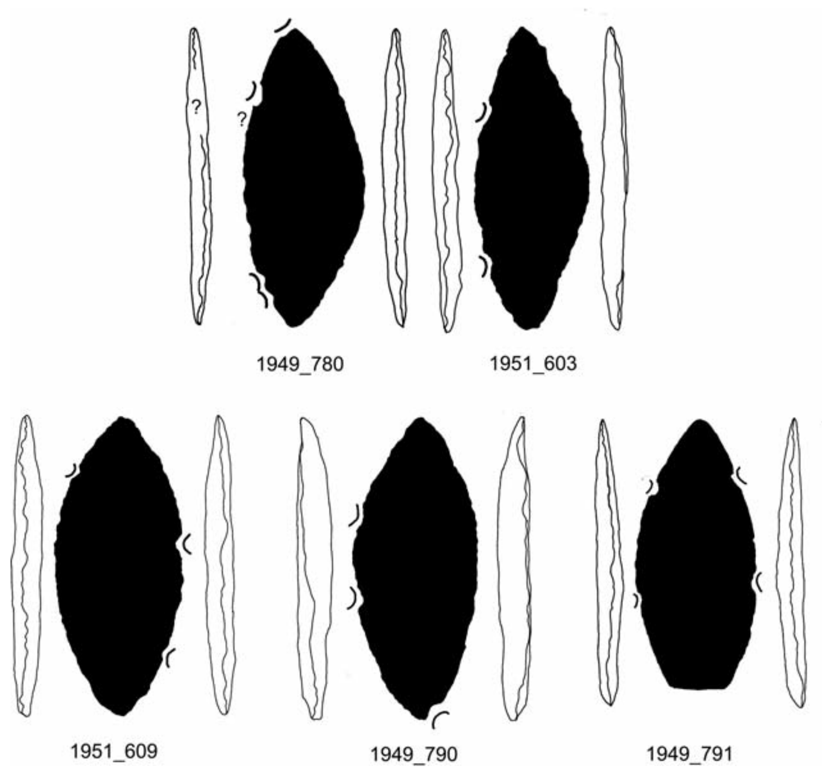

FIGURE 4. Positions of notches in group I tools and the profile line of both edges.

Bohmers (1951: 71) may probably be traces of tool hafting, or movements of the implement in the haft. The arrangement of notches suggests that first one of the tips could have been used, and then the tool was rotated and the second tip was at work. This might be indicated by equal treatment of both tool ends, as well as both edges on their entire length.

Group II

The second group of artefacts is characterised by significant edge asymmetry, of which one is much more convex than the other (*Figure 5*). In this respect, the artefacts resemble the tools from group I, but what distinguishes them is above all the production technology, which might have led to the marked difference in the arrangement of both edges.

From the perspective of retouches, both edges are treated equally and have a similar, straight profile (*Figure 5*). One can notice significant care for a straight edge profile throughout its entire length, from the tip to the base. The tip, due to edge asymmetry, is not in the tool axis, and it is well exposed. The artefacts reflect a tendency for lack of a marginal retouch at the very tip, perhaps due to the care for edge profile. If so, it would indicate greater attention devoted to the edge profile than to the tip itself. As a result, the tip is slightly exposed but not retouched.

Additionally, the 1949_786 and 1951_612 tools have a characteristic big notch on one of the edges, located near the base (*Figure 5*). The notch is formed with several semi-abrupt or abrupt removals and has traces of usewear. The process of notch knapping removes the base off the tool axis and exposes it at the same time. The 1949_788 tool has multiple postdepositional fractures and it was glued together as well as completed with gypsum in the course of restoration. By courtesy of the Archaeological Museum in Munich it was possible to remove the gypsum and observe the entire artefact. Hence, the very base of the tool is missing, which makes it impossible to see whether the tool had a notch at the base or not.

All artefacts classified into group II have a very similar knapping scheme. This scheme can be described as "consequent edge scheme of knapping", where the tool, after initial manufacturing, was knapped on one of the edges from the moment of shaping until marginal retouch. Only then the second edge was formed, from surface formation to edge retouch. In case of flake tools, knapping was limited to edge formation and retouch. The most consequent edge scheme was applied in the 1949_786 tool, where the convex edge knapping begins with extensive removals forming the surface on the lower face, right after forming, shaping and correcting removals or maybe even after a marginal retouch of the opposite edge (*Figure 6*).

The tools are also characterised by different treatment of both tool surfaces, one of which is flat, and the other one is convex and retouched. Each knapping stage follows a bottom-top scheme, where flattening removals are derived on the lower face, whereas the upper face is formed with semi-flat removals and retouches. It is worth noting that these tools could have been made more symmetrical by performing a series of removals onto the lower face, but the removals would have made the edge profile more S-shaped, which, as it seems, was avoided. This may indicate that for the described tools, the retouch and straight edge profile were more important than the tool symmetry in itself.

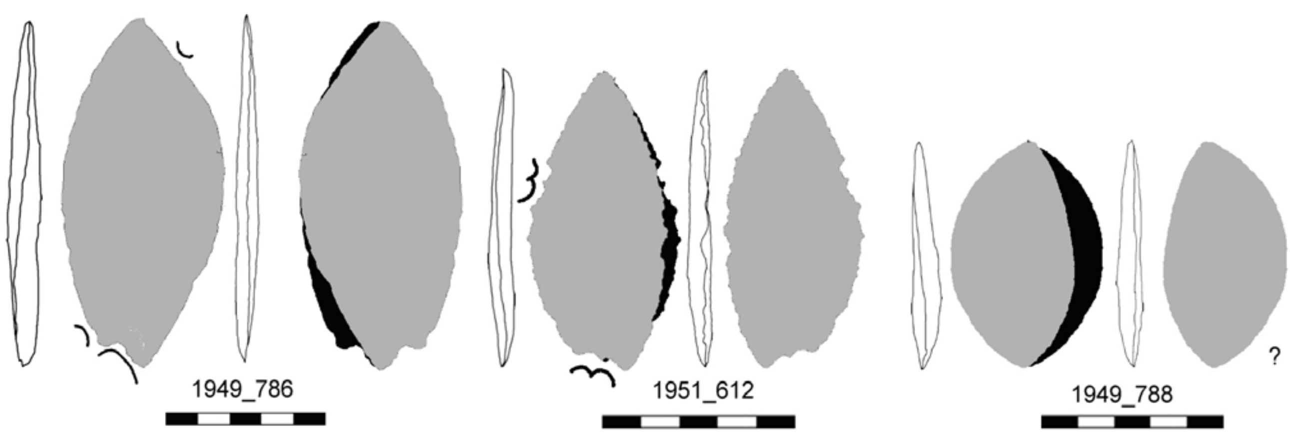

FIGURE 5. Comparison of group II tool shapes with marked edge asymmetries along the vertical axis, and with notches on the edges.

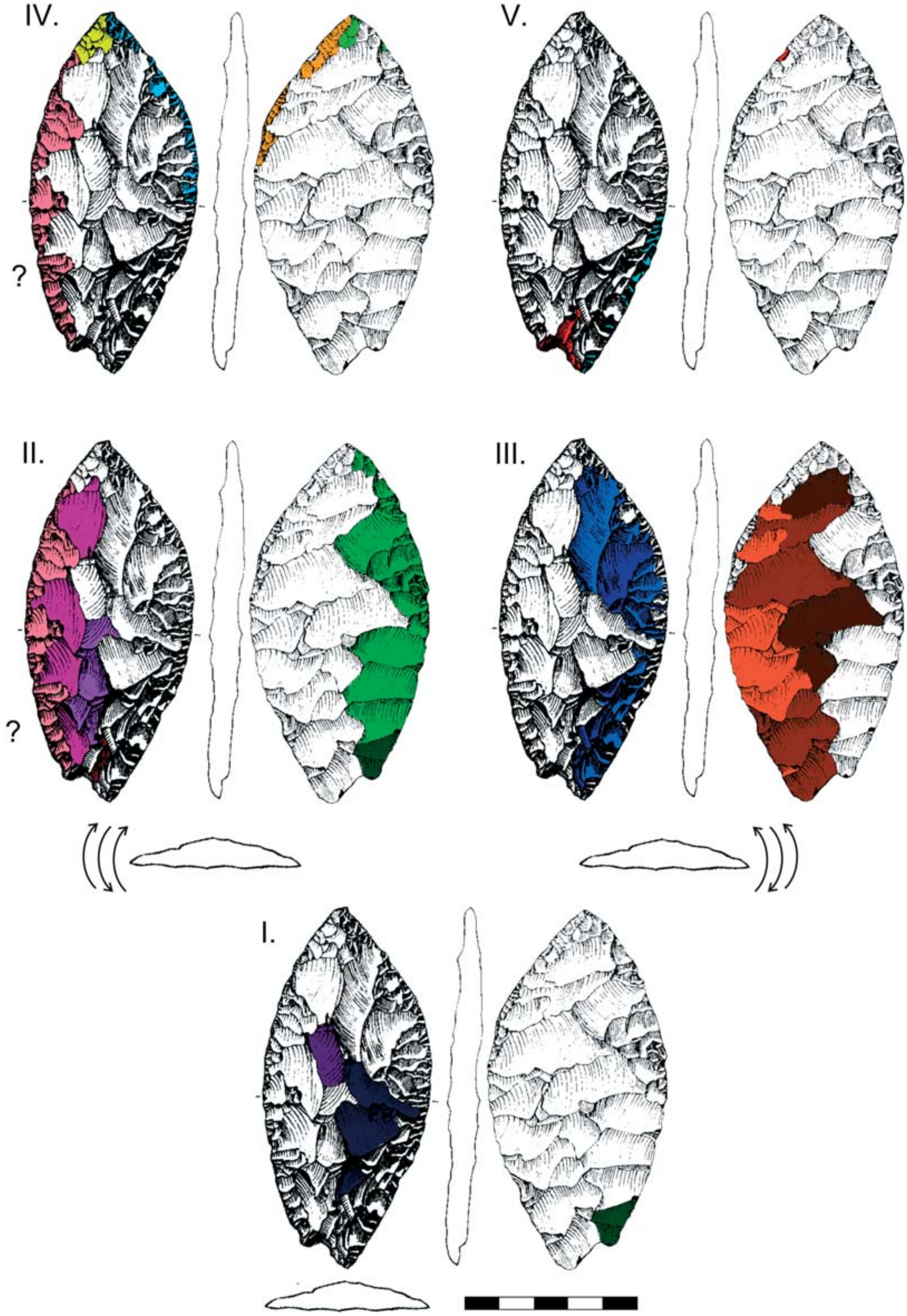

FIGURE 6. Consequent edge scheme of knapping of the 1949_786 tool. Phase I, surface formation; phases II and III, edge formation from extensive removals to probably marginal retouch series; phase IV, repair; phase V, notch formation. Original drawing after Zotz (1955: Fig. 46).

From the point of view of reduction sequence it appears to be an important fact that the steep notches at the base were made during the manufacturing process. In the 1951_612 tool the notch appeared before knapping the other edge. The retouch focused on the near-the-base part of the edge, opposite to the notch. In case of the 1949_786 tool, first a notch near the base had been created, and then the edge opposite to the notch was retouched. An analogous retouching scheme in relation to the created notch as well as identical notch location and morphology suggests that these tools represent a similar way of tool using and, probably, hafting. The following figure shows a hypothetical reconstruction of how these tools were hafted (*Figure 7*).

Parallel to that, it ought to be underlined that on the 1949_786 tool, two zones appear on each edge, different in terms of usewear (Uthmeier 2004: Figure 5.26). In contrast to the part of the same edge located closer to the tip which has traces of intensive usewear, visible even without magnification, the parts located directly near the notch do not have traces of usewear (*Figure 7a*). On the other edge the usewear is very clearly visible on the part of the edge located near the notch. The part closer to the tip has a less intensive usewear. Such a distribution of usewear may suggest not only hafting of the tool, but also the fact that the edges could have been used interchangeably (*Drehsymmetrie*; Richter 1997). Perhaps, therefore, after retouching one of the edges, the first notch was created at one of the tips. Then, after edge blunting, the manufacturing and retouching of the second edge was done by removing the previous notch and creating a new one on the opposite end (*Figure 7b*). Hence, one can assume that the state in which the described artefacts can be seen today is only the final stage of the entire tool using and reshaping scheme.

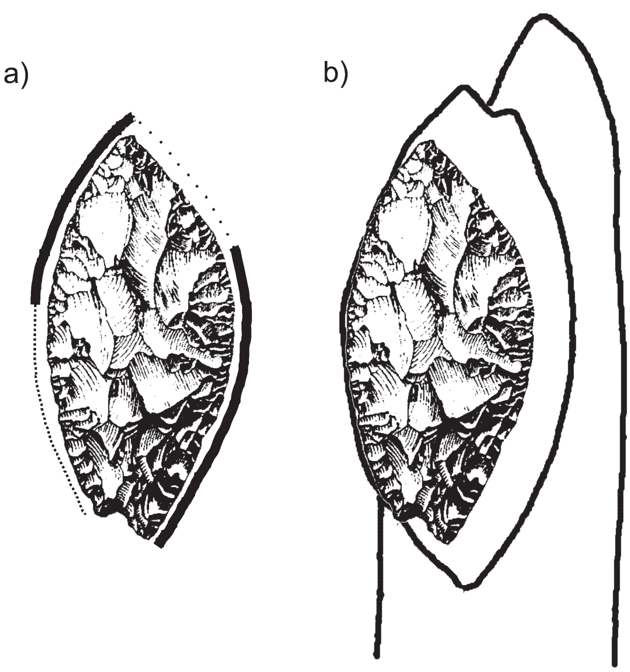

FIGURE 7. Artefact 1949_786. (a) usewear placement on the edges. Red marks edge fragment with intensive usewear, yellow–less intensive usewear, blue–edge without usewear; (b) hypothetical hafting of group II tools according to visible notches and usewear placement. The scheme depicts two usage phases with one tool edge being used first and the other one next. Original drawing after Zotz (1955: Fig. 4.6).

There is no direct data pointing to the presence, of a notch placed at the second tip at earlier knapping stages. In case of the 1951_612 and 1949_788 tools (*Figure 5*), its existence is impossible due to very little flake thickness in its apical part. However, even with the second notch absent, it is a fact that in case of the 1949_786 tool (*Figure 7*), first the apical part of the first edge was subjected to intensive use. Then, the second edge was formed and retouched, and the part near the base was used. The tool in this respect is, therefore, its own mirror reflection in the diagonal axis (*Figures 6, 7a*), which can be explained only by changing the tool's orientation and changing the base into the tip (Richter 1997: 204, Uthmeier 2004: 135).

If the described tools are to be regarded as forms with only one edge used at a time, then the question arises as to the described tools' ergonomics, and mainly the 1949_786 tool. What was, then, the purpose of such precise convex edge line formation and tip exposure, if at that time only half of one edge and tip were used?

Comparing the amount of effort put into the formation of both tools (1951_612 and 1949_786) to the final effect (the length of the cutting edge), one can have doubts as to the validity of the presented tool hafting reconstruction. On the other hand, the diagonal location of the notch, with no technical obstacles for forming a transversal notch which would enable vertical tool hafting, allows for the hypothesis that the artefacts were hafted diagonally.

What is characteristic of the described artefacts is:

– edge manufacturing scheme, focused on obtaining a long, convex edge;
– mirror placement of edge sharpening retouch and usewear in diagonal axis (*Figure 7a*).

The observed edges asymmetry is probably related to their scheme of knapping and their non-parallel manufacturing process. This means that one of the edges was formed from the beginning until the end, and only then the second. Such a manufacturing process indicates that the edges and their profiles were more important than their symmetry, which might have even not been taken into account. The edges, then, do not have shaping sequences. Every consecutive sequence follows the edge shape formed by the previous sequence, only slightly affecting the overall edge shape. In case of these tools, getting a straight edge profile appears to be a major feature in relation to the rest of tool. Also, the system of notches, with a large notch at the base, indicates that at this point, for the purpose of producing or resharpening one of the edges, it was possible to partly remove the opposite edge or blunt it by producing a series of notches (1951_612).

Group III

The largest group consists of broken tools which were retouched and rejuvenated after breaking. These tools have two edges processed in parallel and treated with identical types of removals, one of the edges is usually more convex, but this is not a rule.

The tools, like other bifacially worked artefacts from Mauern, are plano-convex, which is the result of different tool surfaces treatment. At the same time, edges were formed simultaneously during the tool manufacturing process, but also after the breakage when retouch was provided analogously on both edges.

All artefacts included in this group have transversal fracture scars at the base (*Figure 8*). Most tools were broken in about half of their length. Each of the described artefacts was retouched after fracture. It is interesting that in most cases, the fracture appeared after the edge formation stage and before the edge retouch stage. In this case, both edges were retouched only after the transversal fracture. Only the 1951_604, 1949_777 and 1951_618 tools have retouching sequences made on one of the edges before breaking (or the analysis did not allow to establish with full certainty that retouching was performed after fracture). In all three cases, the second edge is retouched after

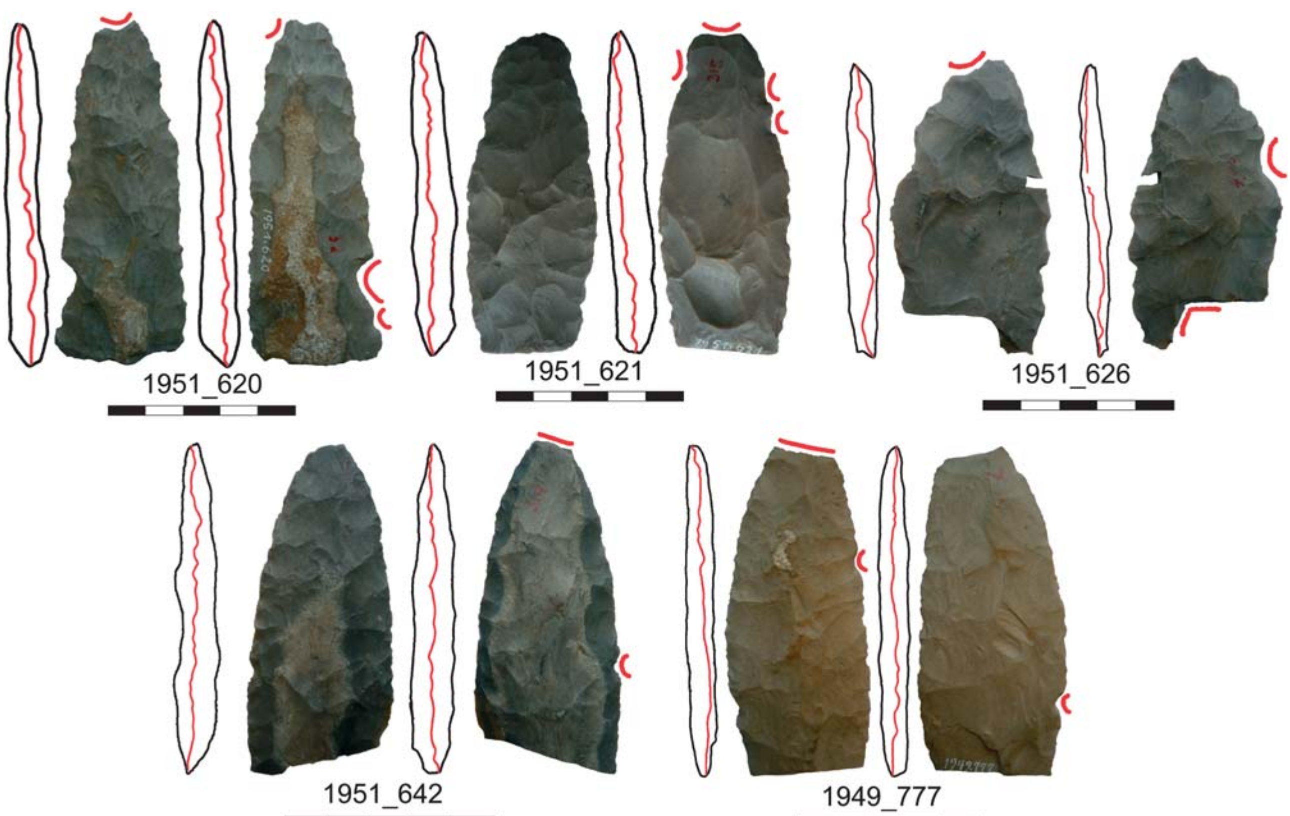

FIGURE 8. Group III tools shape comparison and edge profile scheme. The scheme also shows notches placement.

fracture, whereas there are no traces of post-fracture repair applied on the first edge.

From the perspective of the manufacturing process, the tools were formed analogously to group I tools.

I. Surface formation. By performing flat, broad removals on both surfaces.

II. Edge formation. At this stage, edge shape and profile correcting removals are derived. The removals are less extensive than during surface formation, but they go far onto the tool's surface. Their aim is also to thin the thickest blank parts. Removals are not performed along the entire edge length, but only where this is necessary.

III. Transversal fracture. An impact point is visible on three fracture scars. In the following four cases one can recognise that the tool was broken by a percussion introduced in the middle of either the lower or the upper face. In three cases, the scar is not clearly visible or its observation was not detailed enough to unambiguously determine the fracture's nature. If the fracture scars required correction, its surface was additionally retouched (1951_620, 1951_604), or the angle between the fracture scar and the edge was removed with a series of steep removals (1951_618, 1949_787, 1951_620).

IV. Edge retouch and potential repairs. Edge retouch was derived according to the bottom-top scheme, where a flat removal series on the lower face was done first, and then a convex surface was formed with semi-flat removals retouching the upper face. If necessary, a further series of minor edge profile correcting removals was derived along the lower face. The tools are, then, retouched on both edges to the upper face. Two of the described tools (1951_620 and 1951_626) have an irregular edge profile caused by applying a denticulated marginal retouch. This may indicate that the edges were repaired, and this caused their blunting. Additionally, the 1951_626 tool was retouched on both surfaces. The remaining tools show neither repair signs nor edge resharpening removals.

V. Notches. Eight of the described tools have notches along their edges (*Figure 8*). They differ among themselves in both their size and their creation intensity: from those with a single truncation on the edge up to those formed with multiple, steep removals (1951_620). In most cases, the notch shows signs of wear, which can be the trace of usewear, or getting worn in the hafting process. In three cases, semi-steep or steep removals were derived on the tip, resulting in its removing and blunting, or even more, creating a notch on the tip (1951_620 1951_621, 1951_642). The described notches may be related to the notches at the base observed in group II tools, and therefore could have been used for tool hafting the tool. This conclusion, however, is not a definite one.

One should take into account the fact that the described artefacts' shape was acquired by these forms after the base fracture. In addition to that, the artefacts are characterised by lack of retouching on the very tip, which moves it off the axis.

All of the presented features, that is: the transversal fracture, impact point visible on some fracture scars, no retouching or only partial retouching before breakage, parallel retouching of both edges after breakage or the retouch of an edge non-retouched earlier, indicate that these tools had been intentionally broken after the edge formation stage. Subsequent production stages and edge retouches, ran analogously to those in, e.g. group I tools. It therefore cannot be said that the described tools were reshaped after fracture and that their original concept was different from the ultimate effect.

Even if group III tools were not broken intentionally, which seems to have been successfully proved above, they bear witness to the re-usage of failed preforms of other unfinished bifacial tools. The post-fracture care for both edges, with parallel lack of concern for the tip, or even its obliteration with steep removals, testify to the fact that these artefacts should be seen as double working edge tools (probably not at the same time, but interchangeably).

Other tools

An interesting tool is 1951_663 (*Figure 9*). This is a completely bifacially knapped tool with one edge straight and the other convex. The tool is equally knapped both at the tip and the base, both tip are unexposed. In case of the described tool, the upper or the lower face cannot be considered since the tool, when convex at the tip, it is flat at the base and vice versa on the other face. Perhaps such a form is due to the original shape of blank used for tools production. However, this shape was used to create a tool whose base is the mirror image of its tip after the tool's rotation by 180° (*Figure 9*). Its production was therefore performed in such a way that when rotated, the tool was still functional.

DISCUSSION

Bifacially worked tools from Mauern are called leafpoints in a literature of subject (Allsworth-Jones 1986, 1990, Bohmers 1951, Bolus 2004, Bosinski 1967, Hopkinson 2007, Koenigswald *et al.* 1974, Zotz 1955). The majority of the analysed material fits the general

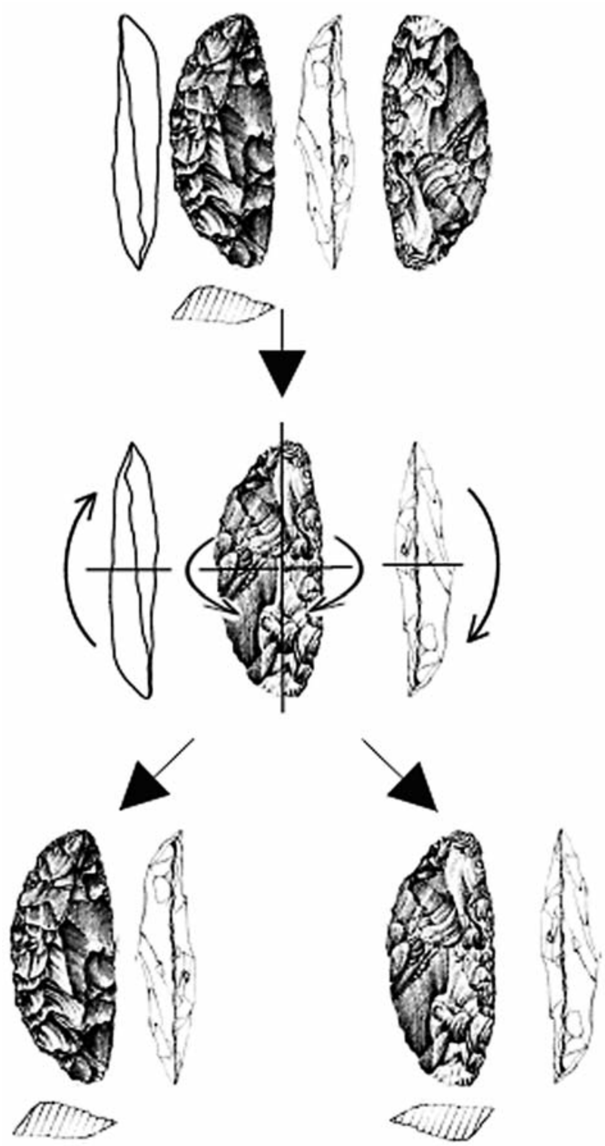

FIGURE 9. Edges arrangement scheme of 1951_663 tool. The tool being symmetrical after its reorientation achieved through rotating it in its vertical and horizontal axes. Original drawing after Bohmers (1951: Taf. 41.1).

typological definition of a leafpoint. However, the technological analysis revealed that in case of Mauern, from the perspective of the manufacturer's plan, the greatest emphasis was put on creating straight in profile, long, sharp edges. The analysed tools from Mauern exhibit therefore a different mental tool template than leafpoints. The whole manufacturing process of these tools differed because of its different aims. Bifacial tools from Mauern, contrary to leafpoints, did not indicate that symmetry was meticulously planned (Kot 2013, in press). Moreover, some of the artefacts became symmetrical only as a result of later repairs. The tools are characterised by the primacy for their sharpness over the shape can be seen.

The tools are plano-convex in cross section, which is caused by different treatment of both tool surfaces, one of which is flat, and the other one is convex and retouched. The scheme was applied in a bottom-top-bottom-top manner by introducing flat removals onto the lower face and semi-flat onto the upper face. All of this was done on first, and then on the second edge. Such a bottom-top-bottom-top edge scheme is substantially different from the plano-convex/plano-convex one described by Boëda (1995a, 1995b) where one edge is formed semi-abruptly on one face and flat on the other, and only then the second edge is knapped analogically but alternately, which contributes to the tool's biconvex cross-section. In such cases, the abrupt removals were aimed at preparing an appropriate angle for further flat removals on the opposite face. In case of Mauern, first the flat removals were derived on the lower face, and only after the semi-flat ones on the upper face. On the other hand, the scheme was also substantially different from WGK described by Bosinski (1967) because one edge was created first, and only then the second one was knapped. The WGK scheme is aimed at creating all the tools surfaces and edges (the back, the cutting edge, the base etc.) simultaneously, whereas in Mauern one is dealing with a tool concept focused on creating only the cutting edge.

The raw material (Plattensilex) used to produce tools from Mauern certainly conditioned the tools' form and knapping scheme in itself. The thickness of material was too small to create tools according to the scheme of knife used in typical Keilmesser forms, e.g. Klausennische, Königsaue A (Burdukiewicz 2000, Jöris 2006, Kot in press, Mania, Toepfer 1973, Obermaier 1927, Obermaier, Wernert 1914, 1929). A knife is a tool whose main aim is to maintain the cutting edge; thus, it is an essential, and supposedly also functional artefact part (Kot 2013, in press). The Keilmessers are constructed in a way which enables multiple resharpening of single edge without its blunting. The main goal of the repair process is to resharpen/rejuvenate the edge without losing its straight profile. The other edges, particularly the distal posterior edge, are created due to the need of adjusting the angle of the cutting edge during subsequent resharpening stages.

In case of tools from Mauern, the raw material did not allow for producing tools with a thickness big enough for subsequent rejuvenation of one edge. Nevertheless, the thin slabs enabled the production of long working edges. It was logical, therefore, to change the manufacturing scheme of subsequent repairs of one edge into creating a tool, in which it would be possible to use interchangeably consecutive edge fragments. Then after one part of the edge was exhausted, the other part could be used. At the same time, notches would enable tool hafting with the use of a subsequent tool part. The described bottom-tom-bottom-top edge scheme of knapping can also be treated as a consequence of adjusting the manufacturing process to the small thickness of flint slabs.

CONCLUSIONS

All the described Mauern items have several common features. On one hand both edges were formed with identical removal series, analogously to each other; both edges were also retouched. On the other hand most tools show certain edges asymmetry, one of which is more convex than the other. They do not bear traces of formation or any special treatment aimed at preserving tool symmetry. Sequences which would enhance the edge asymmetry and form the tool shape are notably absent.

The manufacturing process was divided into three main stages: surface formation, edge formation and retouch. Between those main steps breakages could appear (group III). Both edges were not necessarily knapped simultaneously (group II), but one edge could have been prepared by applying sequences of removal of all three stages, and only then the second edge could have been done. Such formation of the edges symmetrical in the diagonal axis of the edge, the placement of the use-wear and the system on notches suggests the reorientation of tools during the rejuvenation stage.

The described features give us grounds to conclude that we are dealing rather with leaf-shaped knives or "leafknives" instead of leafpoints. Such a concept is more similar to the Micoquian Keilmesser than to a leafpoint, which can strengthen the conclusions by Richter (1997) and Uthmeier (2004) that Altmühlian has no particular cultural significance. Bifacial tools from Mauern shall be therefore seen more as an adjustment to the specificity of raw material than as a significant feature of a separate cultural entity.

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