Quaternary International 428 (2017) 3–25

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Analysis of bifacial elements from Grotte de la Verpillière I and II (Germolles, France)

Jens Axel Frick*, Harald Floss

Department for Early Prehistory and Quaternary Ecology, Institute for Pre- and Protohistory and Medieval Archeology, Eberhard Karls University of Tübingen, Schloss Hohentübingen, Burgsteige 11, 72070 Tübingen, Germany

ARTICLE INFO

Article history:
Available online 13 January 2016

Keywords:
Biface
Asymmetrically bifacially-backed knife
Keilmesser
Middle Paleolithic
Tranchet blow

ABSTRACT

Bifacial objects are iconic lithic artifacts of Middle Paleolithic assemblages. This paper presents a comparative analysis of the production sequences of bifacial objects from Grottes de la Verpillière I and II (VP I and II) in Germolles, Saône-et-Loire, France. This study shows that despite morphological diversity, a general production sequence exists for all of the bifacial artifacts: phases of backing, bottom-side and top-side configuration and cutting-edge regularization. The study also compares the bifacial assemblages from modern excavations in intact sediments (VP II), mixed sedimentological units (VP I and II), the backdirt of old excavations (VP I) and museum collections from prior excavations and surface collections (VP I), which show notable diversity. An attempt is made to resituate assemblages without clear spatial provenience into the framework established by studies of the material from *in situ* sediments containing bifacial elements from Verpillière II, with reference to the notes of former excavators of Verpillière I. Asymmetrically bifacially backed knives from Verpillière I derive from the entrance of the rock shelter. Moreover, despite distinctive differences of both sites and their bifacial assemblages, they share similarities with regard to both production sequences and components.

1. Introduction

Bifacially-worked lithic objects (bifaces) are a common feature of Late Middle Paleolithic (LMP) assemblages in Europe. They have served and continue to serve as *fossiles directeurs* and important elements of the definitions of several lithic industries, including the *Moustérien de tradition acheuléenne* (MTA), Mousterian with Bifacial Tools (MBT), *Keilmessergruppen* (KMG), and Micoquian (MIC). Assemblages with bifacial elements from southern Burgundy (Saône-et-Loire, France) have therefore been variably attributed to lithic industries that are centered in southwestern France (MTA) or central Europe (KMG), or integrated into newly-defined assemblage clusters (MBT). However, the precise attribution of these assemblages yielding bifacial lithic elements remains a subject of debate (e.g. Farizy, 1995; Richter, 1997; Jöris, 2003; Koehler, 2009; Frick, 2010; Ruebens, 2013).

Initial studies performed by Desbrosse et al. (1973, 1976) showed that the *Keilmesser* (bifacially backed knives) with tranchet blow (KMTB) from the Grotte de la Verpillière I (VP I) at Germolles display strong similarities to objects from Ciemna and Okiennik (Poland), as well as Buhlen (Germany). Farizy (1995) documented a Micoquian influence on assemblages in Eastern France and defined a group called *industries charentiennes à influences micoquiennes*. In the late 1990s, VP I (often referred to simply as "Germolles" prior to the 1990s) was integrated into discussions of the so-called *Keilmessergruppen* (name from Mania, 1990) and was seen as *Keilmesser* assemblage with a unifacial Quina industry (Richter, 1997; Jöris, 2003).

New studies on old collections from VP I (Floss, 2003, 2005; Frick, 2010; Dutkiewicz, 2011) showed that this lithic industry attributed to the Middle Paleolithic contains a strong Levallois component and identified additional bifacial elements.

Renewed excavation at the site has been undertaken since 2006 under the direction of H. Floss with the aim of establishing correlations between the old collections and, remaining intact, stratified sediments at the site. An unexpected outcome of these excavations was the discovery of a new site 50 m south of VP I, which has been named Grotte de la Verpillière II (VP II; Frick and Floss, 2015). This newly identified site, a collapsed rock shelter with a cave tunnel, has been under excavation since 2006 and has yielded intact

* Corresponding author.
E-mail address: jens-axel.frick@ifu.uni-tuebingen.de (J.A. Frick).

http://dx.doi.org/10.1016/j.quaint.2015.10.090

Middle Paleolithic stratigraphic units. At present, only one of these units (Geological Horizon 3, or GH 3) has yielded bifacial elements (Frick and Floss, 2015). Analysis of bifacialelements from stratified units at VP I provides a local point of comparison for similar material from VP I (from old collections and the backdirt of the old excavations). At this juncture, the excavated undisturbed layer (GH 16) from VP I, attributed to the Middle Paleolithic, has yielded only one bifacial preform. However, GH 15 and 18 (directly overlying GH 16) constitute a horizontally-mixed layer of Middle and Early-Upper Paleolithic implements, and have yielded two bifacial objects (Floss et al., 2013a,b, 2014a,b).

In this paper, we present a comparative assessment of bifacial elements from both, Grotte de la Verpillière I and II. Our research on the bifacial elements identified thus far suggests a strong affinity with assemblages from Central Europe bearing *Keilmesser*, called *Keilmessergruppen*.

2. Regional setting

The sites of Verpillière I and II (Fig. 1) are located on the eastern cliff-face of the Montadiot massif (around N 46,8090; E 4,7418; 212 m a.s.l.) in the small valley of the Orbize River in the village of Germolles (community of Mellecey, Saône-et-Loire, France). The sites are named after the local subdistrict of Verpillière and were formed by erosion of soft limestone elements of the Upper Oxfordian formation. The karstic formation of both sites corresponds with the opening of the Rhine-Saône-Rhône graben system (Bons and Wißing, 2009). Both sites are in fact rock shelters sealed by collapses at their openings, rather than caves, as their name suggests.

Unfortunately for the present discussion, radiometric dating (ESR/U–Th, IRSL and AMS ^{14}C) is in progress and the final results cannot be presented at this time. Preliminary results, however, suggest that the Middle Paleolithic layers of VP II could have been deposited during the late OIS 4 or early OIS 3 (pers. comm. L. Zöller, Bayreuth). This is supported by the faunal remains, which include medium-to-cold condition species like mammoth (*M. primigenius*), wooly rhino (*C. antiquitatis*), bovids (*B. primigenius* and *B. bonasus*) and cervids (*R. tarandus* and *M. giganteus*) (Wilk, 2014a,b).

2.1. Grotte de la Verpillière I

The Grotte de la Verpillière I has been known as an archeological site since 1868, when it was discovered during road construction. The first excavations were conducted in the same year by Charles Méray and his collaborators (Méray, 1869). Since then, around 20 excavations have taken place in the rock shelter and on its terrace (Dutkiewicz, 2011; Dutkiewicz and Floss, 2015). The site is well known for its assemblages of bifacially backed knives (*Keilmesser*) from the Middle Paleolithic (Desbrosse and Texier, 1973a,b; Desbrosse et al., 1976; Floss, 2005; Frick, 2010). It has also yielded the easternmost known Châtelperron points and many typical Aurignacian implements like carinated pieces and split-base points (Gros and Gros, 2005; Dutkiewicz, 2011; Floss et al., in press). Breuil (1911) used the assemblage of this site (as well as e.g. Solutré and Aurignac) to demonstrate his hypothesis that the Aurignacian was positioned stratigraphically between the Mousterian and Solutrean.

In the course of the last decade, all accessible museum collections from previous excavations and surface collections at VP I were archived in a single database (Frick, 2010; Dutkiewicz, 2011). The recent excavations have yielded bifacial elements as well as other artifacts attributed to the Late Middle Paleolithic, Aurignacian and Gravettian, and, to a much lesser extent, Neolithic and Medieval material.

2.2. Grotte de la Verpillière II

Grotte de la Verpillière II is located around 50 m south of VP I. As mentioned above, the site was first identified in 2006 during the excavations at VPI. Since 2009, excavation activities have focused on the present-day entrance to the cave tunnel in stratified, intact units attributed to the Late Middle Paleolithic on the basis of lithic and faunal material (Table 1).

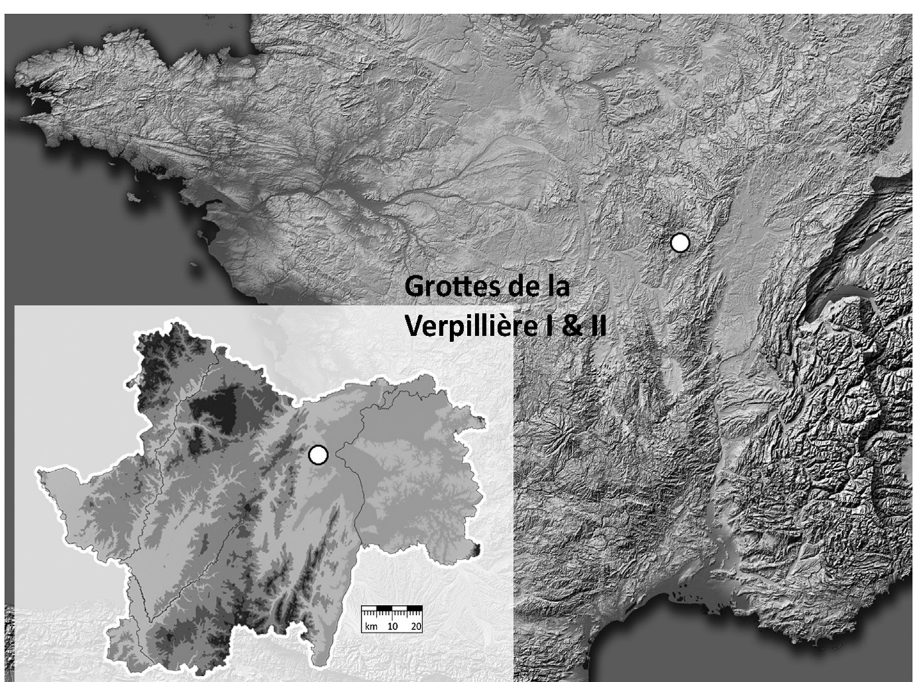

Fig. 1. Position of the Grottes de la Verpillière in Eastern France and in the Department of Saône-et-Loire. Base maps from NASA Shuttle Radar Topography Misson 2000 (eoimages.gsfc.nasa.gov).

Table 1
Stratigraphical Geological Horizons (GHs) of VP II (Frick and Floss, 2015).

Geological layer (GH)	Status	Yield	Sediment	Thickness
1	Mixed	Modern material, items from the middle ages, upper and middle paleolithic artifacts	Cover soil with many limestones and less humus and throw-off of the badger den (maybe also from the top of the plateau)	Around 0.1 m
2	Mixed	Modern material, items from the middle ages, upper and middle paleolithic artifacts	Soil with a big humus content, mostly bigger limestones, limestone blocks of the roof collapse, patches of cave sediments, badger den	0.2–3 m
3	Intact	Middle paleolithic artifacts	Mostly aeolian soil with a small fluvial component, slightly altered through bio- and cryoturbation, very find grained	0.4–1 m
4x	Intact	Middle paleolithic artifacts	Mostly aeolian soil with a small fluvial component, almost no alteration visible, mid-fine grained	0.05–0.1 m
4	Intact	Middle paleolithic artifacts	Mostly aeolian soil with a small fluvial component, almost no alteration visible, mid-fine grained	0.1–0.4 m
5	Intact	Sterile	Dark-brownish soil horizon under the contemporary entrance	0.05–0.1 m
6	Intact	Sterile	Yellow weathering horizon of limestones inside the cave	0.05–0.5 m
7	Intact	Sterile	Weathered flowstone	Around 0.1 m
8	Intact	Sterile	Concreted limestone blocks	Around 0.7 m
9	Intact	Possibly another find horizon	Crusts and blocky deposits of limestone (only in a small depth sondage)	Possibly 0.1 m

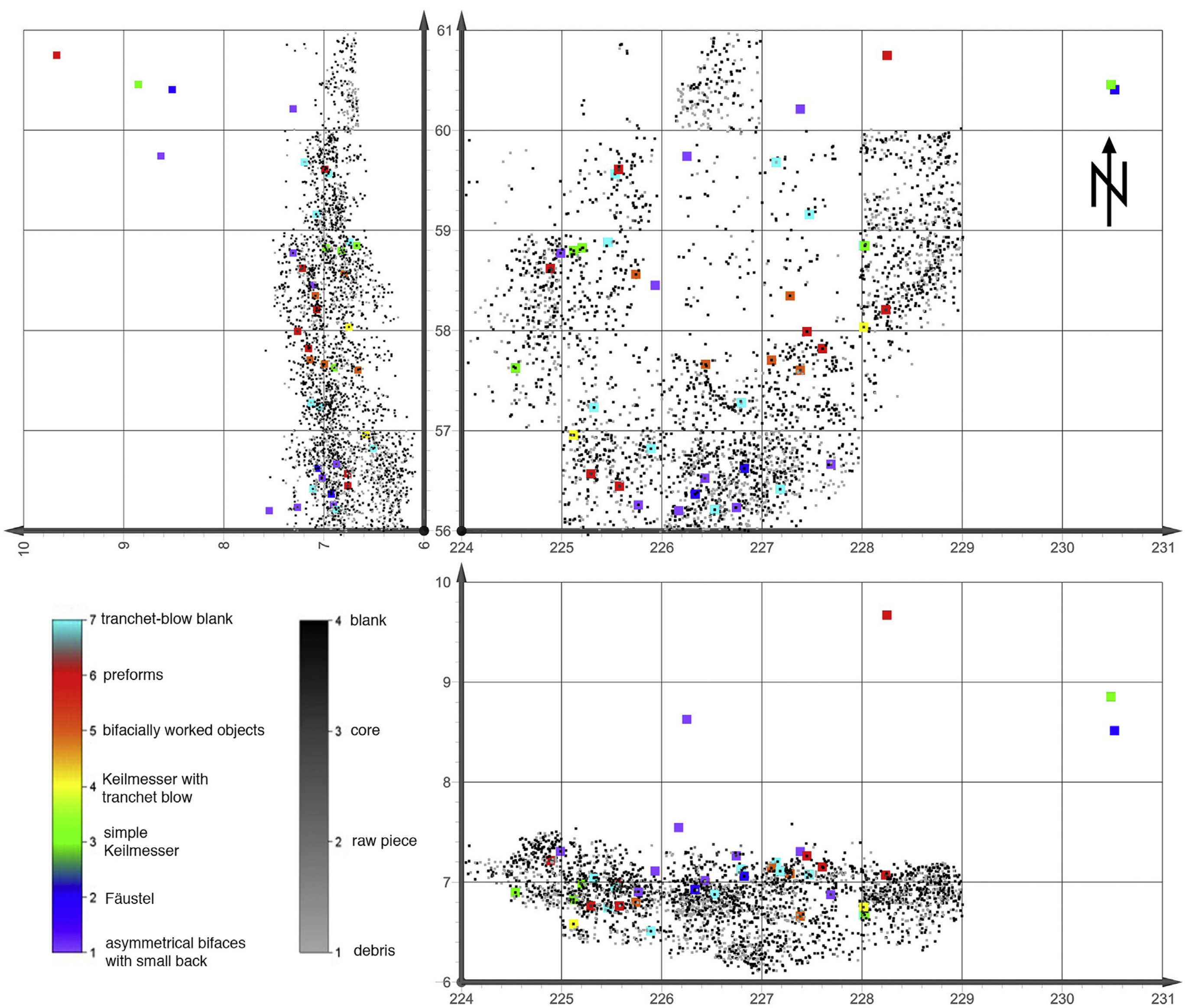

Fig. 2. Three dimensional distribution of lithic artifacts from GH 1 and 2 (colored dots outside the gray point cloud) and GH 3 (colored dots inside the gray point cloud) of the Grotte de la Verpillière II (from excavations between 2009 and 2014). Gray to black squares are all piece-plotted lithic object of every silicious raw material from GH 3. Color squares are all bifacial elements from GH 1, 2, 3 and 4x. Top left – view to west; top right – top view; bottom left – legend and bottom right – view to north. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Currently, three Middle Paleolithic units are known (GH 3, GH 4x and GH 4). These layers (around 1.5 m thick) were deposited on top of a previous rock collapse and are sealed by a second collapse. On top of the massive, collapsed limestone blocks that sealed the Middle Paleolithic units, landslide sediments from the plateau and mixed sediments from an animal den were deposited (GH 1 and GH 2). Bifacial elements are known from these two mixed layers, as well as from the underlying, intact GH 3. The underlying GH 4x and 4 have so far yielded only unifacial elements. Three-dimensional piece-plotting shows that the bifacial elements are distributed in the upper parts of GH 3 (Fig. 2).

The uppermost, mixed layers of GH 1 and 2 are moderately rich in artifacts and include objects of Medieval and Roman origin, Upper Paleolithic artifacts (bladelets and carinated pieces), Châtelperron points, and diverse Middle Paleolithic artifacts (including bifacial objects).

3. Stratigraphy, deposits and bifacial assemblages

3.1. Grotte de la Verpillière I

The assemblages of bifacial elements from VP I consist of pieces from three different sources: 1. stratified units from the ongoing excavations; 2. the backdirt of old excavations; 3. collections of material from former excavations and surface collections. In the first case, the correlated units of GH 15 and 18 (probably reworked material from Middle and Upper Paleolithic deposits) contain bifacial elements (n = 2). The backdirt of many previous excavations has also yielded bifacial elements (GH 1 n = 12, GH 31b n = 1, and GH 41b n = 1). It is highly possible that backdirt from the terrace was brought into the cavity to fill in old, collapsing trenches. The third set of assemblages, bifacial elements from various prior excavations and surface collections, are currently curated at Musée Denon in Chalon-sur-Saône (collections of Aimé, Bonnamour, Guillard, Gros, Jeunet and Méray) and at the University of Tübingen (collections of Pelatin and Jeannin). Table 2 provides an overview of the bifacial assemblages from VP I, including type, curating institution, and excavation year, as well as spatial provenience when available.

Intriguingly, all *Keilmesser* with tranchet blows from previous excavations (n = 17) derive from the first excavation conducted by Charles Méray (Coll. of Méray, Jeannin and Jeunet). From studying the research history and the old collections from VP I, Dutkiewicz (2011) demonstrated that this excavation very likely took place in the (current) entrance and in front of the (current) cliff face (Dutkiewicz and Floss, 2015; see Fig. 3 in the center). At the time of occupation, this entire area was almost certainly the entrance of a large rock shelter. The Gros collection includes artifacts from Delporte's excavation work as well as surface collections. Fortunately, a biface (No. 02.14.62) and a tranchet-blow blank (No. 02.14.142) are labeled with the trench section (D) and layer number (7) from the terrace (see its position in Fig. 3 upper right corner) and the exact position of this trench was verified recently with the aid of GPR survey (Leach, 2014). Future work will assess the remaining archaeological potential of this trench, initially excavated by Delport between 1953 and 1955, but unpublished. The precise findposition of the other bifacial elements from the old excavations at VP I could not be verified. It is likely that they derive from excavation, but could also derive from surface collections under the rock shelter and on its terrace (see Dutkiewicz, 2011). For the recent excavations (2006–2014) three-dimensional provenience data is available (see Fig. 3).

Various analyses currently in progress, such as micromorphology, radiometric dating, spatial analysis, and analyses of the lithic and osseous industries, as well as faunal remains, will provide additional support for these assessments.

3.2. Grotte de la Verpillière II

The assemblage of bifacial elements (including tranchet-blow blanks) from VP II derives from GH1, GH 2, GH 3 and GH 4x. As mentioned, GH 1 and GH 2 are mixed sediments overlying the most recent rock collapse within the cavity. We infer, based on the three-dimensional distribution of bifacial objects and observations that these artifacts were moved out of the intact sediments (beneath the rock collapse) by animal activities. GH 3, GH 4x and GH 4 are intact sedimentary units of primarily aeolian deposition. Thus far, only GH

Table 2
Collection and assemblages of bifacial elements from Grotte de la Verpillière I.

Collection	Inventory number	Kind of collection	Kind of bifacial elements	Quantity
Aimé	89.78.1	Surface collection between 1971 and 1974, hosted in Musée Denon	One preform of a biface and a tranchet-blow blank	2
Bonnamour	63.1.1	Surface collection in the 1950s and 1960s, hosted in Musée Denon	Two preforms	2
Guillard	61.3.10	Collection from excavation in 1938, hosted in Musée Denon	One preform	1
Gros and Gros	02.14	Surface collection from the 1950s and artifacts from Delporte's 1953–1955 excavation, hosted in Musée Denon	Four bifaces, one preform and three tranchet-blow blanks	8
Jeannin	Jeannin	Collection from Méray excavations in 1868, collected by Chabas and bought by Jeannin, hosted in University of Tübingen	Two bifaces, nine *Keilmesser* with tranchet blow, one preform and one tranchet-blow blank	13
Jeunet	81.12.1	Collection from Méray excavations in 1868, collected by Méray, given to Hubert and bought by Jeunet, hosted in Musée Denon	13 bifaces, three simple *Keilmesser*, four *Keilmesser* with tranchet blow, seven preforms	27
Méray	CA 27	Collection from his 1868 excavation, hosted in Musée Denon	Four bifaces, one simple *Keilmesser*, four *Keilmesser* with tranchet blow and five preforms	14
Lènez	CA 27t	Excavation and surface collection from 1920s to 1930s, hosted in Musée Denon	One preform and simple *Keilmesser*	2
Pelatin	Pel	1970s, hosted in University of Tübingen	One biface, one preform, three tranchet-blow blanks	5
Floss	GERyear.squarem eter.number	Artifacts from the excavations between 2006 and 2014	Eight bifaces, four simple *Keilmesser*, one *Keilmesser* with tranchet blow and eight preforms	22
Total		9		96

3 and 4x have yielded bifacial elements. Almost all known tranchet-blow blanks derive from GH 3 (n = 9); only one derives from GH 4x. Also the two known *Keilmesser* with tranchet blows derive from GH 3 (see Table 3).

Overall, the lithic industry of GH 3 is characterized by a unifacial Levallois concept, and includes diverse bifacial elements. This sedimentary unit is highly homogenous and fairly thick (see Fig. 2). One aim of ongoing analysis is the determination of internal variability in the lithic industry from this stratigraphic unit. GH 4x contains some Levallois elements and only one tranchet-blow blank. The other Middle Paleolithic level (GH 4) has yielded a highly similar Levallois industry, but also lacks bifacial elements so far.

Table 3
Amount of bifacial elements from GH 1, 2, 3 and 4x of Grotte de la Verpillière II (excavation 2006–2014).

Stratigraphical unit	Integrity of unit	Kind of items	Quantity
GH 1	Mixed sediments above rock collapse	Two bifaces, one simple *Keilmesser* and one preform	4
GH 2	Mixed sediments above rock collapse	Three bifaces	3
GH 3	Stratified Middle Paleolithic unit	11 bifaces, four simple *Keilmesser*, two *Keilmesser* with tranchet blow, nine tranchet-blow blanks and nine preforms	35
GH 4x	Stratified Middle Paleolithic unit	One tranchet blow	1
Total			43

In general, the lithic artifacts from GH 3 are sharp-edged and suggest little post-depositional movement. This is further supported by micromorphological analysis (Wißing, 2012) and the regular, horizontal orientation of the lithic artifacts in this sedimentary unit.

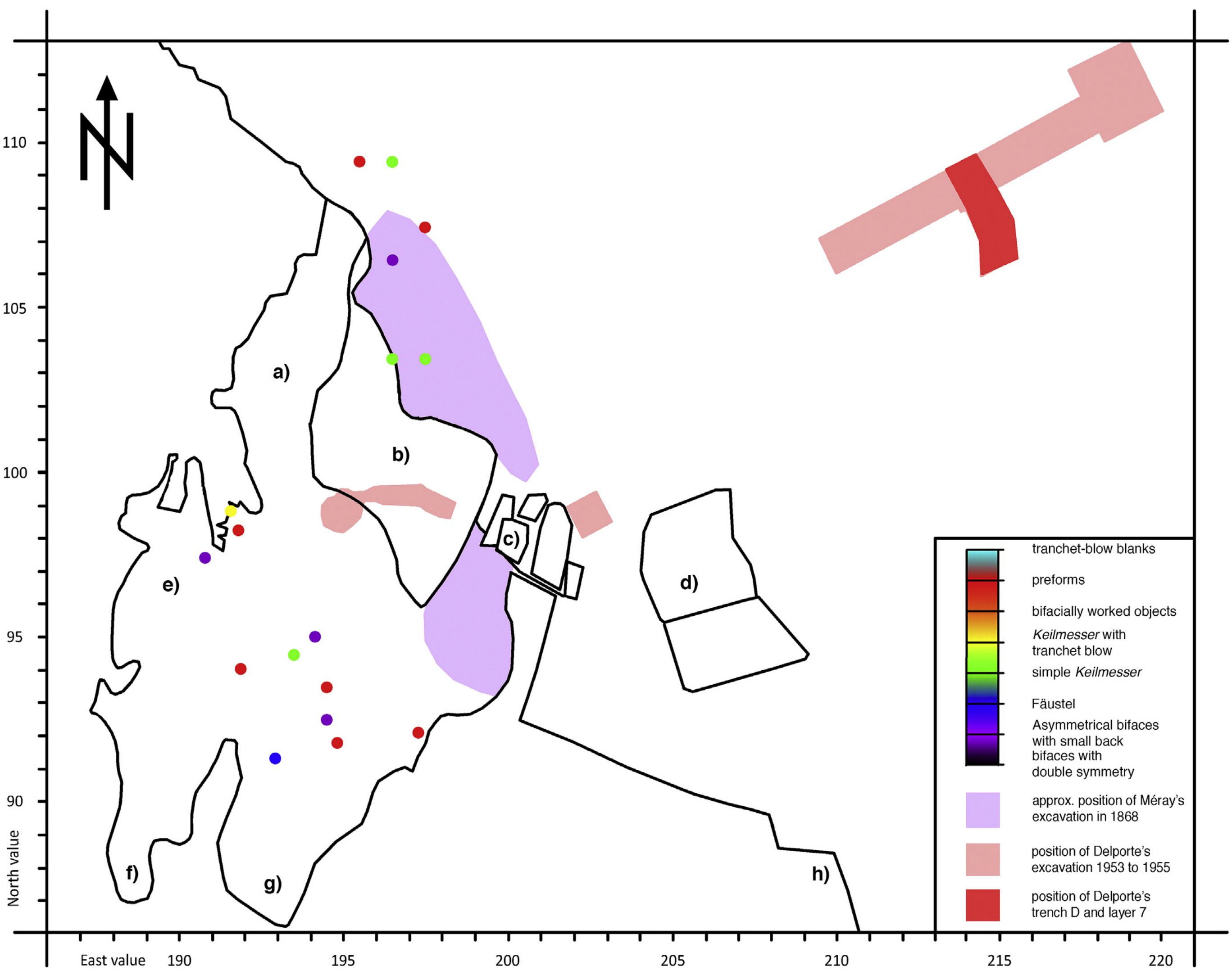

Fig. 3. Located positions of the bifacial elements from Grotte de la Verpillière I. Color dots show the position of bifacial elements from recent excavations (2006 to today). Inked zones show the excavation areas from Méray and Delporte. a) so called gallery (right area of the former entrance); b) collapsed blocks; c) today's entrance with wedged blocks; d) collapsed blocks in the exterior; e) sediment hill with different layers containing artifacts from the Middle Paleolithic to the Gravettian; f) ascent to the upper chamber; g) so called apsis and h) cliff face leading to VP II. Base map from Floss (2005, Fig. 4), position of old excavation trenches from Dutkiewicz (2011, Plan 9). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

4. Methodology

Our approach in studying these assemblages is to provide a detailed morphological overview of the bifacial elements of both sites, a comparison between the two assemblages, and a description of the patterns in their spatial distribution. In addition to morphological analysis (dimension and angle measurements), *chaîne-opératoire* (*Herstellungsanalyse*) and techno-functional approaches were applied in the study production steps (including perimeter and cross-section analysis). Here, we combine approaches from Boëda (1995a,b), Bosinski (1967), Iovită (2014), Jöris (2001, 2006), Neruda and Nerudová (2010) and Weißmüller (1995). The term bifacial elements – as used here – combines bifacially worked lithic pieces (bifaces or so called bifacial objects) made from raw pieces or blanks, as well as blanks deriving from (mostly lateral) resharpening processes of the cutting edge, which are called tranchet-blow blanks (see Iovită, 2014), because these blanks normally show one bifacially worked lateral edge (deriving from bifacial rework of a bifacial object). Tranchet-blow blanks cannot be seen as formal tools, but from their shape (bifacial edge modification before the removal), they are good evidence for a former presence of specific bifacial objects.

On lithic objects interpreted as working tools, it is possible to measure cutting-edge angle (β). We used a mechanical hand-held goniometer (see the discussion in Dibble and Bernard, 1980), which is precise enough (±2 or 3°), because the surfaces of lithic artifacts are never totally flat. We measured the angle of the presumed active edge at the distal, proximal and medial points of the bifaces as well as the tranchet-blow blanks and used the arithmetic mean to compensate for measurement errors: arithmetic mean $= (\alpha_{distal} + \alpha_{medial} + \alpha_{proximal})/3$ (see also Iovită, 2014). The typological criteria for the separation of the studied bifacial elements are summarized in Table 5):

Fig. 9) and unfinished preforms (Fig. 10). Bifacial treatment can range from extensively-worked surfaces (sometimes the entire piece in three dimensions) to minimal bifacial invasion. In some cases (bifacially worked objects, BWO), only a bifacial cutting-edge was produced. For the purposes of this study, we have defined seven primary typological groups (bifacial objects and tranchet-blow blanks):

- Formal bifaces with double reflection symmetry
- Formally asymmetric bifaces with restricted backing
- Small symmetric bifaces with plano-convex surfaces
- Asymmetrically bifacially backed knives (simple *Keilmesser*)
- Asymmetrically bifacially backed knives (*Keilmesser*) with tranchet blow
- Bifacially worked objects (bifacial scrapers)
- Tranchet-blow blanks

Objects that show bifacially worked edges and/or surfaces but lack a clear, detectable active edge (*partie transformative*) and evidence of systematized production were classified as bifacial preforms. Overall, the substantial number of bifacial objects in the study assemblage shows close similarities in their production sequences, concerning approaches to manipulating the pieces during reduction (turning and rotating) as well as the approaches to modifying surfaces and edges (see Figs. 14–16) of bifacial objects that are common in a *Keilmessergruppen* context. As Fig. 13 shows, there is no clear dimensional division between the individual types of bifacial objects. The only clear dimensional definition can be made for so called Fäustel (blue signs), which are always shorter that 70 mm. Bifacially worked objects possess almost the same dimensional range as the Fäustel. Conversely, bifaces with double symmetry (black signs) tend to be large objects. Objects classified as preforms are dimensionally spread over the dimensional range, but are always in the range of flake dimension. Some *Keilmesser* with tranchet-blow negatives are situated in the blade dimension range. Independent from its overall size, bifacial objects from these both caves show no clear absolute relation between type and size, as well as their support (blank or core, etc.). The size of tranchet-blow blanks of both sites differ clearly. In the following sections (5.1–5.8) we describe the defined groups of bifacial elements from both sites.

Table 4
Productions steps for a *Keilmesser* with tranchet blow, after Jöris (2001), Pastoors (2001), Richter (1997) and Migal and Urbanowski (2006).

	Production step	Description	Notes
1	Selection of support	Selection of a raw piece or of a black that seems to be suited for backing an surface thinning	In Buhlen (Jöris, 2001) tabular lydite was used for *Keilmesser* production; for VP I and II it seems that mostly blanks were used as support
2	Back configuration	One narrow site of the support is shaped that it can be used as striking platform	A back can be configured from the top side or bottom side
3	Surface configuration	Mostly the so called bottom side (flatter surface) is configured first	Shaping of one surface
4	Surface configuration	The top side (more convex surface) is configured next	Shaping of the other surface
5	Surface configuration	Production of s specific scare pattern on the upper face for having a crest character	This crest is used later for the removal of the tranchet-blow blank
6	Edge configuration	Backing and regularizing the edge (that later will be the active edge) for having a crest character	This crest is used later for the removal of the tranchet-blow blank
7	Preparation of a striking platform	Backing, regularizing the edge and bow for having a striking platform for removing the tranchet-blow blank	The platform installation can also be integrated into the surface configuration
8	Preparation of edges and crests	Little removals and abrasion for shaping the edges of the striking platform and the regularized active edge, as well as the crest on the side where the tranchet-blow blank will be removed	Reduction of force necessary to do the blow
9	Sharping the active edge	Removing of the tranchet-blow blank	Production of an asymmetric cutting edge

5. Results

The category of “bifacial object” includes a diverse array of artifacts. The category of formal bifaces includes Acheulian-like hand axes (Fig. 4.2), and similar bifaces from the *Moustérien de tradition acheuléenne* (MTA biface, Fig. 4.1), but also include *Micoquekeile* (Fig. 5.1) or small *Fäustel* (Fig. 6). Furthermore, there are *Keilmesser* with and without tranchet blow (Figs. 7 and 8), flakes with a bifacially worked cutting edge (bifacially worked objects, BWO,

Table 5
Criteria used to separate the studied bifacial objects.

Criterion	Description	Double symmetrical bifacials	Bifacial with a plan-convex cross section and small back	Fäustel	Simple *Keilmesser*	*Keilmesser* with tranchet blow	Bifacially worked objects	Preforms
Regularization and confection	Can we see a regular or irregular outline? Is the outline shaped specifically?Is it possible to distinguish techno-functional units of the outline?	Yes	Yes	Yes	Yes	Yes	Yes	No
Active edge	Is there a (convex or straight) active edge?	Yes	Yes	Yes	Yes	Yes	Yes	No
Passive part (back)	Is there a back for grasping visible?	No	Yes	No	Yes	Yes	Yes and no	Yes and no
Passive part (base)	Is there a base for grasping visible?	Yes	Yes	Yes	Yes	Yes	Yes	Yes and no
Systematized production sequence	Is it possible to replicate the objects by following stricts production steps?	Yes	Yes	Yes	Yes	Yes	Yes	No
Invasiveness of the surface and edge working	Is only the edge worked?	No	No	No	No	No	Yes	No
Symmetry of the top side	Is the top view symmetric? What kind of symmetry?	Yes	Yes and no	Yes and no	No	No	No	No
Symmetry of the cross section	Is the cross section symmetric?	Yes	No	No	No	No	No	No
Cross section	Plan-convex on thicker or thinner object, bi-convex on or thinner object, plan-convex to plan, plan-convex on both sides	Bi-convex	Plan-convex	Plan-convex	Mostly plan-convex on both sides	Mostly plan-convex on both sides	Mostly plan-convex on both sides	Diverse

5.1. Formal bifaces with double reflection symmetry from VP I

Only VP I yielded bifacial objects with double reflection symmetry (in top view and cross section, n = 10). These objects have no backed edges and a biconvex cross section. All but one derives from old excavations. The majority of them (n = 7) were found in Méray's excavation in 1868 (coll. Méray n = 3 and coll. Jeunet n = 4), others derive from coll. Gros and Gros (n = 2) and only one such object was found during the new excavations in the backdirt (GH 1) (see also Table 6).

Despite their perimeter symmetry, all of these objects display a circumferential cutting edge on which the most intensively worked zones are isolated to one lateral side (finer and more intensive regularization of this perimeter part). It would not be surprising to find such objects in a MTA or even Acheulian context (02.14.62 and 81.12.1.144, see Fig. 4.1–4.2). Only two objects (81.12.1.146 and GER08.194-095.48.1, Fig. 4.3–4.4) appear oval but are terminally broken. Four of these bifaces are made on flakes, and six were classified as cores (in the sense of being a support) because of entire surface modification. The production sequence (see Fig. 4) shows an alternating surface modification on each lateral side (rotating around the transversal axis during production), but the final cutting-edge regularisation was performed in an unidirectional way (comparable to many MTA bifaces, see Soressi, 2002).

5.2. Formally asymmetric bifaces with restricted backing

Bifacially worked objects that showt distinct backing along the perimeter but cannot be classified as *Keilmesser*, are very common in *Keilmesser*-bearing industries (e.g. Bosinski, 1967). We can class n = 28 from VP I in this category and n = 11 from VP II (see Table 7). Generally speaking, they are quite similar when compared to the formal bifaces with double reflection symmetry from VP I. With the exception of the limited backing on certain zones of the perimeter, they would be quite congruent and symmetric.

Table 6
List of the formal bifaces with double reflection symmetry from VP I.

Collection	Inventory number	Description
Gros and Gros	02.14.35	Made from tablet flint or flat nodule, convex circumferential cutting edge
	02.14.62	Support unknown, the circumferential cutting edge is wavy
Jeunet	81.12.1.144	Elongated bifacial with a wavy, circumferential, straight-convex cutting edge
	81.12.1.145	Probably made out of a big flake, wavy, circumferential, straight-convex cutting edge
	81.12.1.146	Quite oval bifacial with a recent fracture and a wavy, circumferential cutting edge
	81.12.1.148	Elongated bifacial with a very straight circumferential cutting edge
Méray	CA 27.4	Made from tablet flint or flat nodule, circumferential, quite straight cutting edge
	CA 27.5	Probably made out of a big flake, wavy, circumferential, straight-convex cutting edge
	CA 27.209	Probably made out of a big flake, quite straight, circumferential, cutting edge
Floss	GER08.194-095.48.1	Quite oval bifacial with a recent fracture and a quite straight, circumferential cutting edge
Total	10	

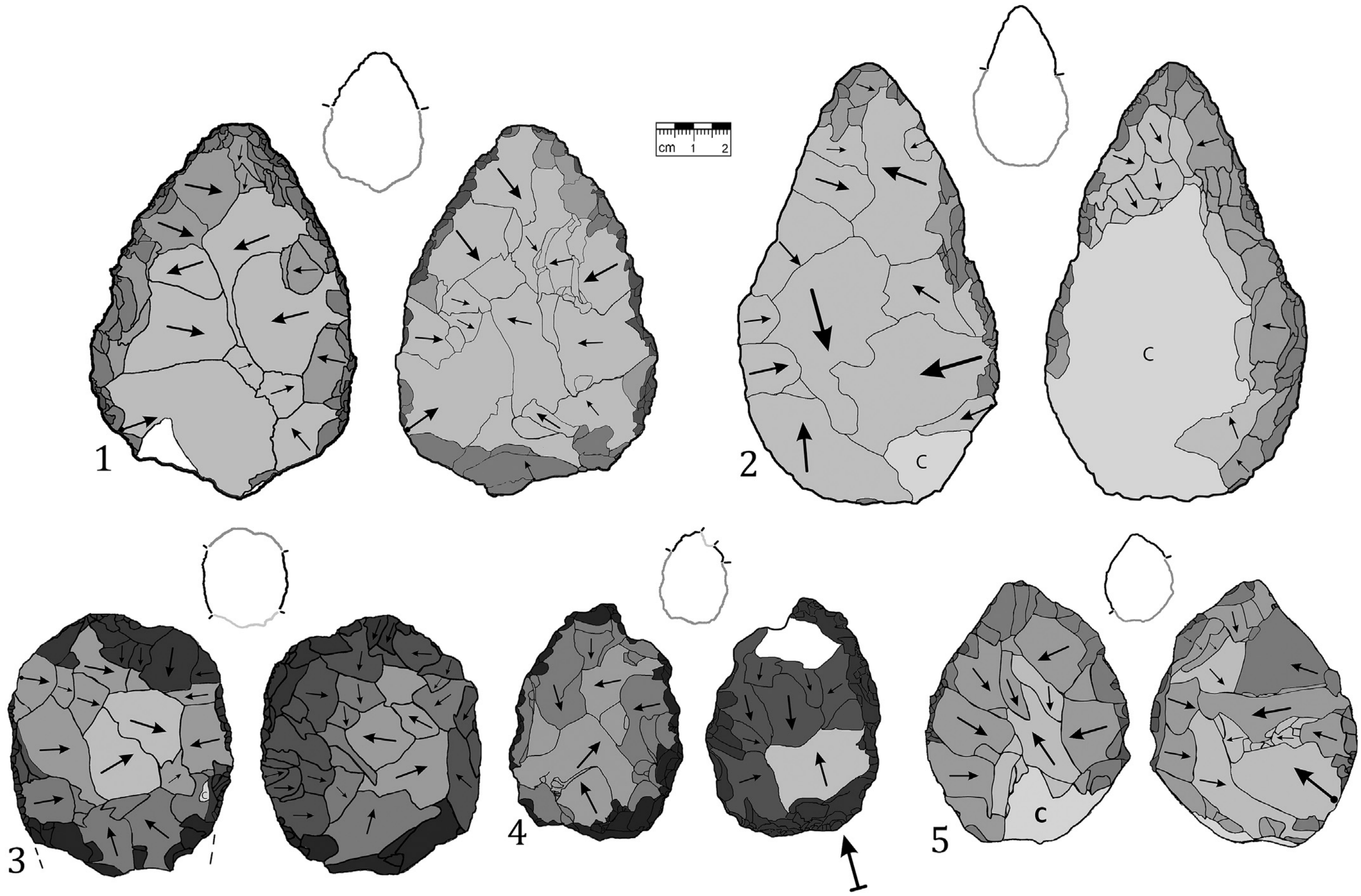

Fig. 4. Examples of formal bifacial objects with double reflection symmetry from VP I. Diacritic scheme following Dauvois (1976). Drawings show the production sequence in RGB grayscale (modern damage 255/255/255; cortex 220/220/220; 1st reduction step or negative rests on former dorsal face 200/200/200; 2nd reduction step or former ventral face 170/170/170; 3rd reduction step 140/140/140; 4th reduction step 100/100/100; 5th reduction step 70/70/70; 6th reduction step 50/50/50). The small drawings reflect the UTFs (transformation (or cutting) edge 0/0/0; passive edge 160/160/160 and modern damage 210/210/210). 1) 02.14.62; 2) 81.12.1.144; 3) GER08.194-095.48.1; 4) 81.12.1.146 and 5) CA 27.209.

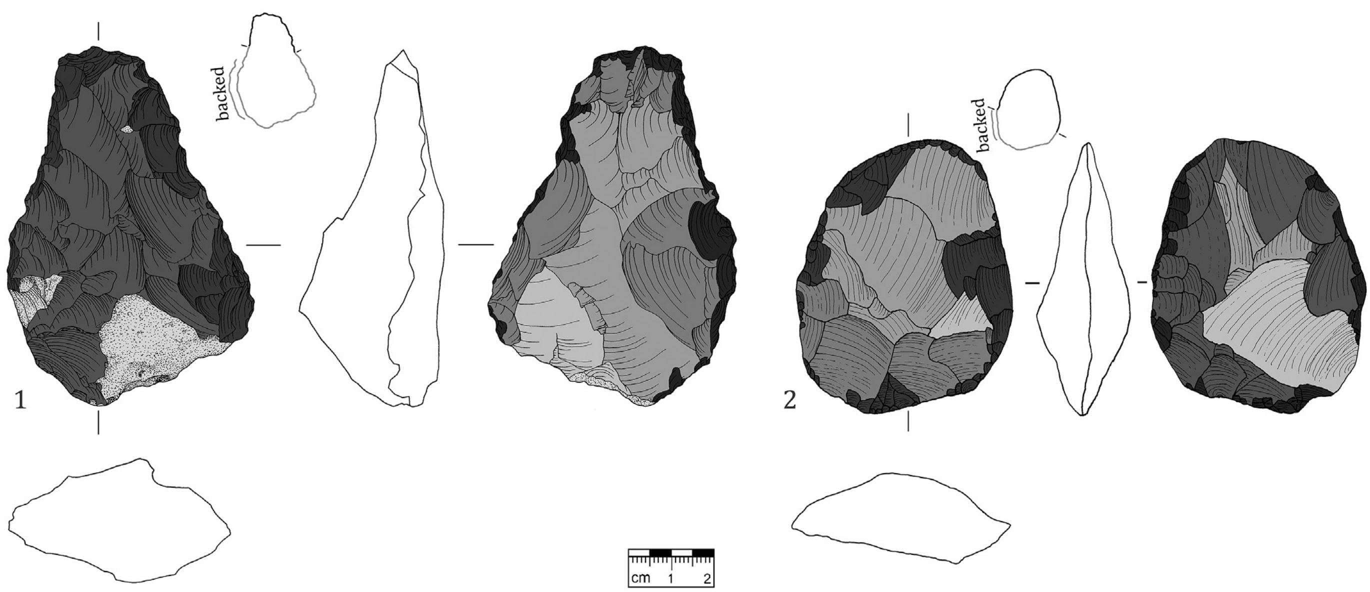

Fig. 5. Examples of formally asymmetric bifacial objects with small backed parts (color and symbol codes see Fig. 4; both from VP II). 1) GER09.227-060.48.1 and 2) GER10.227-057.64.

The old excavations at VP I provided n = 8 objects (coll. Gros and Gros, Guillard, Jeannin, Jeanet and Méray); while the new excavation yielded n = 5 (one of these from GH 15, the others form GH 1 and 41b). The mixed layers of VP II yielded n = 4 and GH 3 of VP II n = 5 asymmetric bifaces with small backed parts (see Fig. 5).

Most of these objects present a quite flat bottom side, while the top side is convex (see especially Fig. 5.1). They differ in size and shape but all possess one cutting edge along a lateral side (identifiable by intensive retouch for regularization) and backing on a limited zone of the perimeter. In terms of production, we can see that the flat surface is normally prepared first, with the more convex surface following. The production of the backed edge is integrated into the process of surface-preparation (see Fig. 5). Two of these objects from VP II are exceptional, but unfortunately from mixed sediments (GH 1 and 2). The first is a Micoque biface (GER09.227-060.48.1, see Fig. 5.1) with restricted backing and two adjacent cutting-edges: one straight along the right lateral side, and the second transverse on the terminal end. The second is asymmetrically oval with a backed lateral edge and a convex cutting edge (GER10.227-057.64, see Fig. 5.2).

Table 7
List of formally asymmetric bifaces with small backed parts.

VP	Collection	Inventory number	GH	Description
I	Gros and Gros	02.14.37	?	Made out of a flat nodule, alternating unidirectional edge reduction for the production of bifacial edges, terminal end broken
I	Jeannin	Jeannin 81	?	Made out of a flake, dorsal face almost complete reshaped, removal of bulbe, terminal a bifacial edge
I		Jeannin 86	?	Support unknown, entire surfaces are bifacial reworked, right lateral side and terminal broken
I	Jeunnet	81.12.1.85	?	Support unknown, entire surfaces are bifacial reworked, right lateral side and terminal broken
I		81.12.1.87	?	Made out of a flake, alternating unidirectional edge reduction for the production of bifacial edges
I		81.12.1.91	?	Support could be a frost fragment or a flake, clear back and convex cutting edge
I		81.12.1.114	?	Probably made out of a flat nodule, alternating unidirectional edge reduction for the production of bifacial edges, main working edge seems to be the left one
I	Méray	CA 27.168	?	Made out of a flake, alternating unidirectional edge reduction for the production of bifacial edges with minimal invasion on ventral face
I	Floss	GER14.191-098.837	15	Made out of a flake, production steps are flattening the ventral face, shape the dorsal face, left lateral edge regularization
I		GER09.195-093.25	1	Made out of a flake, production steps are flattening the ventral face, shape the dorsal face, left lateral edge regularization
I		GER07.195-094.52.1	1	Probably made out of a cortical flake, preference of the left edge as working edge, quite symmetrical, but a clear back, production steps are backing, bottom side, top side, edge regularization of the bottom side
I		GER14.195-096.47	41b	Made out of a flake, production steps are backing, reworking of the ventral face, reworking of the dorsal face and edge regularization
I		GER07.197-107.13	1	Made out of a flake, production steps are flattening the ventral face, shape the dorsal face, left lateral edge regularization
II	Floss	GER09.227-060.48.1	1	Micoquekeil, made out of a big flake, back is on the left lateral side, production steps are backing, top side, bottom side, edge regularization at the left lateral
II		GER09.226-059.32	2	Made out of a flake, production steps are reworking the ventral face, shape the dorsal face, left lateral edge regularization
II		GER10.227-057.64.1	2	Probably made out of a flake, unknown raw material, with calcedony veins, right lateral backing, circumference cutting edge on left lateral and terminal
II		GER14.228-061.84	2	Made out of a flake, production steps are reworking the ventral face, shape the dorsal face, left lateral edge regularization
II		GER11.225-059.222	3	Made out of a flake, alternating unidirectional edge reduction for the production of bifacial edges, probably a tip of a big bifacial that was reworked and used again
II		GER12.226-057.385	3	Made out of a flake, production steps are flattening the ventral face, shape the dorsal face, left lateral edge regularization
II		GER12.227-057.141	3	Made out of a flake, production steps are reworking the ventral face, shape the dorsal face, left lateral edge regularization
II		GER12.227-057.457	3	Made out of a flake, production steps are flattening the ventral face, shape the dorsal face, left lateral edge regularization
II		GER13.228-057.474	3	Made out of a flake, production steps are reworking the ventral face, shape the dorsal face, left lateral edge regularization
Total		32		

5.3. Small symmetric bifaces with plano-convex surfaces

These n = 8 bifacial objects (see Table 8) are small in size and could be classified as *Fäustel* (see Bosinski, 1967). They occur at both sites (VP I n = 5, VP II n = 3) and are made on flakes. Despite their quite similar shapes, two different production sequences are evident. In the first sequence, small flakes are flattened on the ventral face (bulb reduction, shaping the surface in a plano-convex manner), then the dorsal face is shaped in the same way. After this has been done, the edge is partially bifacially regularized (see especially Fig. 6.1 and 6.6). In the second production sequence (see Fig. 6.5), a small nodule is bifacially shaped to get a similar but slightly thicker product.

5.4. Asymmetrically bifacially backed knives (simple Keilmesser)

There is a huge variety of names for lithic objects with an asymmetric top view and cross section that are bifacially worked and backed, and are often interpreted as knives (Bosinski, 1967; Burdukiewicz, 2000; see e.g. Müller-Beck, 1956; Koulakovskaya et al., 1993; Jöris, 2006; Migal and Urbanowski, 2006). The term simple *Keilmesser*' is used here for all bifacially worked objects that have a back opposing the cutting-edge and a wedge-shaped cross section (see also Jöris, 2006), but without signs of a tranchet-blow negative.

Over all, there are n = 15 simple *Keilmesser* at both sites (see Table 9). Among these, n = 10 derive from VP I (from old excavations n = 6 and from new excavations n = 4). VP II has yielded n = 5 of such objects (n = 4 from GH 3 and n = 1 from GH 1). These simple

Table 8
List of small symmetric bifaces with plano-convex surfaces.

VP	Collection	Inventory number	GH	Description
I	Guillard	61.3.10.28	?	Very small bifacial object, made from a flake, first ventral face and than dorsal face reduction
I	Jeunet	81.12.1.88	?	Very small bifacial object, made from a flake, first flattening the ventral face and than dorsal edge reduction
I		81.12.1.90	?	Very small bifacial object, made from a flake, first flattening the ventral face and than dorsal edge reduction
I		81.12.1.112	?	Very small bifacial object, made from a flake, first flattening the ventral face and than dorsal edge reduction
I	Floss	GER13.193-092.129	31b	Very small bifacial object, made from a flake, first flattening the ventral face and than dorsal edge reduction
II	Floss	GER09.231-061.21.1	1	Very small bifacial object, made from a flake, first flattening the ventral face and than dorsal edge reduction
II	Floss	GER12.227-057.420	3	Very small bifacial object, made from a cortical flake, production steps are performed in an alternating unidirectional edge reduction way
II		GER13.227-057.1790	3	Small bifacial object, made from a cortical flake, production steps are performed in an alternating unidirectional edge reduction way

Keilmesser can be produced on flakes (see especially Fig. 7.2 and 7.4) or nodules (Fig. 7.3 and 7.5) and can vary morphologically, but share the basic characteristics of backing that oposes the cutting-edge and a similar production sequence (Fig. 7).

5.5. Asymmetrically bifacially backed knives (Keilmesser) with tranchet blows

A peculiarity of *Keilmesser* is that there is the opportunity to sharpen the cutting edge by the removal of burin-like blanks along the cutting edge (therefore sometimes the name para-burin blow is used, see Conard and Fischer, 2000). We prefer the term *Keilmesser* with tranchet blows (KMTB), and have identified n = 20 such artifacts at both sites together. Desbrosse et al. (1976) described n = 9 of these objects all from the coll. Jeannin and Méray and displayed n = 7 of them in their publication (see Table 10).

From VP I, n = 17 are from the Méray excavation (see Fig. 8.1–8.6) and one is from GH 18 of the recent excavations (see Fig. 8.9). Only two were identified at VP II, both from GH 3. Of all KMTB in the study assemblages, n = 12 are made on large flakes, n = 2 on blades, n = 2 on geofacts (products of gellifraction), and n = 4 are classified as cores. The morphological variety is considerable, but the production of these objects appears to focus on the production of a tranchet blow. All of these objects show the combination of surface- and edge-regularization (production of a convexity and maybe also crested scars, cutting-edge regularization and platform formation) as preparation for the final tranchet blow. The production sequence (see Table 4) is consistent in that the backing is usually the first step, followed by flattening of the bottom side (mostly the ventral face), and then convex reworking of the top-side (mostly the dorsal face). This produces surfaces and edges suitable for preforming of the tranchet blow (cutting-edge regularization and platform formation). Even from the shape and position of the cutting edge (modified by the tranchet blow) it is obvious that some pieces were subject to recurrent sharpening processes (see especially Fig. 8.3–8.4). The mean cutting-edge angle of all objects is 56.117°, so we can assume that longitudinal cutting and whittling were the main actions performed with these objects (see: Fig. 8 and Table 10).

Table 9
List of asymmetrically bifacially backed knives (simple *Keilmesser*).

VP	Collection	Number	GH	Description
I	Jeunet	81.12.1.108	?	Made from a flake, production steps are backing, reworking of the ventral face, reworking of the dorsal face and finishing the cutting edge by regularization on the dorsal face
I		81.12.1.110	?	Probably made from a flat nodule, working steps are backing, alternating unidirectional edge reduction, regularization of the cutting edge
I		81.12.1.131	?	Made from a flake, production steps are flattening the ventral face, backing, reworking the dorsal face, bifacial cutting edge regularization
I		81.12.1.147	?	Made from a flake, production steps are backing, reworking of the ventral face, reworking of the dorsal face and finishing the cutting edge by bifacial regularization
I	Lénez	CA 27t.61	?	Probably made from a nodule, production steps are flattening the bottom face, flattening the top face, minimal cutting edge regularization
I	Méray	CA 27.130	?	Made from a flake, production steps are flattening of the ventral face, reworking of the dorsal face and regularization of the cutting edge on the dorsal face
I	Floss	GER08.194-095.44.1	1	Made from a nodule, production steps are reworking the bottom face, reworking the top face, minimal cutting edge regularization
I		GER06.197-104.14.1	2	Made from a flake, production steps are backing, reworking of the ventral face, reworking of the dorsal face and finishing the cutting edge by bifacial regularization
I		GER07.197-110.18.1	1	Support invisible, production steps are backing, reworking the bottom face, reworking the top face and invasive cutting edge regularization
I		GER07.197-104.19.1	2	Made from a flake, the terminal part is broken off, production steps are backing, reworking of the ventral face, reworking of the dorsal face and finishing the cutting edge by bifacial regularization
II	Floss	GER13.225-058.913	3	Made from a flake, production steps are backing, reworking of the ventral face, reworking of the dorsal face and finishing the cutting edge by bifacial regularization
II		GER10.226-059.155	3	Made from a cortical flake or frost fragment, production steps are reworking the bottom face, reworking the top face, intensive cutting edge regularization
II		GER10.226-059.301	3	Made from a flake, production steps are regularization of the cutting edge on the ventral face, reworking the dorsal face and regularization of the cutting edge on the dorsal face
II		GER12.229-059.533	3	Made from a flake, the terminal part is broken off, production steps are backing, reworking of the ventral face, reworking of the dorsal face and finishing the cutting edge by bifacial regularization
II		GER09.231-061.16	1	Made from a nodule, production steps are reworking the bottom face, reworking the top face, bifacial cutting edge regularization
Total		15		

Table 10
List of asymmetrically bifacially backed knives (*Keilmesser*) with tranchet blow.

VP	Collection	Number	GH	Description	Former description by whom
I	Jeannin	Jeannin.62	?	Small flake with bulb removal, dorsal edge regularization and tranchet blow (right handed)	Dutkiewicz 2011
I		Jeannin.71	?	Bigger flake with ventral flattening, partially dorsal backing and surface reworking, platform formation, cutting edge regularization and tranchet blow (right handed)	Desbrosse and Texier, 1973a,b, Fig. 7 Desbrosse et al., 1976, Fig. 7.1 Dutkiewicz 2011
I		Jeannin.72	?	Elongated flake with bulb removal, ventral reworking, cortical back, dorsal flattening, ventral platform formation, cutting edge regularization and tranchet blow (left handed), resharpend	Desbrosse and Texier, 1973a,b, Fig. 6 Dutkiewicz 2011
I		Jeannin.73	?	Bigger flake with ventrally produced convexity, partially dorsal backing, bifacially cutting edge regularization, platform formation and tranchet blow (right handed), resharpend	Desbrosse and Texier, 1973a,b, Fig. 4 Dutkiewicz 2011
I		Jeannin.74	?	Made out of a small nodule, decortication and flattening on bottom side, cutting edge regularization, platform formation and tranchet blow on top side (right handed), resharpend	Desbrosse and Texier, 1973a,b, Fig. 1; Desbrosse et al., 1976, Fig. 1.1 Dutkiewicz 2011
I		Jeannin.75	?	Made out of a small nodule, decortication and flattening on bottom side, cutting edge regularization, platform formation and tranchet blow on top side (right handed)	Desbrosse and Texier, 1973a,b, Fig. 3; Desbrosse et al., 1976, Fig. 4.1 Dutkiewicz 2011
I		Jeannin.76	?	Terminal flake fragment, flattening of the ventral face, reworking of the dorsal face, cutting edge regularization, platform formation and tranchet blow (right handed)	Desbrosse and Texier, 1973a,b, Fig. 5; Desbrosse et al., 1976, Fig. 3.1 Dutkiewicz 2011
I		Jeannin.77	?	Bigger flake, dorsal flattening, massive ventral reworking (convexity), backing and platform formation and edge regularization ventrally, three repeated tranchet blow (right handed)	Desbrosse and Texier, 1973a,b, Fig. 2 Dutkiewicz 2011
I		Jeannin.92	?	Small flake with bulb removal, backing, dorsal reworking, bifacially cutting edge regularization, platform formation and dorsal tranchet blow (left handed)	Dutkiewicz 2011
I	Jeunet	81.12.1.107	?	Terminal flake fragment, backing, ventral flattening, dorsal reworking, cutting edge regularization and platform formation, tranchet blow (right handed)	Méray, 1876, Fig. 17 Floss 2005, Fig. 5.1 Frick 2010 Dutkiewicz 2011
I		81.12.1.109	?	Blade, ventral and dorsal reworking, cutting edge regularization, platform formation and tranchet blow (right handed)	Frick 2010 Dutkiewicz 2011
I		81.12.1.135	?	Blade, bulb removal, backing, dorsal reworking, cutting edge regularization and platform formation, tranchet blow and cutting edge regularization (right handed)	Dutkiewicz 2011
I		81.12.1.137	?	Bigger flake, dorsal flattening, backing, massive ventral reworking (convexity), ventral platform formation and bifacial edge regularization, tranchet blow on dorsal face (left handed)	Méray, 1876, Pl. I.6 Dutkiewicz 2011
I	Méray	CA 27.125	?	Frost fragment, backing, top side reworking (convexity), bifacially cutting edge regularization, platform formation and repeated tranchet blow (left handed)	Frick 2010 Dutkiewicz 2011
I		CA 27.126	?	Frost fragment or nodule (invisible), bottom side flattening, top side rework, edge regularization and platform formation, tranchet blow (right handed)	Desbrosse et al., 1976, Fig. 1.2; Desbrosse et al., 1976, Fig. 1.2; Floss, 2005, Fig. 5.4 Frick 2010 Dutkiewicz 2011
I		CA 27.146	?	Frost fragment, bottom side flattening, top side reworking, cutting edge regularization and platform formation and tranchet blow (right handed)	Frick 2010 Dutkiewicz 2011
I		CA 27.171	?	Bigger flake with backing and ventral flattening, dorsally cutting edge regularization, platform formation and multiple (five are visible) tranchet blows (right handed), resharpend	Desbrosse et al., 1976, Fig. 4.2; Desbrosse et al., 1976, Fig. 4.2; Floss, 2005, Fig. 5.3 Frick 2010 Dutkiewicz 2011
I	Floss	GER11.192-099.275	18	Small terminal flake fragment, ventral flattening, bifacial secondary (scraper) cutting edge regularization, platform formation, tranchet blow (right handed), resharpend	Floss, 2011, Pl. 2.3
II		GER12.226-057.1227	3		Floss et al. 2013a, Fig. 552 Floss et al. 2013b,
II		GER12.229-059.428	3	Support invisible (core), bottom side completely reworked and flattened, top side completely reworked (convexity), backing, cutting edge regularization, platform formation and tranchet blow on bottom side (right handed)	Floss et al. 2013a, Fig. 75 Floss et al. 2013b, Fig. 45.1 Frick and Floss, 2015, Fig. 10
Total		20			

5.6. Bifacially worked objects (bifacial scrapers)

Another category of objects in the assemblage from VP II are bifacially-worked objects (BWO) or so-called bifacial scrapers (n = 5, see Fig. 9 and Table 11). All five derive from GH 3. On these objects mostly only the cutting edge is bifacially shaped, or one edge is regularized ventrally and the other dorsally, and the resulting pieces are more or less plane-to-convex on both sides (while the term plano-convex refers to one flat surface and an opposing convex surface, we use the term plane-to-convex to refer to single surfaces that range from flat to convex across their extent. This is to avoid confusion; cf. Boëda, 1995a,b). Only one object was made on a raw piece; the others are produced on flakes (see Table 11).

Table 11
List of bifacially worked objects (bifacial scrapers).

Number	GH	Description
GER10.226-059.196	3	Flake with bulb removal, backing, left lateral edge ventral regularization, terminal edge dorsal regularization
GER10.227-058.219	3	Terminal flake fragment, right lateral edge ventral regularization, left lateral edge dorsal regularization
GER10.228-058.58	3	Terminal flake fragment, right lateral edge shows an burin like negative, left lateral edge ventral regularization
GER10.228-058.200	3	Flat nodule that was flattened on its bottom side, the top side is reworked and shows a regularized cutting edge
GER09.228-059.116.8	3	Small flake whose cutting edge unifacially worked on the ventral face, but both faces are before reworked

5.7. Bifacial preforms

In all assemblages from VP I and II, so-called bifacial preforms (pre-products or semi-finished products) could be identified. These unfinished objects are blanks or cores that show partial bifacial reduction without clear regularization of surfaces and edges. For the most part, they show only a few removals on both sides. Knapping mistakes are frequent on these pieces, and could to be one of the reasons that they were discarded prior to completion. No common production-sequence could be detected for these artifacts; each object shows its individual reduction sequence (see examples in Fig. 10). VP I has thus far yielded n = 32 such preforms. There are n = 14 that derive from Méray's excavation (coll. Méray, Jeunet and Jeannin), and n = 9 from other old excavation activities (coll. Pelatin, Aimé, Bonnamour, Gros and Gros, Guillard and Lénez). The new excavations uncovered an additional n = 8 from the backdirt and one derives from GH 16 in VP I. VP II displays n = 9. The uppermost mixed level of VP II (GH 1) yielded n = 1 preform, while n = 8 were recovered from GH 3 (see Table 12).

The preforms fall within the same range of dimensions (length, width and thickness) as the other bifacial objects (see Fig. 13), but were made on a variety of supports. GH 3 of VP II yielded n = 3 objects made on geofacts produced by gelifraction. The collections of Bonnamour and Jeunet from VP I have each yielded one preform

Table 12
List of bifacial preforms.

VP	Collection	Number	GH	Description
I	Jeannin	Jeannin.80	?	Ventrally flattened flake with some dorsal edge regularization
I	Pelatin	Pelatin.181	?	Small entire bifacially reworked object without a clear edge regularization
I		Pelatin.182	?	Flat nodule, beginning of bifacial decortication
I	Aimé	89.78.1.25	?	Flat nodule or tablet, beginning of bifacial decortication
I	Bonnamour	63.1.1.1	?	Frost fragment with a hole in the middle, 3/4 of the outline is bifacially worked, edge is wavy retouched but not regularized
I		63.1.1.10	?	Flat nodule that was bifacially worked, unfortunately no clear visible cutting edge was produced
I	Gros & Gros	02.14.36	?	Small cortical flake, the ventral face is completely worked, edge is bifacially retouched but not regularized
I		02.14.447	?	Small flat nodule that was flattened on its bottom side and decorticated on its top side, the edge shows no clear sign of regularization, perhaps the terminal end was regularized in that way that a small nose was retouched
I	Guillard	61.3.10.38	?	Small flake that shows bifacial edge working, the bulb and butt section was completely removes
I	Jeunet	81.12.1.83	?	Small flake that was flattened on its ventral face, removal of bulb and butt section, minimal rework on dorsal face, terminal broken
I		81.12.1.84	?	Bigger nodule that was bifacially reworked, the edges show coarse retouch
I		81.12.1.86	?	Small bifacially worked nodule, one lateral edge shows a regularization but with many hinges and steps
I		81.12.1.89	?	Terminal fragment of a bigger bifacial object, it seems to be broken during production
I		81.12.1.106	?	Frost fragment that was reduced on its bottom side and shows lateral negatives on its top side, the edges seems to be regularized with steps and some hinges
I		81.12.1.111	?	Bigger flake that shows massive reduction on its ventral face, the dorsal face shows cortex and neocortex, but its edge was completely worked, the alleged cutting edge shows some hinges, this preforms looks as it was supposed to become a *Keilmesser* but the hinges and a small terminal break led to discard
I		81.12.1.113	?	Small flake with reworked dorsal and ventral face, the edge regularization shows many steps and produced a more or less rounded edge
I		81.12.1.128	?	Small flake that was massive reduced, but only on its edges, that produced a wavy edge without any regularization
I	Lènez	CA 27t.44	?	Small flake that was shaped into a small biface with a plan-convexe cross section, first the bottom side was flattened, than the top side was reduced (convexity), no clear edge regularization is visible
I	Méray	CA 27.165	?	Small bifacially worked core that was reduced on both sides, on lateral edge seems to be regularized but also shows recent negative
I		CA 27.167	?	Big but flat nodule that was bifacially worked, but this produced a quite round edge
I		CA 27.169	?	Small bifacially worked flake that shows a round back and opposed an non-regularized edge
I		CA 27.172	?	Small bifacially worked flake that shows non-regularized edges
I		CA 27.174	?	Heavy bifacially reduced nodule that shows no regularized edge
I	Floss	GER11.192-095.41.1	1	Flake that was shaped in the way of a *Keilmesser* without regularization of the cutting edge

Table 12 (*continued*)

VP	Collection	Number	GH	Description
I		GER11.192-099.46.1	1	Thick cortication flake with plan-convexe reduced ventral face but with unfinished cutting edge
I		GER13.195-092.18.1	1	Bifacially worked small flake with back and opposed regularized edge, also possible that the object was heavily used and the last resharpening failed
I		GER07.195-094.22.1	1	Small flat nodule with coarse bifacial reduction and unfinished regularized edge
I		GER11.198-093.33.1	1	Small flake that was flattened on its ventral face, and reworked dorsally (convexity), the edge regularization produced steps and hinges
I		GER08.198-108.19.1	1	Flat nodule that shows invasive reduction on its bottom side and minimal reduction on its top side, no edge regularization
I		GER06.196-110.8.13	2	Flake that shows minimal reduction on its ventral and dorsal face, no edge regularization visible
I		GER06.197-104.18.5	2	Bigger flake that shows invasive reduction on its ventral face and minimal reduction on its dorsal face, no edge regularization
		GER11.192-099.428	16	Tabular raw piece with a naturally broken back and bifacial reduction on one end, one mistake blow removed a big part of the tip, beginning of edge regularization
II	Floss	GER07.229-061.24.1	1	Flake that shows edge eduction on its dorsal face and intensive flattening reduction on its ventral face, edge is not regularized
II		GER12.225-059.702	3	Small flake that was flattened on its ventral face, and reworked dorsally (convexity), the edge regularization produced steps and hinges
II		GER12.226-057.723	3	Bigger frost fragment that shows bifacial reduction on one edge but without edge regularization
II		GER12.226-057.861	3	Small cortical flake, the ventral face is completely worked, edge is bifacially retouched but not regularized
II		GER10.226-060.146	3	Small flake that was flattened on its ventral face, and reworked dorsally (convexity), the edge regularization produced steps and hinges
II		GER09.228-058.7.1	3	Frost fragment that was minimally reduced on the bottom side and invasively reduced on its top side, no edge regularization
II		GER10.228-058.252	3	Small flake that was flattened on its ventral face, and reworked dorsally (convexity), but without edge regularization
II		GER09.228-059.116.5	3	Small flake that was massive reduced on its ventral face and flattened on its dorsal face, it was started to regularize one edge ventraly
II		GER12.229-059.124	3	Flake that was reduced on both sides, but without producing a regularized edge
Total		41		

on such supports. Knapped flakes as supports are also known from the old collections of VP I (coll. Jeannin n = 1; Guillard n = 1; Jeunet n = 4), as well as from the backdirt (n = 4). GH 3 of VP II yielded n = 3 preforms on flakes. The majority of the artifacts classified as preforms were so extensively worked that no support could be clearly identified, and were therefore categorized as cores. Here, VP I shows n = 8 from Méray's excavation, one each in the collections of Lénez, Gros and Gros, Bonnamour, and Aimé. The collection

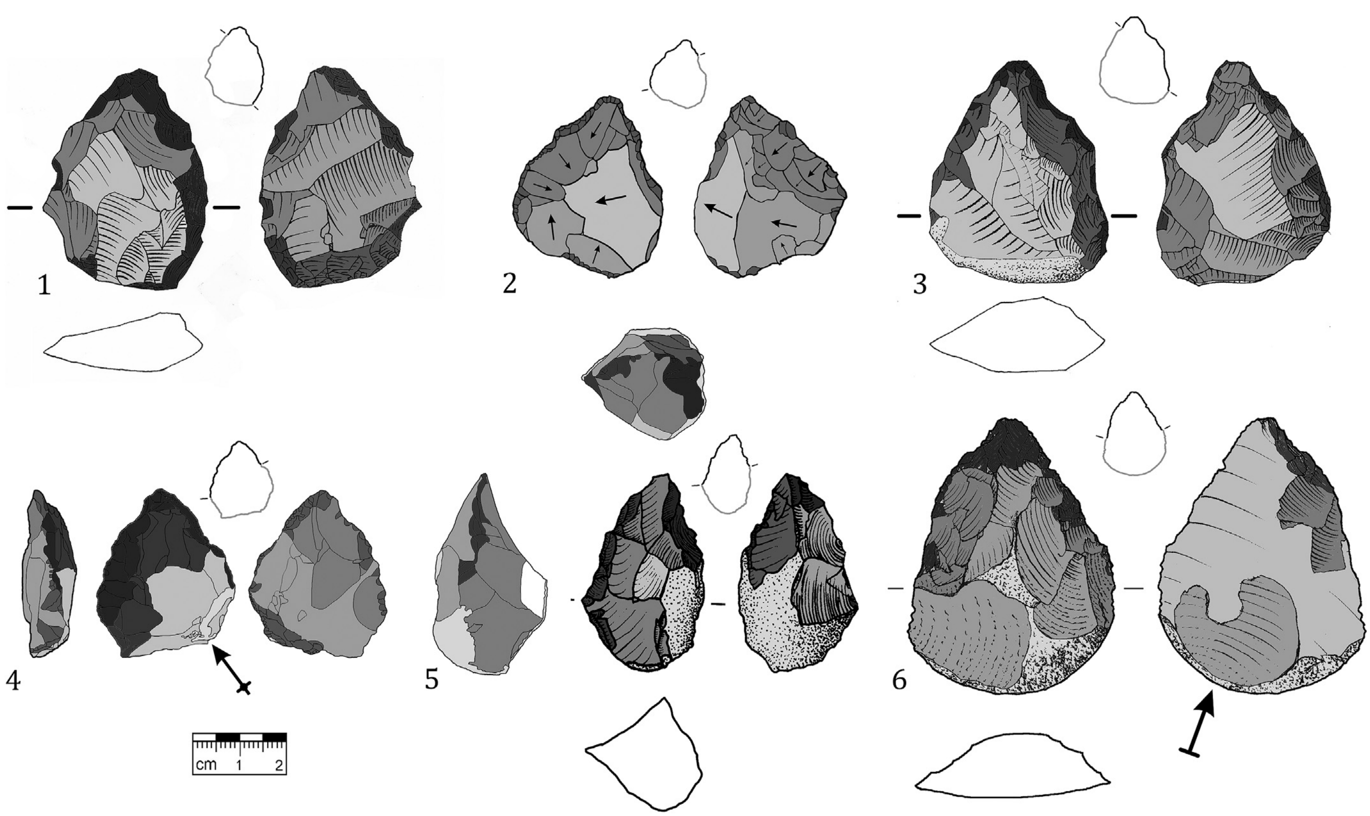

Fig. 6. Small symmetric bifaces with plano-convex surfaces (color and symbol codes see Fig. 4); 1) to 4) from VP I; 5) and 6) from VP II. 1) 81.12.1.88; 2) 61.3.10.28; 3) 81.12.1.90; 4) GER13.193-092.129; 5) GER12.227-057.420 and 6) GER13.227-057.1790.

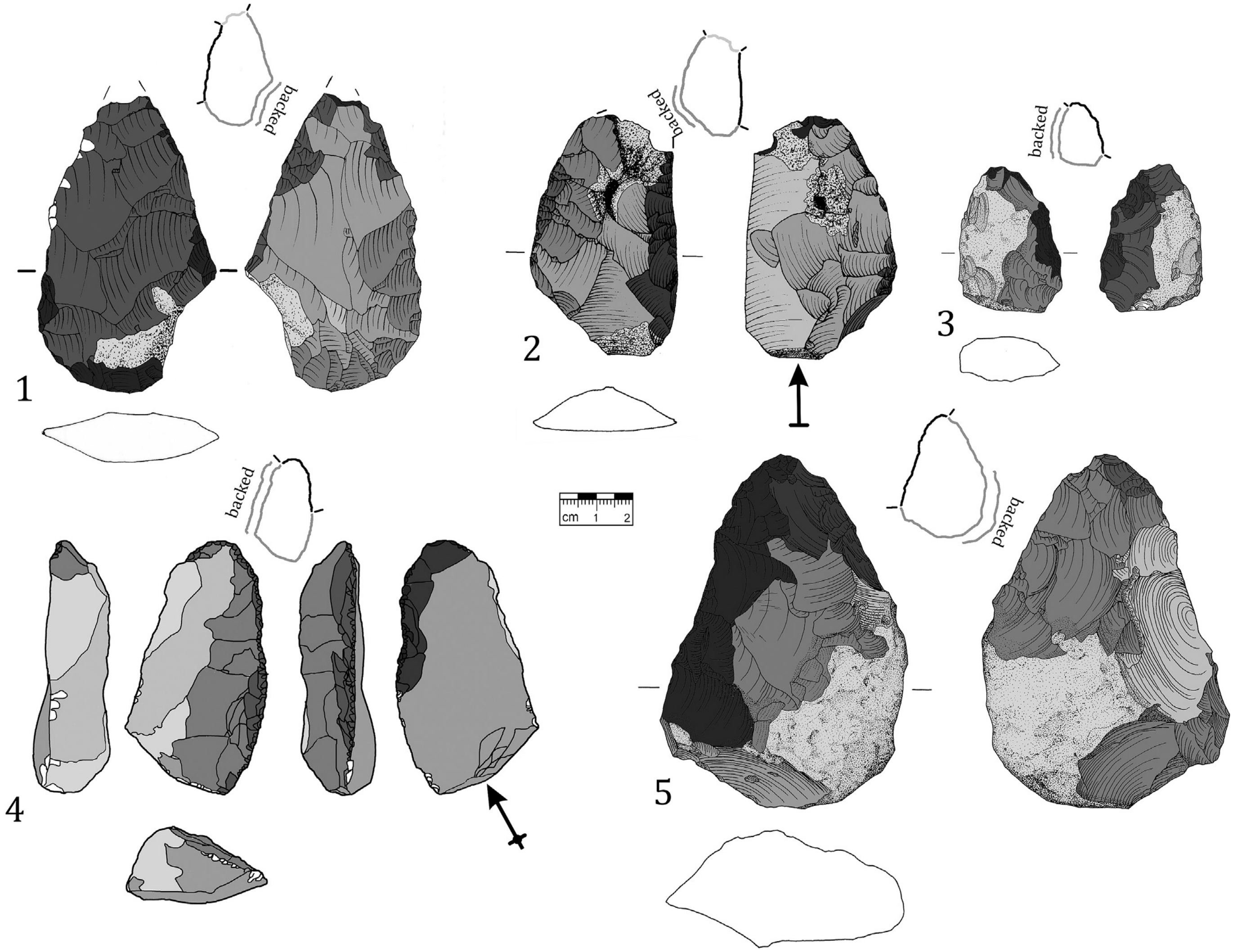

Fig. 7. Asymmetrically bifacially backed knives or simple *Keilmesser* (color and symbol codes see Fig. 4); 1), 2) and 5) from VP I; 3) and 4) from VP II. 1) 81.12.1.110; 2) GER06.198-104.19.1; 3) GER09.231-061.16.1; 4) GER10.226-059.301 and 5) GER08.194-095.44.1.

Pelatin yield n = 2 of these; the backdirt of VP I yielded n = 4. In VP II, n = 1 was recovered from GH 1 and n = 2 from GH 3. The ration between VP I and II (32:9) show a clear misbalance between both sites. Interestingly, it can also be noted that all such unfinished preforms are made from local Flint of the *argiles à Silex*.

5.8. Tranchet-blow blanks

Tranchet blows are the removals that create the initial cutting edge of *Keilmesser* (but also of the so-called Pradnik scraper, see Jöris, 2001). The resulting blanks are quite distinctive, especially with regard to the ventral surface, which presents the simple removal surface characteristic of lithic flakes alongside one of the bifacially-prepared surfaces of the tool, characterised by many negatives orthogonal to the knapping direction of the tranchet-blow negative (see also Jöris, 2001, but note that there the words primary and secondary are transposed). In total n = 18 tranchet-blow blanks (TBB) could be detected from both sites (Figs. 11 and 12, Table 13). There is the same amount of initial tranchet-blow blanks (VPI = 4, VP II = 6) as consecutive tranchet-blow blanks (VP I = 5; VP II = 4). This can be seen as an indication that the both initial formation of the tools and resharpening took place in both sites.

Table 13
List of tranchet-blow blanks from VP I and II.

VP	Collection	Number	GH	Fig.
I	Gros and Gros	02.14.26	?	15.1
I		02.14.99	?	15.2
I		02.14.142	?	15.3
I	Aimé	89.78.1.103	?	15.4
I	Pelatin	Pelatin.167	?	15.5
I		Pelatin.168	?	15.6
I		Pelatin.169	?	15.7
		Pelatin.219	?	15.8
I	Jeannin	Jeannin.44	?	15.9
II	Floss	GER09.228-060.70.3	3	16.1
II		GER13.226-057.1362	3	16.2
II		GER10.226-060.182	3	16.3
II		GER10.226-058.164.2	3	16.4
II		GER09.228-060.73.1	3	16.5
II		GER10.227-058.200.2	3	16.6
II		GER12.229-059.538	3	16.7
II		GER13.227-057.1862	3	16.8
II		GER13.228-057.220	3	16.9
II		GER10.226-059.321	4x	16.10
Total		19		

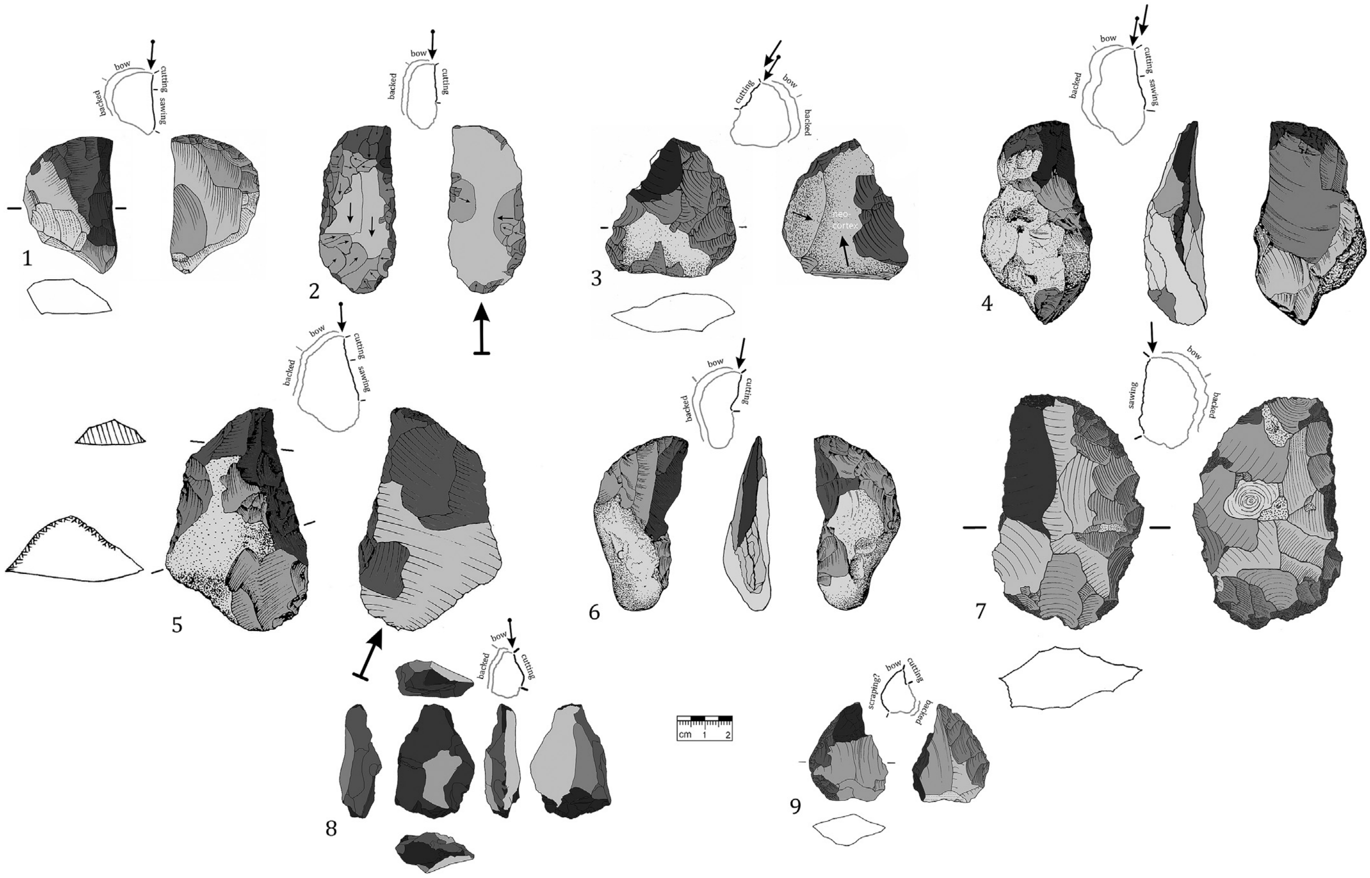

Fig. 8. Asymmetrically bifacially-backed knives (*Keilmesser*) with tranchet blow (color and symbol codes see Fig. 4). 1) to 6) and 9) from VP I; 7) and 8) from VP II. 1) 81.12.1.107; 2) 81.12.1.135; 3) CA27.125; 4) CA27.126; 5) Jeannin.71; 6) Jeannin.74; 7) GER12.229-059.428; 8) GER12.226-057.1227 and 9) GER11.192-099.275.

Half of them are complete blanks; VP I produced one basal and three medial fragments, and VP II n = 5 basal fragments. The majority of all TBBs are produced using direct, hard, linear percussion. For three TBBs from VP II the reduction technique was indeterminable. For each site only one TBB shows diagnostic features indicative of direct, soft, tangential percussion.

The bulk of the TBBs present additional negative(s) on the left side ventral face (VP I = 5 and VP II = 8). Only three from VP I and two from VP II show additional negative(s) on the right side of the ventral face (see Table 14). This is of interest because Jöris (2001) has documented precisely the opposite at the site of Buhlen, where 90% of the *Keilmesser* and 84.5% of the TBBs are right-oriented.

5.8.1. *Tranchet blow negatives on Keilmesser*

In total, n = 20 *Keilmesser* from both sites (VP I = 18, VP II = 2) present tranchet-blow negatives (TBNs). From VP I, n = 17 derive from the first excavation from Méray in 1868 (Méray, 1869). Only one small *Keilmesser* with TBN derives from the new excavation (GH 18) in VP I. In VP II, GH 3 yielded two *Keilmesser* with TBNs. Over all, some of the *Keilmesser* with TBNs (VP I = 4, VP II = 2) show only one TBN (primary TBN). However, some have a secondary TBN (VP I = 8, VP II = 0), and even fewer a tertiary TBN (VP I = 4, VP II = 0, see also Table 15).

5.8.2. *Comparison of tranchet-blow blanks and negatives*

By comparison of the identified tranchet-blow blanks (TBBs) and negatives (TBNs) deriving from the removal of such blanks we can draw a diverse picture. No refits between TBBs and *Keilmesser* with TBNs were possible. A quite similar picture can be drawn for both sites (in particular for the rock shelter entrance of VP I and the area of GH 3 in VP II), based on the presence of finished

Table 14
Observed features of all 19 tranchet-blow blanks from both sites.

Site	Direct-hard-lineal technique	Direct-soft-tangential technique	Undeterminable technique	Complete	Basal fragment	Medial fragment	Terminal fragment	Right sided second ventral face negative	Left sided second ventral face negative	initial tranchet-blow blank	Consecutive tranchet-blow blank
VP I	5	1	3	5	1	3	0	3	6	4	5
VP II	9	1	0	5	5	0	0	2	8	6	4
total	14	2	3	10	6	3	0	5	14	10	9

In terms of dimensions, there is a clear distinction between TBBs from VP I and those from VP II (Fig. 13), with those from VP II being primarily much smaller than those from VP I. This observation cannot be explained by fragmentation, since TBBs from VP II are mostly complete.

Table 15
Overview of the tranchet-blow negative from both sites.

	All TBN	Only TBNs from VP I	Only TBNs from VP II
Total number of TBNs	35	33	2
Number of primary TBNs	20	18	2
Number of secondary TBNs	11	11	0
Number of tertiary TBNs	3	3	0
Total length of all TBNs	707.19	650.25	56.94
Mean length of all TBNs	20.21	19.7	28.47
Minimum length of all TBNs	7.19	7.19	10.1
Maximum length of all TBNs	46.84	42.51	46.84
Total width of all TBNs	266.88	246.74	19.13
Mean width of all TBNs	7.63	7.51	9.57
Minimum width of all TBNs	1.13	1.64	1.13
Maximum width of all TBNs	19.32	19.32	18

Keilmesser with TBNs (and without), soft-hammer flakes from bifacial production (not included in this paper), TBBs (that could not be refitted to the *Keilmesser*) and a colorful diversity of bifacial objects.

If production and resharpening processes of *Keilmesser* and corresponding TBNs took place on the same spot, we would be able to refit at least some of the TBBs to corresponding negatives on *Keilmesser*, which is not the case. This observation connotes different spatial and temporal aspects (unexhausted). First, if production and resharpening was done on the same place in the sites the bifacial objects are exported and second, resharpened *Keilmesser* could have been imported. But other possibilities are still given, concerning the size of the excavated area (of both sites) or undetected find collections (from VP I). In GH3 of VP II *Keilmesser* with TBNs and TBBs are spatially accompanied (see Fig. 2).

6. Discussion

As Table 16 clearly shows, there are many more bifacial elements from VP I than VP II (96:43, which equals a ratio of 2.23:1). Given that only a eighth of estimated intact Middle Paleolithic sediments have been excavated at VP II (estimations after 2014 campaign), there is the possibility that the picture we currently have will change with continued excavation. Concerning the amount of bifacial elements, there are distinct differences between the two sites. Key among them are: the number of *Keilmesser* (28:7), preforms (31:9), bifaces with double reflection symmetry (10:0), and bifacially worked objects (0:5). With regard to other objects, the assemblages are more balanced, as it is the case for tranchet-blow blanks (9:10) and for symmetrical bifaces with plano-convex surfaces (5:3). If we compare the density of bifacial elements at both sites (n = 140) with that of unifacial lithic elements (altogether numbering significantly more than 10,000 blanks and cores from all lithic raw materials at both sites) it is clear that bifacial reduction was present, but constituted a minor component of the lithic repertoire. This misbalance of bifacial and unifacial elements is even more contrasted by the fact that they are extensively used for the characterization, classification and comparison of assemblages belonging to the European Middle Paleolithic (Peyrony, 1920; Jöris, 2003; Chabai et al., 2007, 2008). This is protruded by the division of European Lower Paleolithic industries (Movius line, see Jöris, 2015). The reasons for the emphasis placed on bifaces are complex. An important factor is that the production differs greatly from unifacial products. A bifacial object is an uniquely

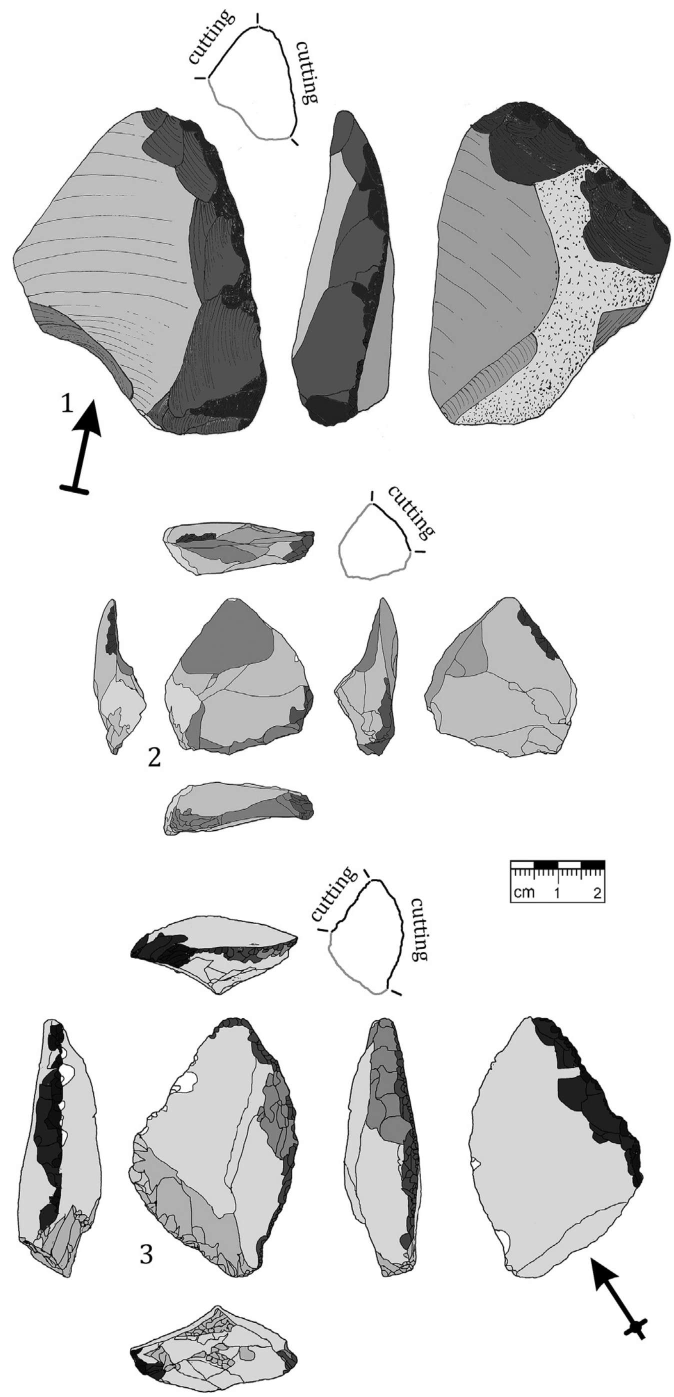

Fig. 9. Examples of bifacially worked objects or so called bifacial scrapers (color and symbol codes see Fig. 4). 1) GER10.226-059.196; 2) GER09.228-059.116.8 and 3) GER10.227-058.219.

individual objects that requires series of reduction and produce many waste products. If we assume a relation of 1:100 (personal estimation from replication) we can see that their production constitutes a high investment of time, skill, and labor for Paleolithic peoples (see also Callahan, 1979; Jöris, 2001; Hallos, 2005), especially in comparison to serially-produced unifacial elements.

Table 16
Inventory of bifacial elements from both sites.

Bifacial elements	VP I, ancient collections	VP I, new excavations	VP II, GH 1 and 2	VP II, GH 3	VP II, GH 4x	Total number
Bifaces with double reflection symmetry	9	1	0	0	0	10
Asymmetric bifaces with small back	8	5	4	5	0	22
Symmetrical bifaces with plan- convex surfaces	4	1	1	2	0	8
Asymmetrically bifacially backed knives	6	4	1	4	0	15
Asymmetrically bifacially backed knives with tranchet blow	17	1	0	2	0	20
Bifacially worked objects (bifacial scrapers)	0	0	0	5	0	5
Bifacial preforms	23	9	1	8	0	41
Tranchet-blow blanks	9	0	0	9	1	19
Total number, each	76	21	7	35	1	140
Total number, per site	97		43			140

The general reduction of double symmetrically shaped bifaces is well understood (Bordes, 1961; Callahan, 1979; Soressi, 2002), but cannot be applied to be used to describe the backed bifacial objects that are a significant and often defining component of certain assemblages and industries (Jöris, 2006). An important factor in the description of bifacial objects is cross section analysis (Boëda, 1995a,b, see Fig. 14a–f) and the detection of specific reduction sequences (e.g., Neruda and Nerudová, 2010 for Moravsk Krumlov IV, Moravia). These descriptions are a specification of the *wechselseitig-gleichgerichtete Kantenbearbeitung* (alternating unidirectional edge reduction, see Fig. 14g) as Bosinski (1967) described it. Weißmüller (1995, Fig. 37) explanation about turning and rotation for the performance of the reduction can also be added (see Figs. 15 and 16).

As can be seen from the summary above, which is far from exhaustive, a diversity of concepts and terminologies has been applied in the study of bifaces. This has made comparative studies somewhat challenging. Our aim here has been to combine several approaches to the study of bifacial objects (Fig. 14–16) in order to determine whether these concepts can be used to describe a general operational reduction chain for bifacial object formation in both sites or if much more sequences are existing. Summed up from diagrams and written explanations in Jöris (2001), Pastoors (2001), Richter (1997) and also Migal and Urbanowski (2006) the general following steps (*chaîne opératoire*) for producing a *Keilmesser* with tranchet blow are (terminology see Frick and Herkert, 2014, see Table 4).

Concerning the assemblage of bifacial elements, we are able to depict a distinct variety of these objects. All defined groups of bifacial elements (with the exceptance of formal bifaces with double reflection symmetry from VP I) can be classified as a common element of *Keilmesser*-bearing assemblages. The most characteristic feature and similarity is the asymmetry in top view

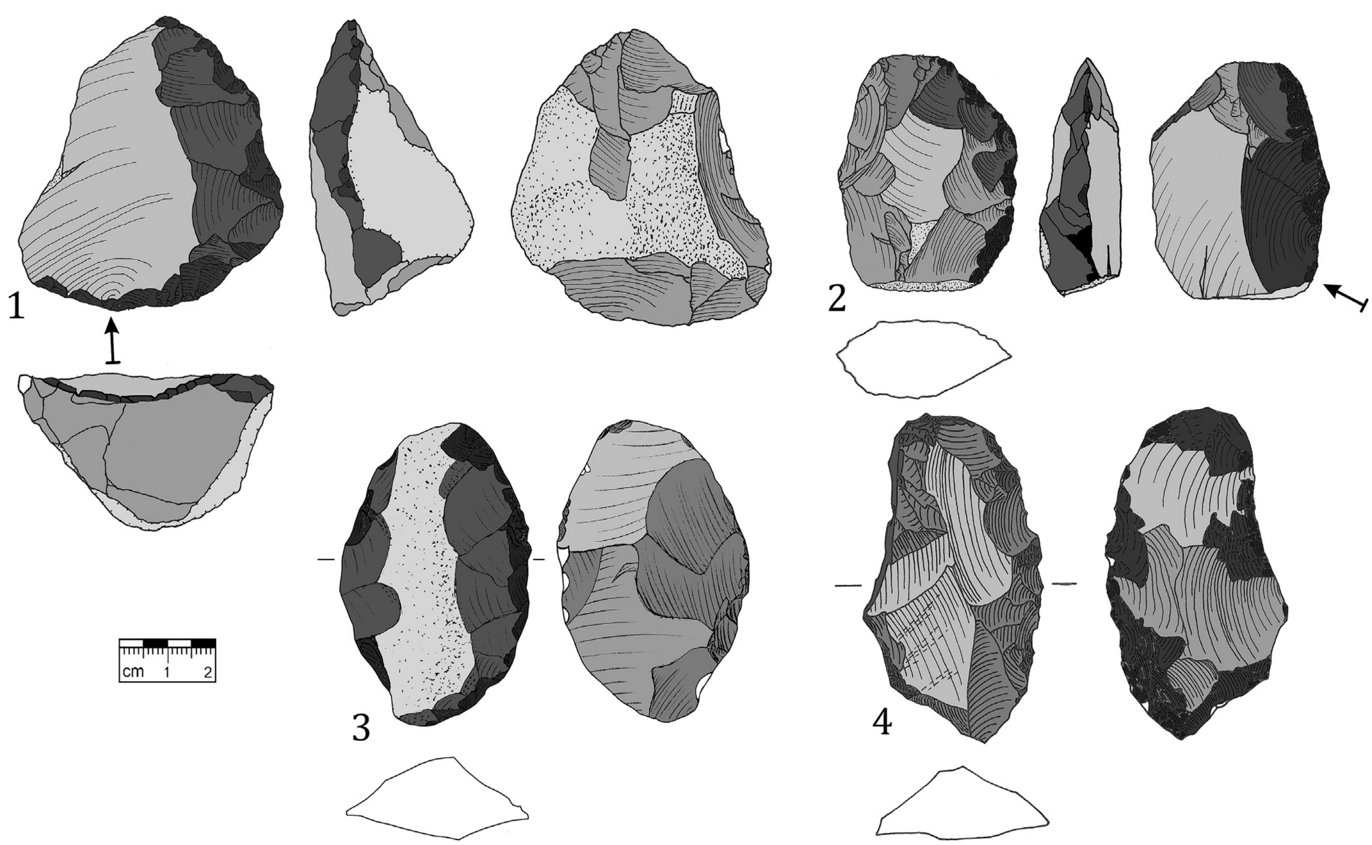

Fig. 10. Examples of bifacially worked preforms (bifacial objects that were discarded before regularization of surfaces and edges (color and symbol codes see Fig. 4). 1) to 3) from VP I and 4) from VP II). 1) GER11.192-099.46.1; 2) GER11.192-095.41.1; 3) 81.12.1.106 and 4) GER07.229-061.24.1.

Fig. 11. Illustration of the tranchet-blow blanks from VP I (*schéma diacritique* based on Dauvois, 1976). 1) Coll. Gros and Gros 02.14.26 (no photography available); 2) Coll. Gros and Gros 02.14.99; 3) Coll. Gros and Gros 02.14.142 (from Delporte excavation, July 1953, trench B7); 4) Coll. Aimé 89.78.1.103; 5) Coll. Pelatin Pel.167; 6) Coll Pelatin Pel.168; 7) Coll. Pelatin Pel.169; 8) Coll. Pelatin Pel.219 and 9) coll. Jeannin Jeannin.44. No. 1) to 7) are made from Flint from the *argiles à silex* and 8) is made from a gray Chaille (jurassic chert).

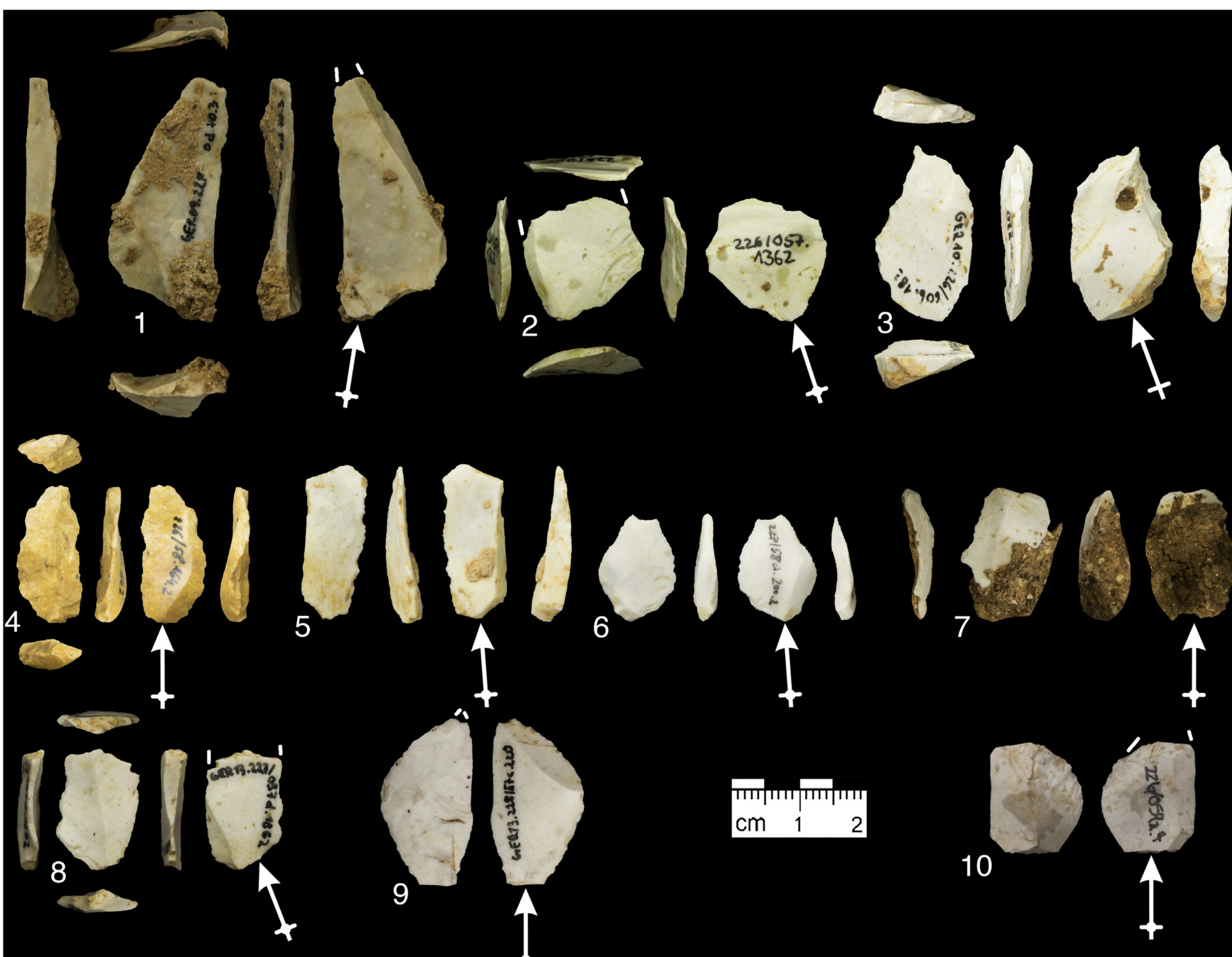

Fig. 12. Illustration of the tranchet-blow blanks from VP II (*schéma diacritique* based on Dauvois, 1976). 1) tranchet-blow blank No. GER09.228-060.70.3; 2) No. GER13.226-057.1362; 3) No. GER10.226-060.182; 4) No. GER10.226-058.164.2; 5) No. GER09.228-060.73.1; 6) No. GER10.227-058.200.2; 7) No. GER12.229-059.538; 8) No. GER13.227-057.1862; 9) GER13.228-057.220 and 10) GER10.226-059.321. No. 1) to 9) derive from GH 3 and No. 10) from GH 4x. All tranchet-blow blanks are made from Flint from the *argiles à Silex*.

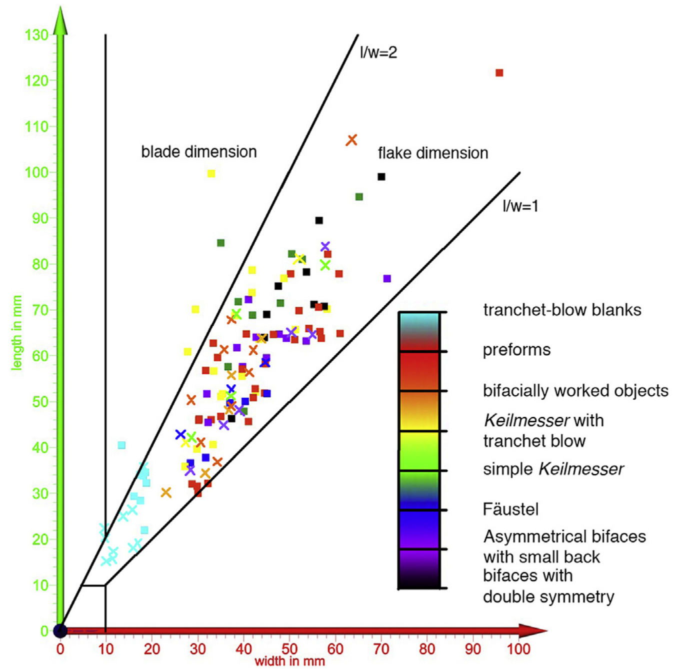

Fig. 13. Dimension (length and width) of all bifacial elements (squares = VPI, crosses = VPII). Note that in the flake dimension l/w < 1 no object can appear because length was defined as the maximum dimension.

and cross section. But the production of cutting edges shows that there is not one specific way to shape and regularize them. Also in a conceptual consideration, there is no overriding principle for the production of these bifacial elements. The only common order of individual operation steps for all of these objects is as follows:

- Procurement and selection of a suitable support (flat nodule, preformed core or blank) for the physical realization of a mental scheme (the idea, the imagining)
- Production of a back as platform for blank removals from one and/or the other side (top or bottom side, ventral or dorsal face)
- Reduction of one and/or the other side for producing flat, convex or plane-to-convex surfaces
- Confection of edge part(s) that should function as cutting edge (active part of the perimeter, *partie transformative*)

The confection can include quite different tasks like preparation of tranchet-blow blank removals (platform formation, crest formation, backing of edges, etc.), the performance of this tranchet-blow removal and/or the uni- or bifacial retouch of the supposed cutting edge (what we call edge regularization, because it seems not to be important that a cutting edge has to be unifacially or bifacially worked, much more that a cutting edge is shaped regarding the position and form in a suitable way to transform other material), as it is comparable to assemblages from Bockstein, Germany, see Çep 2014).

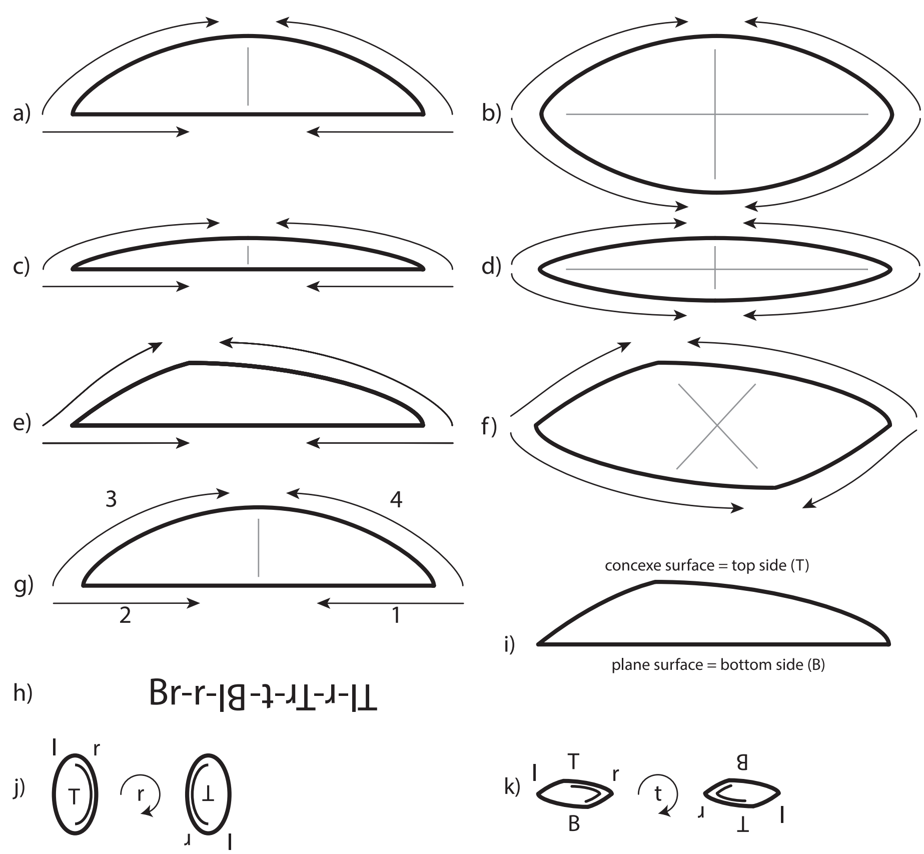

Fig. 14. Description of bifacial reduction analysis using cross-sections. a) to f) after Boëda (1995a,b), g) after Bosinski (1967) and j) and k) after Weißmüller (1995). a) plano-convex reduction on thicker object; b) bi-convex reduction on thicker object; c) plano-convex reduction on thinner object; d) biconvex reduction on thinner object; e) plane-to-convex reduction of one side and plane reduction on the other side; f) plane-to-convex reduction on both sides; g) sequence of reduction for alternating unidirectional edge reduction (*wechselseitig-gleichgerichtete Kantenbearbeitung*); h) reduction code for No. g (bottom side on the right, rotation, bottom side on the left, turning, top side on the right, rotation, top side on the left); i) name determination for convex and plane surfaces, the more convex surface is defined as top side; j) illustration of rotation (the same side is visible, but the other edge can be worked); k) illustration of turning. Gray lines in a) to d) and f) to g) reflects symmetry axes.

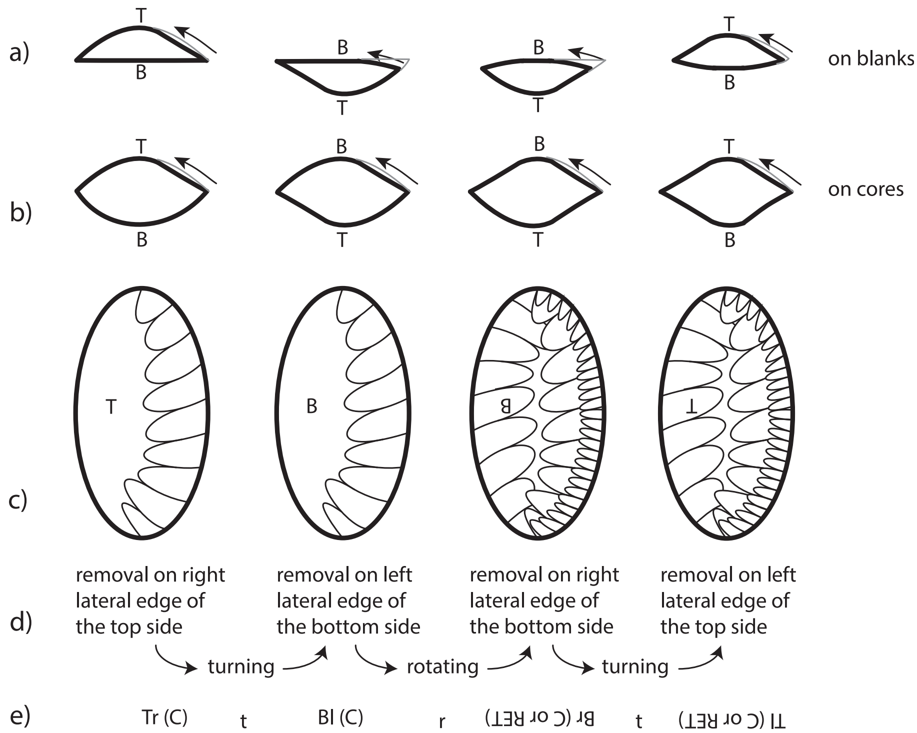

Fig. 15. Description of the reduction analysis for symmetric bifaces using cross sections and top views, from left to right. a) cross-section of alternating unidirectional edge reduction for blanks; b) cross section of alternating unidirectional edge reduction for cores; c) top view of this reduction sequence; d) description of the reduction in each step and the turing or rotation while knapping; e) reduction code for this sequence (T = top side, B = bottom side, r = right edge, l = left edge; C = surface configuration and RET = retouch). a) to d) illustration of Weißmüller (1995) description for alternating unidirectional edge reduction from Bosinski (1967).

Almost every bifacial object shows the combination of flat and convex surfaces (plano-convex surfaces), as well as the combination of flat and slightly curved parts of a surface (plane-to-convex surface). This rule seems to be independent whether the object is shaped almost symmetrically in its top view (such as small symmetric bifaces with plano-convex surfaces, 5.3) or asymmetrically (such as KMTB, 5.5). To follow this production rule the edge is regularized in that way as Bosinski (1967) described the "*wechselseitig-gleichgerichtete Kantenbearbeitung*" (alternating unidirectional edge reduction). For the VP I and II assemblages, this means

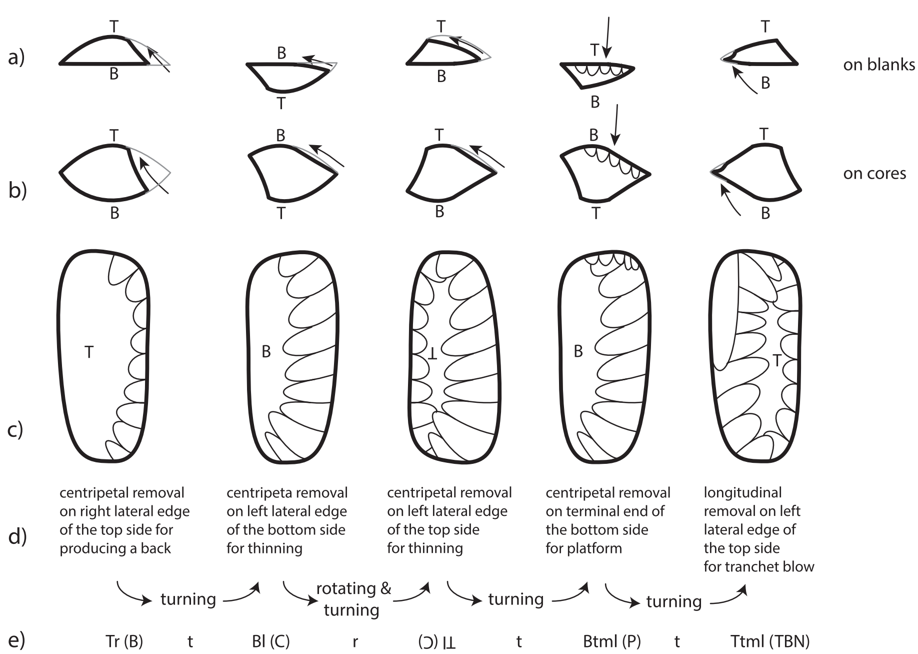

Fig. 16. Description of the reduction analysis for asymmetric bifaces (*Keilmesser*) using cross sections and top views, from left to right. a) cross section of backing, surface configuration, platform installation and tranchet blow for blanks; b) cross section of backing, surface configuration, platform installation and tranchet blow for cores; c) top view of this reduction sequence; d) description of the reduction in each step and the turing or rotation while knapping; e) reduction code for this sequence (T = top side, B = bottom side, r = right edge, l = left edge, tml = terminal end; in brackets B = back configuration, C = surface configuration, P = platform installation and TBN = tranchet-blow negative).

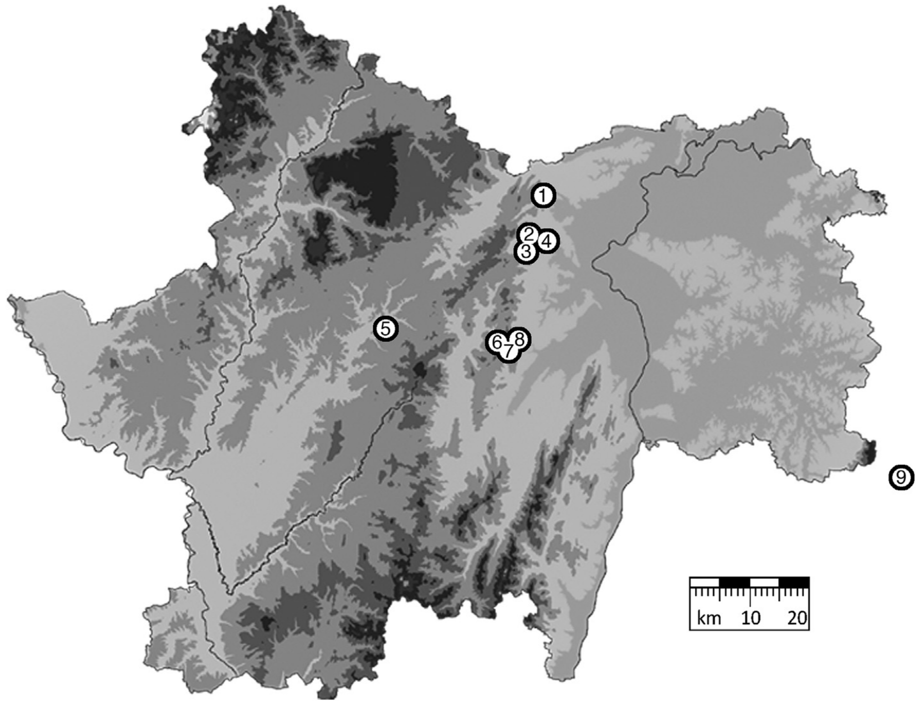

Fig. 17. Middle Paleolithic sites in Dept. Saône-et-Loire (and Jura), France that contain *Keilmesser* with and without tranchet blows, and could be associated with central European KMG. 1) Grotte de la Mère Grand à Rully; 2) La Roche à Saint-Martin-sous-Montaigu; 3) Grotte de Teux Blancs à Saint-Denis-de-Vaux; 4) Grottes de la Verpillière I and II; 5) Le Bois des Ranches à Blancy; 6) Grotte de Culles-les-Roches; 7) Bissy-sur-Fley; 8) Beaux-Regards à Chenoves and 9) La Baume de Gigny, Jura.

that the last production blows (finishing) of the cutting edge are performed in a unidirectional way (see Figs. 14–16).

7. Conclusion

In the certainty that all of the bifacial elements from the Grottes de la Verpillière I and II are not from one assemblage, we are still able to draw a picture of similarities and differences between these bifacial assemblages from these different sources. The first is that all (except formal double symmetric bifaces form VP I) can be classificed as elements common in *Keilmessegruppen*-assemblages.

If we agree that the presence of *Keilmesser* in assemblages can be seen as index fossiles as it was assumed by Jöris (Jöris, 2002, 2003) for the KMG of central and western Europe and if we also agree with the Micoquian *Formengruppe* of Bosinski (1967) integrating other bifacial objects like *Fäustel* or *Micoquekeile*, we can place the assemblages from Grotte de la Verpillière I and II into the *KMG*. Because of the appearance of TBBs and KMTBs in these assemblages, we can further group both sites in KMG B (assemblage with KMTBs) in Jöris (2002, 2003) definition. This would suggest a chronological dating of something between 55 and 65 ka BP. Preliminary ISRL results for GH 3 of VP II suggest a terminus ante quem of 45 $\pm$ 4 ka BP (pers. comm L. Zöller), which could place this sedimentological unit into this assumed timespan or even at the end of the Middle Paleolithic. Following Jöris (2003) chronological model for the *Keilmessergruppen*, it can also be assumed that all *Keilmesser*-bearing assemblage in Saône-et-Loire are from similar age.

Concerning the affiliation of the bifacial assemblages of the Grottes de la Verpillière I and II, we can declare that they are remote from singularity in Dept. Saône-et-Loire (see Fig. 17). Our new studies on museum and private collections observed that different other sites also contain bifacial elements (in particular *Keilmesser* with and without tranchet blows) like Bissy-sur-Fley (earlier study by Desbrosse and Texier, 1973a,b, who called these *Keilmesser* simply *racloirs à retouches bifacials*), Chenôves (see Guillard, 1959, 1960) or Saint-Martin-sous-Montaigu (Gros and Gros, 2005), further sites like Culles-les-Roches, Mère Grand or Teux Blancs need more and additional confirmation. In that way, we are able to round out the picture drawn by Farizy (1995), who named sites like Blanzy (Desbrosse, 1979), Germolles, Saint-Martin-sous-Montaigu and Bissy-sur-Fley as containing Prondniks (*Keilmesser* with tranchet blows).

Acknowledgements

This paper is dedicated to René Desbrosse (* 1931, + January 29th, 2015) and to Catherine Farizy (*1947, + 1997). Desbrosse performed the first description and comparison of an important series of the bifacially backed knives from Grotte de la Verpillière I in the 1970s and Farizy showed that there are many sites with similarities in this region. This research was funded by the DFG (German Research Foundation, project FL 244/5-1). A warm thanks goes to Gwénaëlle Marchet-Legendre and her team (Cathérine Michel and Denis Dubois) at Musée Denon in Chalon-sur-Saône to have the possibility to study all Germolles material (from the résèrves and from the vitrine) hosted there. Thanks also to all people who produced conventional illustrations of lithic artifacts for the Germolles project over the years (e.g. Nadine Huber, Stefan Wettengl, Heike Würschem, Nadine Pasianotto, Yamandú Hilbert and Sabine Boos). A friendly thanks goes to our colleagues Ewa Dutkiewicz, Klaus Herkert and Christian Thomas Hoyer for concerted data collection and for sure a big thanks to all members of the Germolles excavation team. A cordial thanks goes also to Claire Heckel for improvements to a previous version of this manuscript, including revision of the English. Furthermore, we would like to say thanks a lot to the anonymous reviewers of this paper, whose suggestions helped to transform the initial manuscript into a paper worthy of publication.

References

Boëda, É., 1995a. Caractéristiques techniques des chaînes opératoires lithiques des niveaux micoquiens de Külna (Tchécoslovaquie). Paléo Supplément 1 (1), 57–72.

Boëda, É., 1995b. Steinartefakt-Produktionssequenzen im Micoquien der Kulna-Höhle. Quartär 45, 75–98.

Bons, P., Wißing, C., 2009. Aspects of local geological structure in connection with the palaeolithic cave site in Germolles (Commune de Mellecey, France). In: Floss, H. (Ed.), Rapport de fouille programmée. Lieu-dit: Les Grottes de La Verpillière I et II à Germolles. S.R.A. Dijon und Abteilung für Ältere Urgeschichte und Quartärökologie, Dijon and Tübingen, pp. 1–11.

Bordes, F., 1961. Typologie du paléolithique ancien et moyen. Imprimerie Delmas, Bordeaux.

Bosinski, G., 1967. Die Mittelpaläolithischen Funde im westlichen Mitteleuropa. Fundamenta A4, Monographien zur Urgeschichte. Böhlau, Köln.

Breuil, H., 1911. Etudes de morphologie paléolithique II: l'industrie de la grotte de Chatelperron (Allier) et d'autres gisements similaires. Revue anthropologique 11, 29–40.

Burdukiewicz, J.M., 2000. The backed biface assemblages of East Central Europe. In: Ronen, A., Weinstein-Euron, M. (Eds.), Toward Modern Humans: the Yabrudian and the Micoquian 400–50 k-years Ago. Proceedings of a Congress Held at the University of Haïfa November 3–9, 1996. British Archaeological Reports International Series 850, pp. 155–165.

Callahan, E., 1979. The basics of biface knapping in the eastern fluted point tradition: a manual for flintknappers and lithic analysts. Archaeology of Eastern North America 7, 1–180.

Çep, B., 2014. Das mittelpaläolithische Silexinventar des Bocksteins im Lonetal (Schwäbische Alb). Vielfalt der Formen oder Fortbestand einer technologischen Idee? In: Beier, H.-J., Einicke, R., Biermann, E. (Eds.), “Material-Werkzeug: Werkzeug-Material” and “Klinge, Messer, Schwert and Co – Neues aus der Schneidenwelt” Aktuelles aus der Neolithforschung. Beiträge der Tagungen der Arbeitsgemeinschaft Werkzeuge und Waffen Pottenstein (Fränkische Schweiz) 2011 and Herxheim bei Landau in der Pfalz 2012 sowie Aktuelles. Beiträge zu Ur- und Frühgeschichte Mitteleuropas 75, Beier and Beiran, Langenweissbach, pp. 79–92.

Chabai, V.P., Richter, J., Uthmeier, T., Kabazi, V., 2007. Interstratification of Micoquian and Levallois-Mousterian Camp Sites Palaeolithic sites of Crimea, 3/1. National Academy of Sciences of Ukraine, Institute of Archaeology, Crimean Branch University of Cologne, Institut of Prehistoric Archaeology, Simferopol Cologne.

Chabai, V.P., Richter, J., Uthmeier, T., Kabazi, V., 2008. Interstratification of Micoquian and Levallois-Mousterian Camp Sites Palaeolithic sites of Crimea, 3/2. National Academy of Sciences of Ukraine, Institute of Archaeology, Crimean Branch University of Cologne, Institut of Prehistoric Archaeology, Simferopol Cologne.

Conard, N.J., Fischer, B., 2000. Are there recognizable cultural entities in the German middle Palaeolithic?. In: Ronen, A., Weinstein-Evron, M. (Eds.), Toward Modern Humans: the Yabrudian and the Micoquian 400–50 k-years Ago. Proceedings of a Congress Held at the University of Haïfa November 3–9, 1996. British Archaeological Reports International Series 850Archaeopress, Oxford, pp. 7–21.

Dauvois, M., 1976. Precis de Dessin Dynamique et Structural des Industries Lithiques Préhistoriques. Pierre Fanlac, Paris.

Desbrosse, R., 1979. Blanzy aux temps préhistoriques. La Physiophile 55 (90), 1–7.

Desbrosse, R., Kozlowski, J.K., Zuate y Zuber, J., 1976. Prondniks de la France et d'Europe centrale. L'Anthropologie 80, 431–488.

Desbrosse, R., Texier, P.-J., 1973a. La station moustérienne de Bissy-sur-Fley (S.-and-L.). La Physiophile 79, 8–31.

Desbrosse, R., Texier, P.-J., 1973b. Les silex de Germolles dans la collection Jeannin. La Physiophile 79, 64–69.

Dibble, H.L., Bernard, M.C., 1980. A comparative study of basic edge angle measurement techniques. American Antiquity 45 (4), 857–865.

Dutkiewicz, E., 2011. Die Grotte de La Verpillière I – 150 Jahre Forschungsgeschichte. Die Aufarbeitung und Auswertung der Altgrabungen des paläolithischen Fundplatzes Germolles (Commune de Mellecey, Saône-et-Loire, Frankreich). Abteilung für Ältere Urgeschichte und Quartärökologie (Magister's thesis). Eberhard Karls Universität Tübingen, Tübingen.

Dutkiewicz, E., Floss, H., 2015. La Grotte de la Verpillière I à Germolles, site de reference Paléolithique en Bourgogne méridionale. Histoire des 150 ans de recherches. La Physiophile 162, 13–32.

Farizy, C., 1995. Industries charentiennes à influences micoquiennes, l'exemple de l'Est de la France. Paléo Supplément 1 (1), 173–178.

Floss, H., 2003. Did they meet or not? Observations on Châtelperronian and Aurignacian settlement patterns in eastern France. In: Zilhão, J., d'Errico, F. (Eds.), The Chronology of the Aurignacian and of the Transitional Technocomplexes. Dating, Stratigraphies, Cultural Implications. Proceedings of Symposium 6.1 of the XIVth Congress of the UISPP (University of Liège, Belgium, September 2–8, 2001). Trabalhos de Arqueologia 33Instituto Português de Archeologia, pp. 273–287.

Floss, H., 2005. Das Ende nach dem Höhepunkt, Überlegungen zum Verhältnis Neandertaler – anatomisch moderner Mensch auf der Basis neuer Ergebnisse zum Paläolithikum in Burgund. In: Conard, N.J., Kölbl, S., Schürle, W. (Eds.), Vom Neandertaler zum modernen Menschen. Jan Thorbecke Verlag, Ostfildern, pp. 109–130.

Floss, H., 2011. Rapport de fouille pluriannuelle 2010–2012. Rapport intermédiaire 2011. Les Grottes de La Verpillière I et II à Germolles. Sérvice Régional d'Archéologie, Dijon and Abteilung für Ältere Urgeschichte, Universität Tübingen, Dijon and Tübingen.

Floss, H., Hoyer, C.T., Frick, J.A., Heckel, C.E., Herkert, K., 2013a. Rapport de fouille pluriannuelle. Rapport final et rapport 2012. Lieu-dit: Les Grottes de la Verpillière I and II à Germolles, Commune Mellecey, Saône-et-Loire, vol. 71. Sérvice Régional d'Archéologie, Dijon and Abteilung für Ältere Urgeschichte, Universität Tübingen, Dijon and Tübingen, p. 185.

Floss, H., Hoyer, C.T., Frick, J.A., Heckel, C.E., Herkert, K., 2013b. La Grotte de la Verpillière II à Germolles, commune de Mellecey (Saône-et-Loire). Fouille programmée 2010-2012. Rapport annexe complément suit à la CIRA du février 2013. Sérvice Régional d'Archéologie & Abteilung für Ältere Urgeschichte und Quartärökologie, Dijon and Tübingen.

Floss, H., Hoyer, C.T., Frick, J.A., Heckel, C.E., Herkert, K., 2014a. Les Grottes de la Verpillière à Germolles, commune de Mellecey (Saône-et-Loire). Fouille programmée pluriannuelle 2013–2015. Rapport intermédiaire 2013. S.R.A. Dijon and Abteilung für Ältere Urgeschichte und Quartärökologie, Tübingen, Dijon and Tübingen.

Floss, H., Hoyer, C.T., Frick, J.A., Herkert, K., 2014b. Project Collective du Recherche: Le Paléolithique supérieur ancien en Bourgogne méridionale. Genèse, chronologie et structuration interne, évolution culturelle et technologique. Rapport annuelle 2014. S.R.A. Dijon and Abteilung für Ältere Urgeschichte und Quartärökologie, Tübingen, Dijon and Tübingen.

Floss, H., Hoyer, C.T., Heckel, C.E., Tartar, É.., in press. The Aurignacian in Southern Burgundy. P@léthnologie.

Frick, J.A., 2010. Les outils du Néandertal. Technologische und typologische Aspekte mittelpaläolithischer Steinartefakte, am Beispiel der Grotte de la Verpillière I in Germolles, Commune de Mellecey, Saône-et-Loire (71), FrankreichAbteilung für Ältere Urgeschichte und Quartärökologie (Magister's thesis). Eberhard Karls Universität Tübingen, Tübingen.

Frick, J.A., Floss, H., 2015. Grotte de la Verpillière II, Germolles, France: preliminary insights from a new Middle Paleolithic site in southern Burgundy. In: Sázelová, S., Novak, M., Mizerova, A. (Eds.), Forgotten Times, Spaces and Lifestyles. Institute of Archaeology, Czech Academy of Sciences. Masaryk University, Brno, pp. 53–72.

Frick, J.A., Herkert, K., 2014. Lithic technology and logic of technicity. Mitteilungen der Gesellschaft für Urgeschichte 23, 129–172.

Gros, O., Gros, A.-C., 2005. Le Paléolithique Châlonnais. Collections du Musée de Châlon-sur- Saône. Ville de Chalon-sur-Saône, Chalon-sur-Saône.

Guillard, E., 1959. Note sur les stations et vestiges préhistoriques de la côte Chalonnaise trouvés Chenoves, Saules et Grotte de Culles-les-Roches. La Physiophile 50, 2–16.

Guillard, E., 1960. Note sur les stations et vestiges préhistoriques de la côte Chalonnaise trouvés Chenoves, Saules et Grotte de Culles-les-Roches. La Physiophile 52, 5–16.

Hallos, J., 2005. “15 minutes of fame”: exploring the temporal dimension of Middle Pleistocene lithic technology. Journal of Human Evolution 49 (2), 155–179.

Ioviţă, R., 2014. The role of edge angle maintenance in explaining technological variation in the production of Late Middle Paleolithic bifacial and unifacial tools. Quaternary International 350, 105–115.

Jöris, O., 2001. Der spätmittelpaläolithische Fundplatz Buhlen (Grabungen 1966–69): Stratigraphie, Steinartefakte und Fauna des oberen Fundplatzes. Dr. Rudolf Habelt, Bonn.

Jöris, O., 2002. Die aus der Kälte kamen… von der Kultur Später Neandertaler in Mitteleuropa. Mitteilungen der Gesellschaft für Urgeschichte 11, 5–32.

Jöris, O., 2003. Zur chronostratigraphischen Stellung der spätmittelpaläolithischen *Keilmessergruppen*: Der Versuch einer kulturgeographischen Abgrenzung einer mittelpaläolithischen Formengruppe in ihrem europäischen Kontext. Bericht der Römisch-Germanischen Kommission 84, 49–153.

Jöris, O., 2006. Bifacially backed knives (*Keilmesser*) in the Central European Middle Palaeolithic. In: Goren-Inbar, N., Sharon, G. (Eds.), Axe Age: Acheulian Toolmaking from Quarry to Discard. Approaches to Anthropological Archaeology. Equinox Publishing Ltd, London, pp. 287–310.

Jöris, O., 2015. Early Palaeolithic Europe. In: Renfrew, C., Bahn, P. (Eds.), The Cambridge World Prehistory. Cambridge University Press, Cambridge, pp. 1703–1746.

Koehler, H., 2009. Comportements et identité techniques au Paléolithique moyen (Weichsélien ancien) dans le Bassin parisien: une question d échelle d analyse Doctoral thesis, cole Doctorale Milieux, Cultures et Sociétés. Université Paris X-Nanterre la Défense, Paris.

Koulakovskaya, L., Kozlowski, J., Sobczyk, K., 1993. Les couteaux micoquiens du Würm ancien. Préhistoire Européenne 4, 9–32.

Leach, P.A., 2014. Ground-penetrating radar investigation at archaeological sites in Fuissé, Mellecey, and Saint-Martin-sous-Montaigu, France. Rapport annuel 2014. In: Floss, H., Hoyer, C.T., Frick, J.A., Herkert, K. (Eds.), Projet Collectif de Recherche: Le Paléolithique supérieur ancien en Bourgogne méridionale. Genèse, chronologie et structuration interne, évolution culturelle et technologique. S.R.A. Dijon and Abteilung für Ältere Urgeschichte, Universität Tübingen, Dijon and Tübingen, pp. 182–201.

Mania, D., 1990. Auf den Spuren des Urmenschen: Die Funde aus der Steinrinne von Bilzingsleben. Deutscher Verlag der Wissenschaften, Berlin.

Méray, C., 1869. L'âge de la pierre à Germolles. Materiaux d'Histoire et d'Archéologie, pp. 83–86.

Méray, C., 1876. Compte-rendu des Fouilles de la caverne de Germolles, commune de Mellecey. Mémoires de la Société d'Histoire et d'Archéologie de Chalon-sur-Saône Chalon-sur-Saône 6 (2), 251–266.
Migal, W., Urbanowski, M., 2006. Pradnik knives reuse. Experimental approach. In: Wiśniewski, A., Plonka, T., Burdukiewicz, J.M. (Eds.), The Stone. Technique and Technology. Uniwersytet Wrocawski Instytut Archeologii, Wrocław, pp. 73–89.
Müller-Beck, H., 1956. Das obere Altpaläolithikum in Süddeutschland: ein Versuch zur ältesten Geschichte des Menschen. Hagelt, Bonn.
Neruda, P., Nerudová, Z., 2010. Moravsky Krumlov Iv. A new Multilayer Palaeolithic site in Moravia. Archäologisches Korrespondenzblatt 40 (2), 155–174.
Pastoors, A., 2001. Die mittelpaläolithische Freilandstation von Salzgitter-Lebenstedt. Genese der Fundstelle und Systematik der Steinbearbeitung. Salzgitter-Forschungen 3, Archiv der Stadt Salzgitter. Ruth Printmedien, Braunschweig.
Peyrony, D., 1920. Le Moustérien-ses faciès. Association Française pour l'avancement des Sciences 44, 1–2.
Richter, J., 1997. Sesselfelsgrotte III. Der G-Schichten-Komplex der Sesselfelsgrotte. Zum Verständnis des Micoquien. Saarbrückener Druckerei und Verlag, Saarbrücken.
Ruebens, K., 2013. Regional behaviour among late Neanderthal groups in Western Europe: a comparative assessment of late Middle Palaeolithic bifacial tool variability. Journal of Human Evolution 65 (4), 341–362.
Soressi, M., 2002. Le Moustérien de tradition acheuléenne du sud-ouest de la France. Discussion sur la signification du faciès à partir de l'étude comparée de quatre sites: Pech-de-l'Azé I, Le Moustier, La Rochette et la Grotte XVI (Doctoral thesis). cole doctorale des Sciences du vivant – Géoscience, Sciences de l'environnement, Université Bordeaux I, Bordeaux.
Weißmüller, W., 1995. Sesselfelsgrotte II. Die Silexartefakte der Unteren Schichten der Sesselfelsgrotte. Ein Beitrag zum Problem des Moustérien. Saarbrückener Druckerei und Verlag, Saarbrücken.
Wilk, A., 2014a. Détermination ostéologique et évaluation archéozoologique des vestiges fauniques des Grottes de la Verpillière à Germolles. Rapport intermédiaire 2013. In: Floss, H., Hoyer, C.T., Frick, J.A., Heckel, C.E., Herkert, K. (Eds.), Les Grottes de la Verpillière à Germolles, commune de Mellecey (Saône-et-Loire). Fouille programmée pluriannuelle 2013–2015. S. R. A, Dijon and Abteilung für Ältere Urgeschichte, Universität Tübingen, Dijon and Tübingen, pp. 107–113.
Wilk, A., 2014b. Die Tierknochenfunde aus Germolles, Grottes de la Verpillière. Archäozoologische Bestimmung. Rapport annuel 2014. In: Floss, H., Hoyer, C.T., Frick, J.A., Herkert, K. (Eds.), Projet Collectif de Recherche: Le Paléolithique supérieur ancien en Bourgogne méridionale. Genèse, chronologie et structuration interne, évolution culturelle et technologique. S.R.A, Dijon and Abteilung für Ältere Urgeschichte, Universität Tübingen, Dijon and Tübingen, pp. 214–224.
Wißing, C., 2012. Geoarchäologische Untersuchungen in Germolles. Strukturgeologische, paläontologische und mikromorphologische Untersuchungen des Fundstellenkomplexes der Verpillière Höhlen und deren Umfeld in Germolles, Commune de Mellecey, Saône-et-Loire (71), FrankreichAbteilung für Ältere Urgeschichte und Quartärökologie (Master's thesis). Eberhard Karls Universität Tübingen, Tübingen.