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Metallographic examination of two medieval knives from Kobilić (Republic of Croatia)

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ABSTRACT
Archeological excavation conducted in 2010 in Kobilić (Turopolje region, Zagreb County, Republic of Croatia) yielded two knives from which one shows pattern-welding. This is the first pattern-welded knife reported among Croatian archeological finds. Our knowledge of pattern-welded knife production and trade within medieval Europe is still limited, therefore we decided to carry out a metallographic examination of both knives found at the Kobilić 1 site. Both knives are of excellent functional quality. The pattern-welded knife has a single-patterned core, which ends before reaching the pointed part of the blade, and to which another strip of phosphoric iron was welded from above to increase the overall decorative effect. The overall construction of the pattern-welded knife is fairly typical of such 13th-century pattern-welded blades. The other knife blade is made of one heterogeneous piece of steel, distinguishing it from the majority of contemporary knives. The provenance of the knives remains unknown, but considering that the pattern-welded knife is the only find known from the territory of Croatia to date, it is very likely that is was imported.

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Knife; Kobilić; metallography; middle-ages; pattern-welding; phosphoric iron; SEM-EDS

Introduction

The archeological excavation conducted on the site of Kobilić 1 (Republic of Croatia) in 2010 yielded, among other finds, two knives, one of which shows pattern-welding. As our knowledge of pattern-welded knife production and trade within medieval Europe remains limited, each new find is of great interest and importance. In this case, its importance is even magnified by the fact that we apparently deal with the only pattern-welded knife reported in Croatia. Therefore, we mainly focus our attention on this find.

The medieval pattern-welded knives

Blades of pattern-welded knives rank among blades showing a decorative effect when correctly treated (e.g., polished and etched). Blades of simpler construction, though still of attractive appearance, do not contain twisted composites but only strips of phosphoric iron, which could be plain in shape (so-called striped blades) or serrated/wavy-shaped at the lower edge, that is, attached to a cutting edge by a serrated/wavy-shaped weld (such blades are often called serrated blades or serrated/wavy-welded blades) (see Fig. 1b, 1c) [1]. All pattern-welded, striped, and serrated blades achieve their pleasing appearance due to the use of phosphoric iron[1] containing as a rule 0.4–0.9 wt% P [2].

Pattern-welded composites and both forms of phosphoric iron strips could be used separately as well as combined with each other. As a result, even among pattern-welded blades considerable differences in complexity and attractiveness existed (see Fig. 1a, 1d). Because blade construction and possible differences among individual knife blades can be fairly reliably revealed using a combination of metallography and X-radiography, both these research techniques play an indispensable role in their study. Therefore, the opportunity was readily taken to examine the Kobilić 1 knives metallographically.

Studies conducted in countries such as England, Poland, Czech Republic, Russia (where systematic metallographic research of archeological finds was developed in the second half of the 20th century) provide data suggesting that pattern-welded, striped, and serrated/wavy-welded knife blades

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Color versions of one or more of the figures in this article can be found online at www.tandfonline.com/lmmp.

[1]For a better understanding of medieval blacksmith techniques and methods for making knife blades, an archeometallurgical terminology is used in this article for the most basic types of steel; “steel,” hardenable carbon steel; “iron,” nonhardenable carbon steel; “phosphoric iron or P-iron,” nonhardenable carbon steel with high phosphorus content (tenths of percent). Phosphorus is an avoided element in modern steel industry for its detrimental effects, which include various forms of embrittlement, reducing the toughness, and ductility of steel. Although iron with 0.4–0.9% P has higher strength (phosphorus has the strongest solid solution hardening effect on ferrite among substitutional solid-solution strengtheners), its dynamic and static toughness are low, and characteristic values of toughness and ductility are very low. Hence neither pattern-welding (always containing phosphoric iron) nor individual phosphoric iron strips could provide or secure mechanical properties (cf. [11] in detail), and they were used solely for aesthetic purposes. The reason is that phosphoric iron is more resistant to solutions and/or vapors of various acids than nonphosphoric iron and steel. Therefore, in contrast to ordinary iron and steel, phosphoric iron retained its silver-like luster when solutions or vapors of acids were applied on pattern-welded surfaces to reveal their pattern.

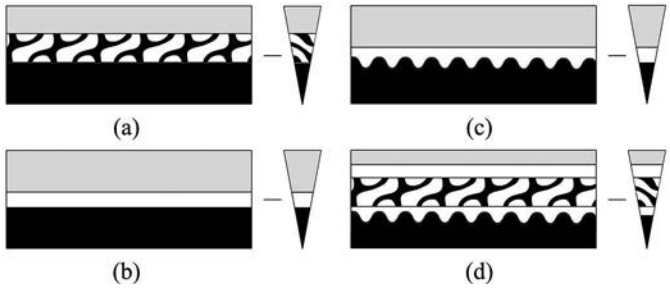

Figure 1. Examples of blade constructions, which are often encountered in the 10th-13th century luxurious knife blades (side view and corresponding cross section; black – 'steel', grey – 'iron', white – 'phosphoric iron'): a) pattern-welded blade; b) striped blade; c) serrated/wavy-welded blade; d) more complex pattern-welded blade.

were manufactured between the 10th and the 13th or maybe 14th century [1, 3–5]. Obviously, pattern-welded and serrate-welded saxes were the predecessors of these knives [6], and it is known that the demise of their production is associated with the spread of blades decorated with nonferrous inlays, as their fabrication was easier and faster. However, it remains unclear where the idea of their manufacture was born, and we do not know when and to which parts of Europe their production spread. Small numbers of pattern-welded knives (in comparison with nonpattern-welded ones) registered in Russia, the Ukraine, and Belarus indicate that they were imported to these countries [6, 7]. In contrast, numerous finds in England, Poland, as well as the Czech Republic allow for the assumption of their local production. The role of other parts of Europe (including the territory of Croatia) in the manufacturing and/or trading of pattern-welded knives is still indistinct (see Fig. 2a). There could be two reasons for this. The first is that the appearance of these objects was actually limited to the territories of the aforementioned countries (England, Poland, etc.). The second could be the lack of systematic restoration and archeometric survey of archeological iron objects or simply the lack of interest for studying this issue in other countries. This article aims to improve this situation.

The archeological background of the Kobilić 1 knives

The archeological site Kobilić 1 is situated on the western edge of the present-day village of Kobilić in the Turopolje region (Zagreb County). It was investigated during the rescue excavations on a track of the by-pass Velika Gorica in 2010/2011. Along with features from the prehistoric and the Roman period, a smaller portion of the medieval settlement was investigated. There were no dwelling units found in this area, just pits, a few fireplaces, postholes, and ditches. These were interpreted as remains of a zone with an economic function [8].

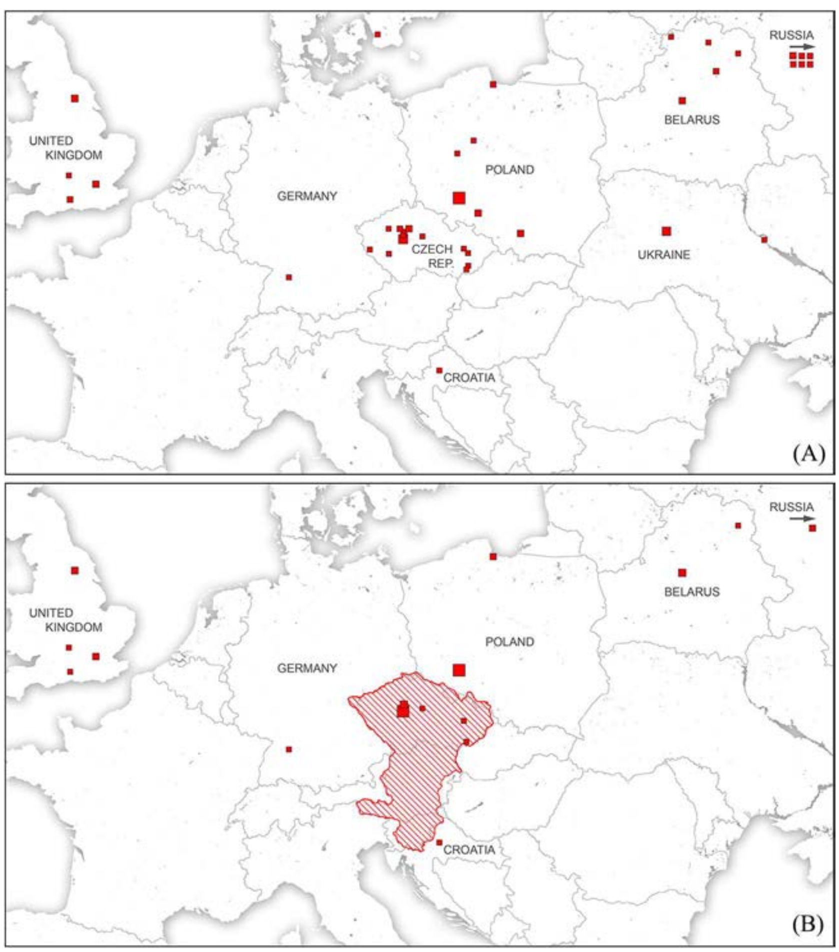

Figure 2. Maps showing sites (museums) from which pattern-welded knives (known to the authors) come: A) sites with 10th to 13/14th century p-w knives; B) sites with 13/14th century p-w knives, and the territory ruled by the king Ottokar II of Bohemia in the second half of the 13th century.

The two knives, PN 52 (pattern-welded) and PN 51 (non-pattern-welded), were found in a pit located farther from the majority of the settlement features. The function of the pit is unclear, but it could possibly have been used as a waste pit. On the basis of pottery fragments, it was dated to the 13th century at the earliest, and more probably to the 14th century. Except for the knives, it did not contain any other metal finds or coins which could date it more precisely.[2]

At the present state of research, taking into consideration that the pattern-welded knife is the only such object found in Croatia so far, it is more likely that it was imported than locally produced. The archeological context in which it was found does not, by itself, give much possibility for understanding the context in which this luxurious object appeared on the site. The other finds were of average value, everyday items used in a medieval village. Also, in general, Turopolje (or *Campus Zagrabiensis* [Zagreb field] as it was called in medieval sources) in the Middle Ages was a rural area, with no urban centers.

However, written sources from the region show that its social structure was diverse, so the appearance of luxurious items is not so surprising. There were villages of lesser nobility (castle warriors), as well as possessions of higher nobility, the Chapter of Zagreb and the Hospitallers (until 1328). Burghers of Gradec[3] were also frequently buying lands in the area. Any of the individuals of a higher economic status could have acquired this knife, either by buying or by receiving it as a gift, or could even have brought it to Turopolje as a war booty (cf. more details in the Results and Discussion section).

Materials and Methods

After restoration and conservation[4], the main dimensions of the PN 51 and PN 52 knives were measured using vernier caliper. Surface examination was carried out in case of the pattern-welded knife by grinding, polishing, and etching with 2% Nital part of the surface of the blade near the tang.

Samples for metallographic examination were taken using a precision cutter (Buehler IsoMe 1000) to avoid overheating. Samples were prepared for metallographic examinations using standard procedures. Afterward, they were assessed in non-etched state (to assess the purity of the metal), and then after etching with 2% Nital (to assess the nature and the distribution of the metallographic structures) and Oberhoffer etchant (to reveal the P-iron layers of the pattern-welded knife). The slag inclusions in the metal were evaluated using the Jernkontoret scale (Js), and the grain size using ASTM E112 standard.

The Vickers hardness was measured using a Boehler 1105 micro-Vickers hardness tester with a load of 0.2 kg and a loading time of 10 s.

The chemical composition of the P-iron layers in the pattern-welded knife was measured using a scanning electron microscope equipped with EDX analysis (SEM-EDX; Philips XL30, Philips Electronics Netherlands, Eindhoven, Holland).

Results and Discussion

The pattern-welded PN 52 knife

Dimensions

The total length of the knife was 126 mm from which the blade was 85 mm with a maximum width of 13 mm and maximum thickness of 4 mm tapering to 2 mm.

Surface examination

The pattern-welded core appeared between the cutting edge and the back of the blade. The back is mostly corroded, but the lateral surface examination of the blade suggested that a simple decorative P-iron strip was welded on the patterned core (cf. Fig. 3b), which ends before reaching the pointed part of the blade (cf. Fig. 3c). The blade was carefully ground, using P80-P1200 grinding paper, and polished and etched with 2% Nital in half its length in front of the tang. A pattern-welded core with an “X” pattern accompanied by the decorative P-iron strip was revealed (cf. Fig. 3d).

Sampling

One sample was cut from the back of the blade (at the beginning of the blade) and a second one from the cutting edge (15 mm from the tang) (cf. Fig. 4a).

Metallographic description

Both samples have a well-preserved metallic core with a shallow corroded surface. Also, the tip of the cutting edge could be recognized. The matrix of the edge contains a small number of slag inclusions (level 1 on Js), however two deep cracks are present, one reaching the surface and elongating on the left side of the blade (cf. Fig. 4b and also Fig. 3a). The pattern-welded core and the back of the blade contain a moderate number of slag inclusions (level 3–4 on Js).

Seven basic areas can be recognized on the cross-section after 2% Nital and Oberhoffer etching. Area I (cutting edge of sample number 1) contains a tempered martensitic microstructure (see Fig. 5a) whose carbon content was estimated at 0.5–0.6 wt%. The hardness of the tip of the cutting edge is 583 HV0.2. Area II on the sample number 2 has a bainitic microstructure with little ferrite, while Area III, which has a lower carbon content of ca. 0.3 wt%, consists of a ferritic and bainitic microstructure.

A well visible and wide welding line separates the pattern-welded core from the cutting edge (cf. Fig. 5b). Fourteen layers of steel (Area IV) and P-iron (Area V) can be distinguished in

[2]The pit did not contain animal bones either and the traces of charcoal found in it were too small for radiocarbon analysis.

[3]Gradec is today’s Upper Town of Zagreb, and in the 13th century (from 1242) it was a Free Royal Town.

[4]The conservation–restoration treatment was obviously undertaken by immersion in phosphoric acid which completely removes corrosion products including internal corrosion products. The remaining objects are reduced to their preserved metallic cores which are not corresponding to the original profile and size of the knives. Details associated with the internal structure (pattern-welding, welds, etc.) are directly visible on objects cleaned in this way. However, this method of restoration is now considered unethical. The reason is that the limit of the original surface is usually located within corrosion products. Their complete removal means a loss of integrity of the object. Cutting edges of both Kobilić knives were considerably more affected by corrosion than the other parts of the blades. Because the corrosion layer corresponding to the original surface was removed, the exact shape of the blades can no more be determined with certainty. Therefore, we do not know to what extent the cutting edges were worn off and hence how long and/or how intensively the knives were used (for cutting). This information would certainly be useful to our deliberations on the age and possible usage of the knives.

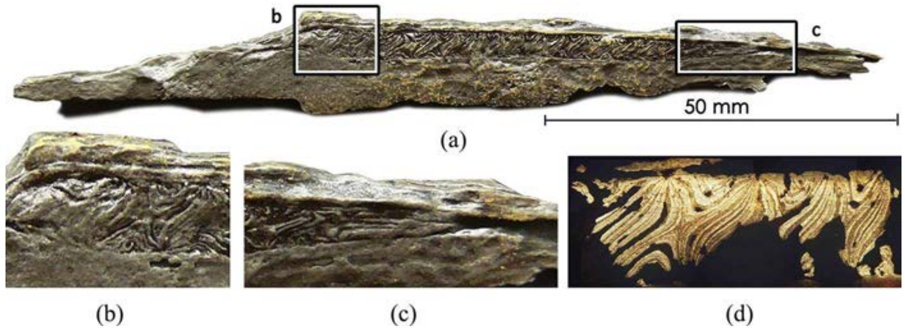

Figure 3. Surface examination on the pattern-welded knife from Kobilić: a) photo of the knife; b) and c) macro photos of the pattern-welded core; d) macro photo of the pattern-welded core after grinding, polishing and etching with 2% Nital.

the pattern-welded core. Area IV has a fine-grade ferrite-pearlitic structure (ASTM7) with a hardness of 134–165 HV0.2 and a carbon content of ca. 0.3 wt%, while Area V has a ferritic microstructure (ASTM5) with an increased content of phosphorus ($0.5 \pm 0.1\%$) and with a hardness of 210–213 HV0.2 (cf. Fig. 5c).

The pattern-welded core is bordered with a decorative strip of P-iron (Area VI) at the back of the knife. Microstructure, hardness, and P-content in the Area VI are similar to those in Area V. Arsenic was not detected either in Area V or Area VI. The upper part of the back (Area VII) is iron with a pure coarse-grained ferritic microstructure (ASTM4) with a hardness of 125–128 HV0.2 and no phosphorus (cf. Fig. 5d).

Presumable manufacturing of the PN 52 knife

Results of the metallographic examination allow for the description of the possible manufacturing of the knife. Concerning the materials employed, three basic ferrous alloys were used: iron, steel, and phosphoric iron. All of them were at the time obtained directly in the form of solid, malleable blooms by smelting iron ores in small shaft furnaces. This process of malleable iron production is called the bloomery process. When nonphosphoric iron ores and charcoal were charged, a low-phosphoric iron bloom was obtained. Carbon was usually distributed unevenly within the bloom, and its overall content depended mainly on the chosen charcoal-to-ore ratio and on the air rate, by which the temperature inside the furnace was controlled. Steel could also be obtained by the further treatment of bloomery iron, for example, by re-smelting small iron pieces in a furnace with a highly reducing atmosphere [9]. Phosphoric iron could be smelted from phosphorus-rich bog iron ores and the phosphorus content could be controlled by charging a lime [10]. During the smelting process, the iron blooms remained in a solid state, therefore slag could not be separated from the metal phase. Slag inclusions cause notching and stress concentration effect and

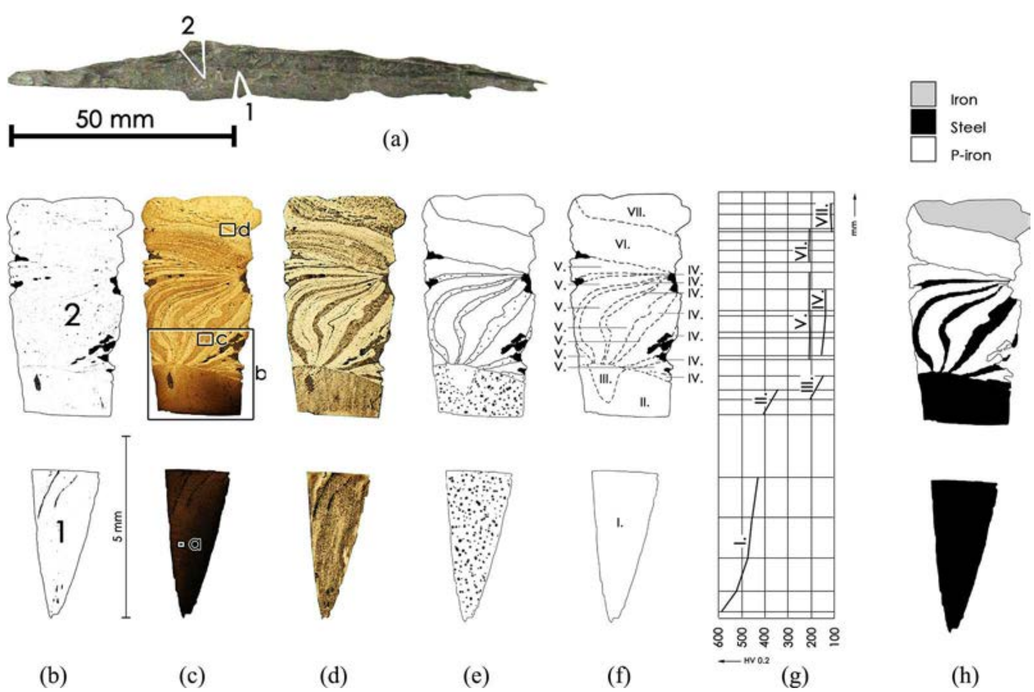

Figure 4. Metallographic examination on the samples detached from the PN 52 pattern-welded knife from Kobilić: a) sampling; b) macro photo of the cross section in unetched state; c) macro photo of the cross section after etching with 2% Nital (areas marked with a rectangle are showed in Fig. 3); d) macro photo of the cross section after etching with Oberhoffer etchant; e) distribution of the structures and of the main welds across the cross section; f) layout of areas described; g) hardness distribution chart; h) schematic drawing of the construction of the knife showing the ferrous alloys used.

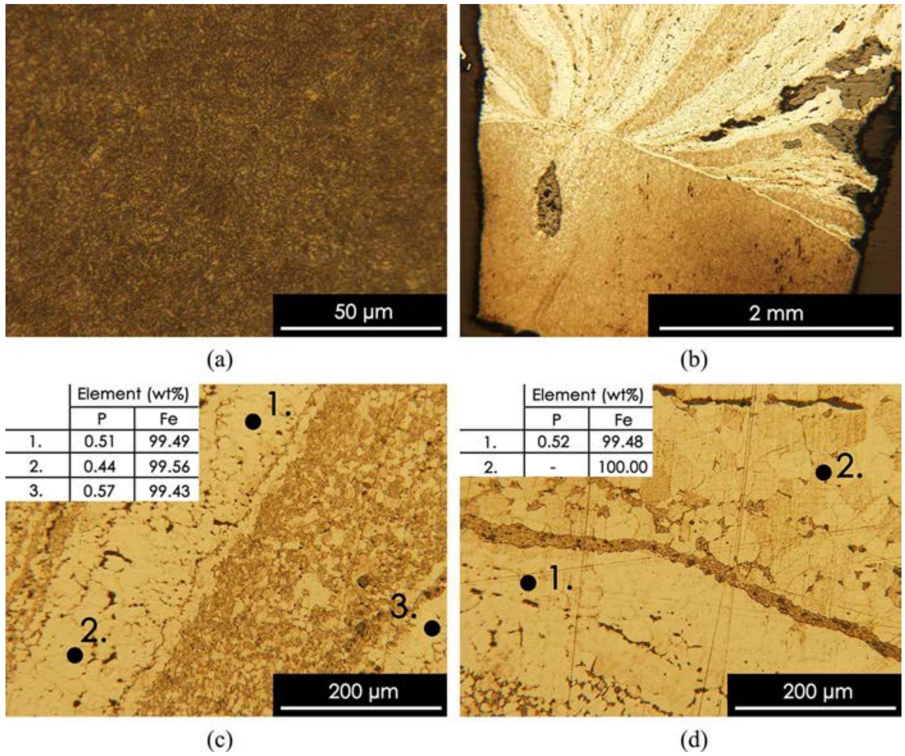

Figure 5. Micrographs of metallographic samples taken from the PN 52 pattern-welded knife from Kobilić: a) tempered martensitic microstructure of the cutting edge; b) cutting edge and pattern-welded core separated by a wide welding line; c) ferrite-pearlitic structure of the steel lines vs. ferritic structure of the P-iron lines in the pattern-welded core and results of SEM-EDS analysis of the P-iron; d) ferritic structure of the decorative P-iron strip (at the bottom) and coarse-grained ferritic structure on the back of the knife blade (at the top) with results of SEM-EDS analysis.

provide the starting point for crack initiation. Therefore, bloomery iron has lower characteristic values of toughness and ductility in comparison with modern steels, which are almost free of slag inclusions [cf. 11 in detail].

The knife was forged from four different bars (Fig. 6a). First, the pattern-welded core was prepared from 12 layers of steel and phosphoric iron, welded to each other into a bar. This bar was twisted and hammered again to a rectangular

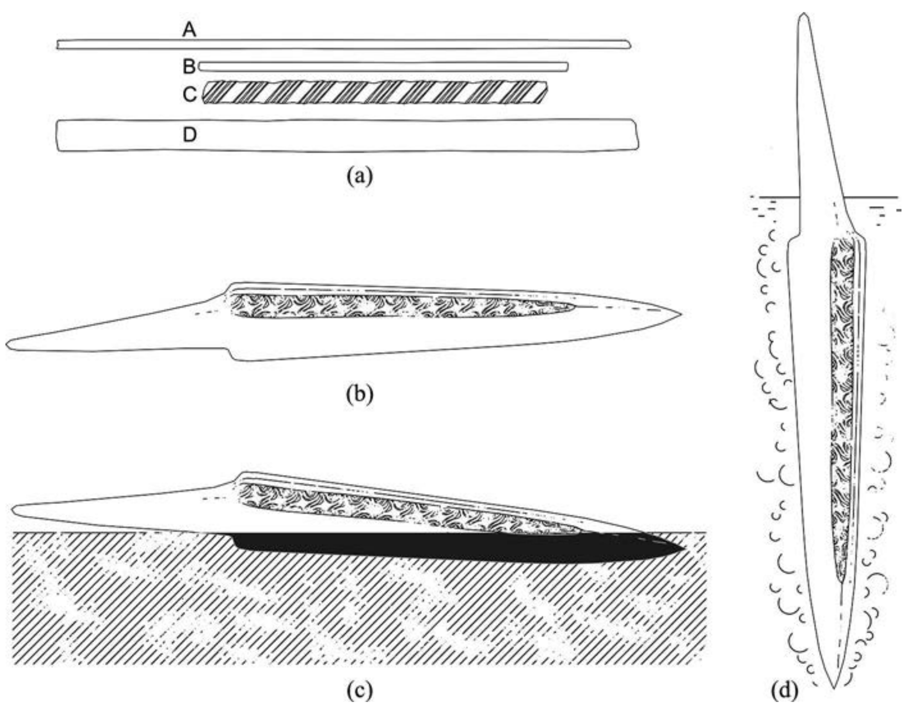

Figure 6. Basic steps of the PN_52-knife manufacturing process: a) initial pieces of iron (A), phosphoric iron (B), twisted lamellar composite (C) and steel (D), from which the blade was forged; b) heating the cutting edge of the semi-finished blade in glowing charcoal before quenching; c) quenching of the heated blade in water (tempering followed); d) the blade after final grinding and etching.

cross-section. Then the bar was ground to remove roughly one-fourth of its thickness from both sides to create "X" patterns. The bar of plain iron (to form a back), the decorative phosphoric-iron strip, the pattern welded core, and the bar of steel (to form a cutting edge) were forge welded together and the blade was forged to its nearly final shape.

After forging, the blade was ground to remove the iron oxides from the surface and then it was heat treated. On the basis of the observed microstructures and measured microhardness values, it can be supposed that the cutting edge of the blade in 3–4 mm width was quenched in water and then the whole blade was tempered at ca. 200°C–250°C (cf. Fig. 6b, 6c). Then the blade was carefully ground again to its final shape and then etched (Fig. 6d). The visibility and contrast of pattern welding is significantly higher in an etched state, therefore it is generally accepted that pattern-welded parts of iron objects were etched in the past, albeit it is yet unknown how exactly.

Discussion of results

To date, more than 80 pattern-welded knives have been registered across Europe. Of these, more than 60 were subjected to metallographic examination. Though a number of published reports lack details needed for a closer comparison of the knives, we have the necessary basis for further discussion of the PN 52 knife.

Like the majority of medieval pattern-welded blades, the find from Kobilić has a single core. Additionally, this one is accompanied by a decorative strip of phosphoric iron, unusually placed above the core instead of being between the core and the cutting edge. Nevertheless, a single-cored blade with one accompanying P-iron strip is not exceptional. The cutting edge itself is good-quality steel, subjected to quenching and tempering, which made the knife a useful tool. However, high functional quality[5] is also not exceptional. The only striking feature that renders this knife different from others is the way in which the core was welded into the blade. Pattern-welded cores either extend down to the blade-point, with an insignificant change in their shape, or they run, gradually narrowing, to about two-thirds down the blade. The latter type, encountered also in the knife from Kobilić, is fairly typical of the 13th-century blades of central Europe [e.g., 12–16]. The reduction of "P-iron"-containing decorative elements in size (pattern-welded composites, serrated/wavy-welded, as well as plain strips) in comparison with the overall size of blades could be explained with the fashion of the period as well as with an effort, typical of the developing medieval-town craft, to produce more items faster and cheaper. In any case, according to the blade construction, the knife PN 52 is most likely a 13th-century product. The shape of the blade is very common and cannot serve as a reliable clue for the determination of its possible provenance.

[5]In the context of our article, the expression "functional" means "well suitable for cutting without a risk of deformation, rapid blunting and excessive wear of the cutting edge." Besides, knives of good quality and also very simple iron knives were produced in the middle ages. Naturally, the use and duration of knives having soft-iron cutting edges were limited in comparison with the knives whose blades were provided with cutting edges of well-hardened steel.

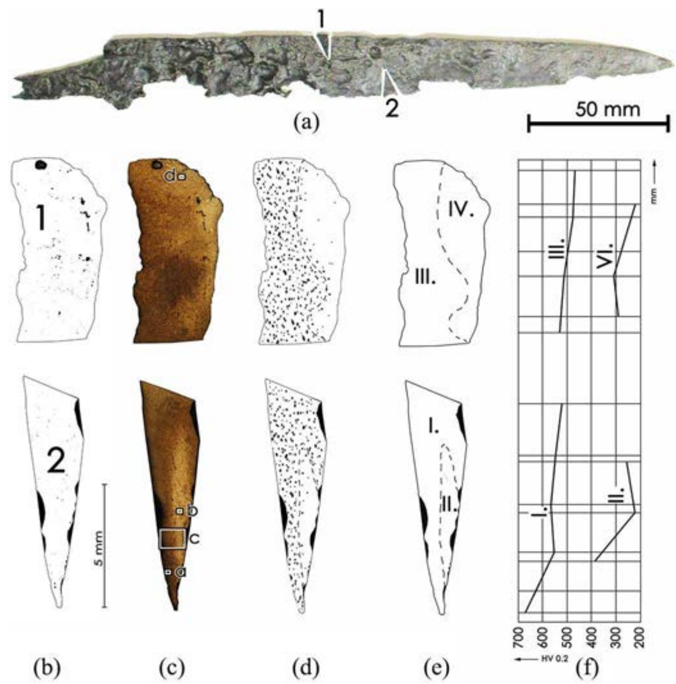

Figure 7. Metallographic examination on the samples detached from the PN 51 non-pattern-welded knife from Kobilić: a) sampling; b) macro photo of the cross section in unetched state; c) macro photo of the cross section after etching in Nital (areas marked with a rectangle are showed in Fig. 5); d) distribution of the structures and of the main welds across the cross section; e) layout of areas described; f) hardness distribution chart.

The plain PN 51 knife

Dimensions

The total length of the knife is 213 mm, with a blade of 183 mm with a maximum width of 23 mm and maximum thickness of 4 mm tapering to 2.5 mm.

Sampling

One sample was taken from the back of the blade (65 mm from the tang) and second one from the cutting edge (75 mm from the tang) (cf. Fig. 7a).

Metallographic description

Both samples have a well-preserved metallic core and even the tip of the cutting edge could be recognized. The matrix of the edge contains a small number of slag inclusions (level 1 on Js) in sample number 1. A moderate number of slag inclusions can be observed (level 4 on Js) in the upper part of the cross-section in sample number 2.

Four basic areas can be recognized on the cross-section after 2% Nital etching. Area I of sample number 1 consists of a needle-like martensitic microstructure (cf. Fig. 8a) with a carbon content estimated at ca. 0.6 wt%. The tip of the cutting edge has a hardness of 671 HV0.2, decreasing toward the back to 520 HV0.2. A ladder-like martensitic microstructure with low carbon content and a little bainite and ferrite can be observed in Area II (cf. Fig. 8b). Accordingly, the hardness is lower than in Area I and values of 213–371 HV0.2 can be measured.

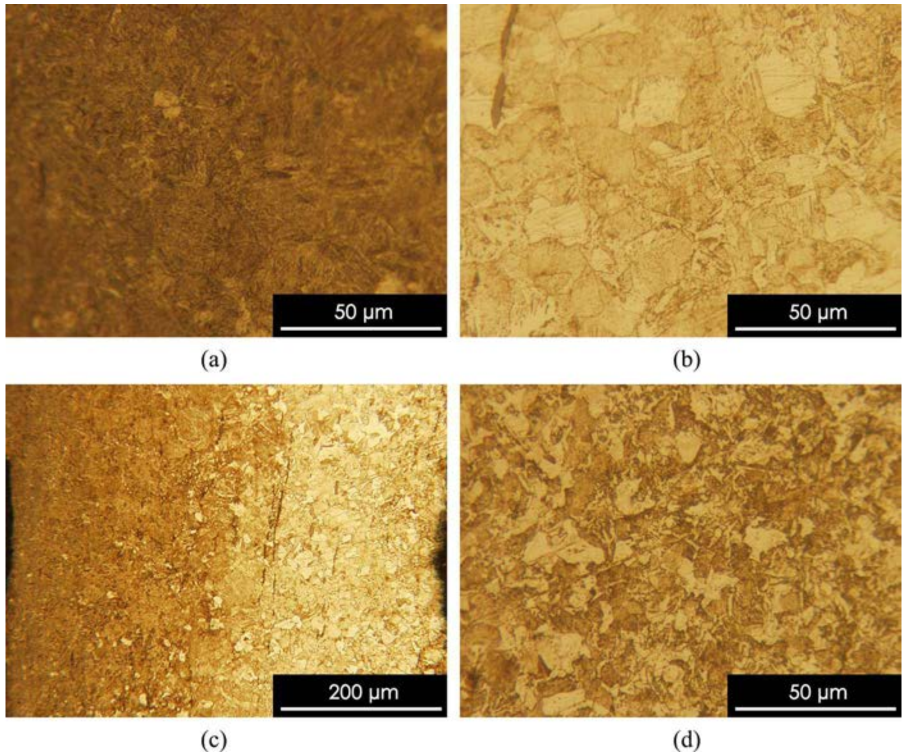

Figure 8. Micrographs of the metallographic samples taken from the PN 51 non-pattern-welded knife from Kobilić: a) needle-like martensitic microstructure at the tip of the cutting edge; b) ladder-like martensitic microstructure with low carbon content and a little bainite and ferrite on the right side of the cutting edge; c) carbon content gradient between the two sides of the cutting edge; d) needle-like ferrite and fine lamellar pearlite in the microstructure of the back of the blade.

Area III in sample number 2 has a mainly bainitic microstructure with a little ferrite, sporadically homogeneous pure bainitic zones can be observed. Hardness decreases toward the back of the blade from 534 to 471 HV0.2. Area IV consists of a fine-grade ferrite-pearlitic microstructure with needle-like ferrite and fine lamellar pearlite (Fig. 8d). Hardness values of 234–305 HV0.2 can be measured in this area.

Areas II, III, and IV have a very fine grade microstructure of ASTM9.

Presumable manufacturing of the PN 51 knife

On the basis of the observed microstructures and measured microhardness values, it can be stated that the blade was forged from one heterogeneous piece of steel. Regarding the heat treatment, it can be supposed that the cutting edge of the blade was quenched about in its half width in water and then the whole blade was tempered only at ca. 100°C–150°C.

Discussion of the results

While the PN 52 knife matches the 13th-century trend in European medieval cutlery very well, the “all-steel” PN 51 blade is rather outside of this trend. Based on our current knowledge, it appears that the vast majority of the 13th-century knife blades were welded, combining iron and steel (as a standard, a cutting edge of steel was welded onto the back of the iron). Nonwelded blades made of a single piece of steel were also produced, but apparently in very limited quantity [e.g., 5, 16, 17–19]. Beside the blade construction, the knife differs from the majority of the 13th-/14th-century knives also by its size. A knife of this length might have been used as a war knife.

Some considerations about the possible origin of the knives

Although a detailed analysis of the site of Kobilić 1 was conducted and historical issues concerning the ownership of the site as well as that of the pattern-welded knife were studied in detail (results will be published in a forthcoming article [20] with extensive references to the relevant literature), the current state of research does not allow for final conclusions on the origin of the knives. Yet, a few possible interpretations, which may prove useful for a further study of this topic, can briefly be mentioned here.

Taking into a consideration the data known so far, the most likely hypothesis is that both Kobilić 1 knives are somehow associated with military events or, in general, with some warrior community of the 13th/14th century. In this context, it must be said that Turopolje is known mainly for the organization called “The noble community of Turopolje.” Its members belonged to a group of castle warriors (*iobagionescastri*). These people were conditional nobles of lesser rank; rural people to whom the king allowed to own the land hereditarily and who did not have to pay taxes. In return, they were obliged to serve in the king’s army. There were many castle warriors in Turopolje. From 15th-century written sources, it is known that Kobilić was one of the villages where they lived. Due to the lack of sources, it cannot be determined if this was also the case in the 13th and 14th century, but it is very likely.

The next historical fact that could help to illuminate the context in which the knives appeared in Kobilić is the following: the closest possible production centers of pattern-welded knives discovered so far are in the territory of the Czech Republic (e.g., the 13th-century monastic town of Ostrov by Davle (Sekanka) [5]). Therefore, there is the question whether the "know-how" of pattern-welded knife manufacturing or the knife itself could have come to Croatia from the 13th-century Czech state. While individual objects could be brought from one part to another part of Europe most commonly by trade or by moving troops (armies), "know-how" was commonly spread by migrating population groups, that settled in a particular area (see e.g., [18]). In our case, we have to mention that in the second half of the 13th century Kobilić was located near the territory controlled by the Bohemian King (see Fig. 2b). During the wars between King Ottokar II of Bohemia and the kings of Hungary–Croatia, an army of the king of Bohemia was, at one point (probably in the period of 1268–1271), present in the western part of the Zagreb County, very close to Turopolje. Members of the Czech nobility were without doubt participating in the campaign and certainly some of them had pattern-welded knives. At the same time, the castle warriors of Turopolje must have also participated in the fights, as did some other higher nobles whose occasional presence in the area is testified in 13th-century written sources. Hence, the knife from Kobilić could be associated with this (or some similar) military event (e.g., could have been brought to Kobilić as a war booty).

On the other hand, a possibility that the "know-how" of pattern-welded knife manufacturing might have been brought from Bohemia to the region of Turopolje cannot be ruled out. Czech settlers were also present in the Zagreb County in the 13th century. Even today, about 10 km west from the site of Kobilić there is a village called Čehi (Czechs) that was also mentioned in the 13th-century written sources. Some scholars think that its name comes from the Czechs who settled in the region.

Unfortunately, although considerable progress was achieved in archeometric methods for conducting studies of the provenance of archaeological/historical iron objects [e.g., 21, 22], we are, at least for the moment, not able to determine the true origin of the discussed knives. Hopefully, further archeological research on both the territory of the Zagreb County and of northern Croatia (medieval Slavonia) in general will bring new data that will show if the pattern-welded knife will remain a unique find or if it was more common, and if it was imported or locally produced.

Conclusion

The results of the metallographic examination of two knives from Kobilić 1 site allow the following conclusions to be drawn:

1. The pattern-welded knife has a single patterned core, which ends before reaching the pointed part of the blade, and to which another strip of phosphoric iron was welded from above to increase the overall decorative effect. The blade was a product of excellent functional quality, and its overall construction is fairly typical of the 13th-century pattern-welded blades.
2. The plain knife was made from a single piece of steel and belongs to products of excellent functional quality. All-steel knife blades are encountered rather rarely in the 13th century. Furthermore, knife with blade length of 183 mm is not common, and might have been employed as a war knife. Thus, this knife differs too from the majority of the contemporary production.
3. The provenance of the knives remains unknown, but considering that the pattern-welded knife is to date the only find known from the territory of Croatia, it is very likely to have been imported.

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