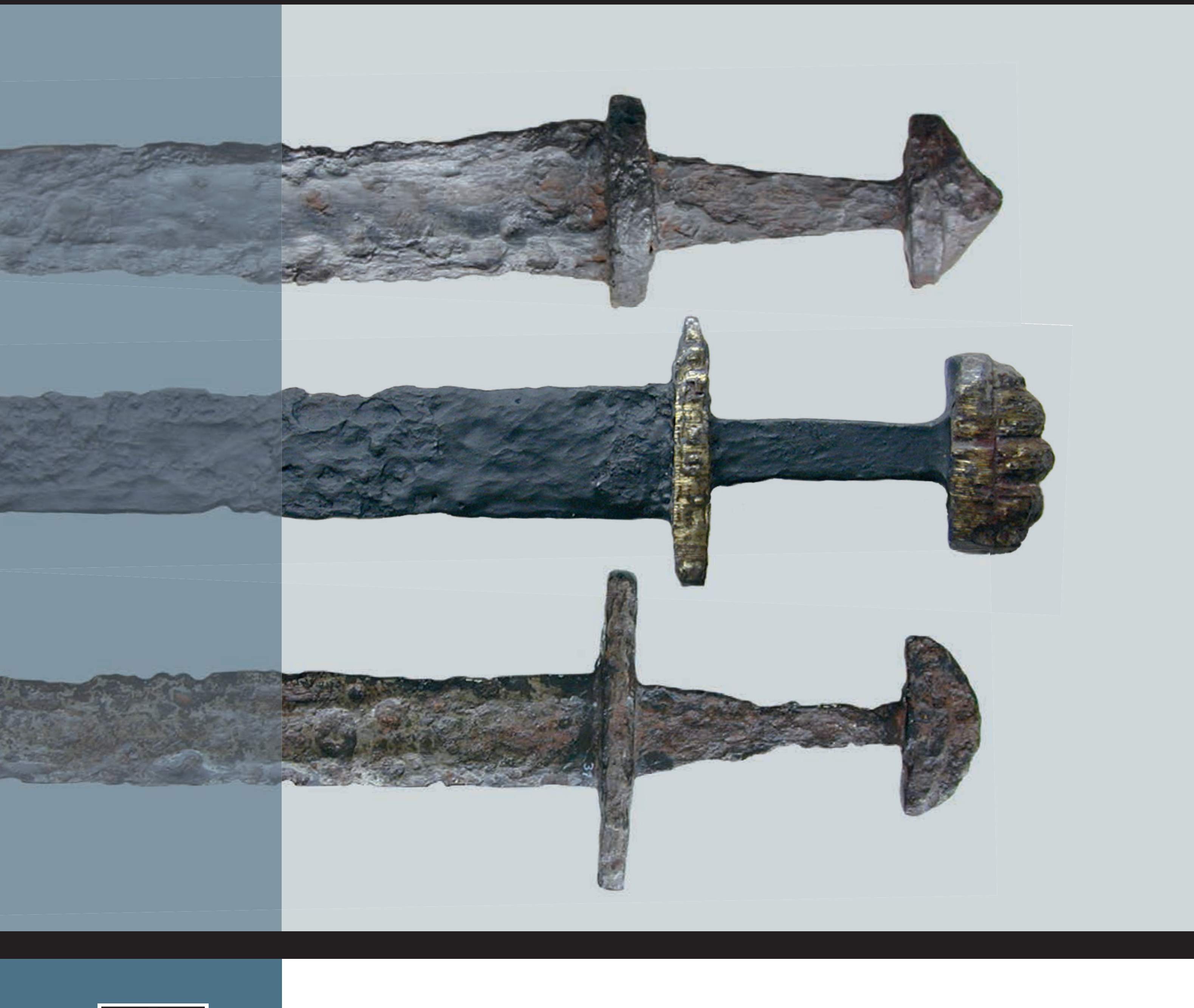
IX

INTERNATIONALE TAGUNGEN IN MIKULČICE



MORAVIA MAGNA

BEWAFFNUNG UND REITERAUSRÜSTUNG DES 8. BIS 10. JAHRHUNDERTS IN MITTELEUROPA

Waffenform und Waffenbeigaben bei den mährischen Slawen und in den Nachbarländern

ARCHÄOLOGISCHES
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BRNO 2019

Lumír Poláček – Pavel Kouřil (Hrsg.)

Bewaffnung und Reiterausrüstung des 8. bis 10. Jahrhunderts in Mitteleuropa

Waffenform und Waffenbeigaben bei den mährischen Slawen und in den Nachbarländern

SPISY ARCHEOLOGICKÉHO ÚSTAVU AV ČR BRNO
50

INTERNATIONALE TAGUNGEN IN MIKULČICE
(ITM)

herausgegeben von

Lumír Poláček

PROJET MORAVIA MAGNA

MORAVIA MAGNA

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Vorwort

Der vorliegende Band enthält Beiträge, die während der gleichnamigen Internationalen Tagung in Mikulčice im Mai 2011 vorgetragen wurden. Wie schon die voraufgegangenen ITM-Kolloquien so war auch diese Tagung einem ausgewählten aktuellen Aspekt der mitteleuropäischen Frühgeschichtsforschung gewidmet, und zwar dem Thema der Bewaffnung und Reiterausrüstung. Damit wurde ein breites Spektrum von Fragen behandelt, beginnend mit Typologie, Chronologie und Technologie einzelner Sorten von Artefakten über allgemeine Probleme der frühmittelalterlichen Bewaffnung und Reiterausrüstung bis hin zum archäologischen Experiment. Der gegebene Themenkreis wird im Buch nicht nur aus Sicht der Archäologie, sondern auch der historischen Wissenschaft erörtert, und zwar mit einer beträchtlichen Gelehrsamkeit und dem Streben nach einer komplexen oder analytischen Darstellung. Die vorliegenden 25 auf ganz unterschiedlichen Quellenbeständen fußenden, oft innovativen Beiträge von Forschern aus Polen, der Slowakei, Tschechien, Ungarn, Kroatien, Österreich und Deutschland bieten ein kompaktes Bild der Bewaffnung und Reiterausstattung der Westslawen und Teilen der Südslawen, aber auch der Awaren und Ungarn vor dem Hintergrund der gesellschaftlichen, kulturellen und politischen Entwicklung Ostmittelosteuropas in den letzten drei Jahrhunderten des ersten Jahrtausends.

Leider erscheint die Sammelschrift mit beträchtlicher Verspätung, wofür wir die Autoren und Leser gleichermaßen um Entschuldigung bitten. Hauptursache der Verzögerung waren die nach dem tragischen Brand der Arbeitsstätte in Mikulčice 2007 zu bewältigenden Aufgaben: die Errichtung und Inbetriebnahme der neuen archäologischen Basis Mikulčice-Trapíkov und die parallel hierzu gebotenen Sicherungsarbeiten an dem umfangreichen, durch den Brand beschädigten Fundmaterial von der Fundstelle Mikulčice-Valy, das nach und nach konservatorisch behandelt und identifiziert werden musste.

Trotz der Verspätung erlauben wir uns, der wissenschaftlichen Fachwelt diesen Konferenzband zu unterbreiten, in der Überzeugung, dass alle Beiträge ihre Relevanz und Aktualität behalten haben. Mögen sie als nützliches Hilfsmittel und Studienmaterial für weitere Forschungen auf dem betreffenden Fachgebiet dienen! Ergänzt sei, dass die letzten Autorenkorrekturen der meisten Beiträge im Jahre 2016 erfolgten und der Inhalt seither nicht mehr aktualisiert wurde.

Es ist uns eine angenehme Pflicht, uns bei allen Autoren der in der Sammelschrift präsentierten Beiträge sowie bei dem Kollektiv der Mitarbeiter, die sich an der Vorbereitung dieses Bandes beteiligten, recht herzlich zu bedanken. Für Übersetzungen und sprachliche Korrekturen sind wir Frau Pavla Seitlová und Frau Tereza Bartošková und sowie den Herren Torsten Kempke und Paul Maddocks verbunden. Für Redaktionsarbeiten gebührt unser Dank Herrn Petr Luňák und Frau Zdeňka Pavková, die auch den Satz des Buches übernahm.

Das Buch erscheint in einem Jahr, in dem das Archäologische Institut der Akademie der Wissenschaften der Tschechischen Republik des 100. Gründungstags seines Vorgängers, des Staatlichen Archäologischen Instituts, gedenkt, der ersten professionellen archäologisch-wissenschaftlichen Arbeitsstätte in der damals eben erst gegründeten Tschechoslowakei.

Erscheinen konnte die Publikation dank der finanziellen Förderung seitens des Editionsrats der Akademie der Wissenschaften der Tschechischen Republik, dem dafür unser Dank gilt.

Lumír Poláček – Pavel Kouřil

Lumír Poláček – Pavel Kouřil (Hrsg.), Bewaffnung und Reiterausrüstung des 8. bis 10. Jahrhunderts in Mitteleuropa
Internationale Tagungen in Mikulčice IX, Brno 2019, 421–430

Pattern-Welding Technique in Early Mediaval Sword-Making

Paweł Kucypera

Pattern-Welding Technique in Early Medieval Sword-Making. *The article discusses the use of pattern-welding in sword blade manufacture in early medieval Europe. This technique derives from piled structures dated to as early as Celtic times. It is a process of forge welding laminates different iron alloys' and manipulating them, which in result produces a composite characterised by a peculiar decorative surface. In the case of sword-making, pattern-welding was used between the 3rd and 10th centuries and reached its peak in terms of complexity and popularity around the 7th century. Originally the characteristic pattern was a by-product of the process, but its striking decorative effect was quickly observed and deeply appreciated. This aesthetic trait seems to play the greatest role in pattern-welding's presence in sword manufacture in later times. It probably became obsolescent because of the development of the smelting industry and economic factors.*

Keywords: pattern-welding – damascening – sword – iron – steel – early medieval Europe

The term pattern-welding refers to the technological process of welding and forging alternating high- and low-carbon iron[1] laminates in order to produce a composite characterised by a striking decorative effect. This distinctive trait observed on the surfaces of products (typically sword blades, spearheads and knives) takes the form of a two-tone banded pattern (straight lines or rose/star-like motif), revealed through polishing and etching (Fig. 1). This visually appealing feature was recognised and sought after, which may explain the reason for the occurrence of a wide variety of pattern-welded figurations similar or equivalent in terms of the technology of their manufacture.

Pattern-welded artefacts are also referred to as damascened or damask,[2] although this could be somewhat confusing, as this term is mostly used to describe Middle Eastern products (to avoid misinterpretation these are sometimes called genuine or crystalline damascus, or bulat), made using a kind of crucible steel called wootz (cf., e.g., Feuerbach 2002; Ranganathan/Srinivasan 2004; Williams 2007).

Records of pattern-welded swords can be found in some written sources (cf. Kucypera 2009), among which the most detailed are Theodoric the Great's letter to Trasamund, King of the Warni (Davidson 1998, 105–109; Żygulski 1982, 45), the Arabic treatises of Al-Kindi (Hoyland/Gilmour 2006, 43, 77–79; Zeki Validi 1936, passim) and Al-Beruni (1989, 217–218; Hoyland/Gilmour 2006, 153, 157; Piaskowski 1974, 249; Zeki Validi 1936, passim), a passage from *Kormáks Saga* about the sword Sköfnung (Collingwood/Stefánsson 1902, 63–64; Jones 1997, 10) and numerous parts of the *Beowulf* epic (Chickering 2006, passim; Davidson 1998, 119, 132–136, 142–144). They can also be found in iconography (Mäder 2001, 62–64, 67–72). All these sources prove that weapons forged using this technique were at least admired as the finest pieces of the art of blacksmithing, and that their

1 For intelligible definitions of terms such as wrought (soft) iron, phosphoric iron, steel, carburising (cementation), annealing, quenching, tempering etc. see, e.g., Pleiner 2006, 240–243.

2 The term pattern-welding was introduced by H. Maryon (1948). In his definition the patterns were produced by welding together twisted strips or rods of low carbon steel or wrought iron, often with very similiar compositions (Maryon 1960, 25). It should also be noted that he was the first to describe the methods of manufacture of such weapons comprehensively and correctly (ibid.; cf. France-Lannord 1949; Janssens 1958; Böhne/Dannheimer 1961; Anstee/Biek 1961, 84–88).

Fig. 1. Fragment of a pattern-welded sword blade from Musée Lorrain, France (in modern times ground down and etched); no scale (Salin 1957, Pl. VII). Graphic design P. Kucypera.

importance was at times raised to the rank of weapon divine, bearing magical qualities, designed for lofty and noble deeds.

Early medieval Europe, at least before the 11th century, did not produce the technical skills which would allow the uniform carburisation of iron bars thorough enough to obtain a roughly homogeneous product of sufficiently high quality (Williams 2003, 12). The primary source of its acquisition, namely bog ore, and the limitations resulting from the methods of smelting practised at the time forced a search for other ways of improving the quality of the metal (Pleiner 2000, 281–282; Edge/Williams 2003, 203–204; Tylecote/Gilmour 1986, 1–3, 7–15, 244–254). The temperature achieved in bloomery furnaces (800–1,200 °C)[3] was too low directly to smelt the metal, but, thanks to the use of charcoal as fuel, it was possible to reduce the iron oxides comprising the ore (Pleiner 2000, 131–136; LaSalvia 1998, 33–37). The conditions of this process caused portions of the reduced metal as well as a large part (often over 40%) of the oxides to remain trapped in slag which did not vaporise or was not tapped (ibid, 33; cf. Pleiner 2000, 132, 136). The product, called bloom, had to be worked mechanically finally to obtain a generally soft (usually – see ibid., 137) wrought iron with a minimum content of carbon (Crew 1991; cf. Sauder/Williams 2002; Pleiner 2000, 215–217, 281). Heating iron (above 900 °C), while keeping its surface in close contact with charcoal and/or other carbon donors (carburising substances most commonly used in the Early Middle Ages were of organic origin, e.g. burnt leather, bone powder mixed with metallic or alkaline carbonates), for a longer time followed by slow cooling allowed for the production of small amounts of low-carbon steel.[4] One such bar was definitely much too small to serve as sword blade material by itself.

The pattern-welding technique derives from piled constructions, dated to as early as Celtic times.[5] Their development introduced the idea of creating alternating soft iron and mild steel laminates which could be further manipulated (e.g. Lang/Ager 1989, 86–87; Jones 1997, 7; Jones 2002, 145). The basic problem in the implementation of this technique was the ability to work within small temperature ranges. The gap between a high enough welding temperature and the vehement burning of different iron alloys is narrow.[6] In terms of modern materials, in the extreme case of welding high carbon steel with technical iron, the best welding temperature is reached between 1,370 and 1,430 °C (ferritic iron: welding temperature – above 1,370 °C, burning – above 1,510 °C; high carbon steel: 1,200 °C and 1,430 °C respectively) (Blackistone 1991; cf. Lipski 1947, 88; Pleiner 2006, 202). The temperature range suitable for the welding of materials that were available in early medieval Europe was of course much wider (a few hundred degrees Celsius); also its upper limit was somewhat lower, owing to the large amount of impurities in the material acquired through the bloomery process[7] (it was best to keep the welding temperature as low as possible due to material loss through burning and the danger of decarburisation)

3 This is roughly the temperature of the formation of iron blooms. Actually, the temperature range of the bloomery process is much wider and fixed with different material transformations (Pleiner 2000, 131–136, Fig. 33).

4 Pleiner 2006, 200–202; Williams 2003, 6–8; Kuśmierek 2009, 200–201; cf. Pleiner 2000, 137.

5 Some swords from the La Tène period bear traces of manufacturing technology which could be rougly defined as primitive pattern-welding (Pleiner 1993, 117–118, 125–126, Fig. 12, 17:12; Lang/Ager 1989, 87).

6 Smiths were able to estimate the temperature by means of the colour of the glowing heated metal (Kosieradzki 1954; Pleiner 2006, 53–54; cf. Lipski 1947, 87–95).

7 Personal experience.

(cf. ibid., 58–60). The most commonly-used iron alloys were coarse-grained phosphoric iron and low-carbon steel.[8] Additionally, welding requires the use of fluxes that are needed for the impurities from the welded surfaces to run off and to ensure uniform heating of the package. Natural borax, silver sand, iron filings, glass slag and mill scale were all probably exploited (Thålin-Bergman 1979, 120; Pelsmaeker 2010, 16; Williams 2003, 7), although clean fine sand produces satisfactory results,[9] so it seems plausible that it was used most commonly (cf. Pleiner 2006, 58). The above-mentioned impurities in the metal acquired through the bloomery process could also provide the necessary covering for welded surfaces, so the use of flux might have been discarded completely (Pelsmeaker 2010, 16, 48–49).

One laminated rod was usually made of seven strips of low and high carbon, arranged alternately (Jones 1997, 7; Thålin-Bergman 1979, 124), the outermost bands usually of low carbon content (to prevent burning). After welding it was twisted – these twists can be uniform, interrupted, graduated and come in a great variety of combinations – and converted back to the form of a square-shaped bar or a strip. The individual parts of the blade, the pattern-welded rods/strips, edge rods (homogeneous or composite, usually sandwiched),[10] the homogeneous core piece (if need be) were welded together to make a bar, from which the blade was forged (Fig. 2–3) (Anteins 1973, 13–19; Jones 2002; Maryon 1960, 26–32; cf. Böhne/Dannheimer 1961). Sword-blanks were prepared in a great deal of variants (cf. Tylecote/Gilmour 1986, 146–262, Fig. 103; Jones 2002, 145–146; Lang/Ager 1989, 87–88, Fig. 7.2). The Author has listed eight of the most basic types (Fig. 4), but there are many more variations. In addition, pattern-welding technique was used to make inlays on sword blades. They were usually[11] placed on homogeneous (non-pattern-welded) surfaces (Fig. 5).

The finished blade was cleaned and degreased. Thus prepared, it could be subjected to heat treatment, which would include quenching (full, slack- or time-quenching), tempering and annealing (Pleiner 2006, 65–70; Kuśmierek 2009).[12] It was then ground, sharpened, polished and probably etched. Various iron-alloy structures react to caustic agents in different manners – while phosphoric iron remains generally untouched, carburised material takes on a noticeably darker colour (Piaskowski 1974, 43–47). Medieval blacksmiths could use natural tannins, vinegar (acetic acid), urine or sour beer for this procedure (Thålin--Bergman 1979, 124–129; cf. Anstee/Biek 1961, 88). On the other hand, some blades could have been left unattached, as the pattern is still slightly visible on well-polished surfaces (cf. Mäder 2001, 282–287, Abb. 47–48, 50–51, 51, 54–57)[13] (in *Kormáks Saga* Sköfnung had to be viewed from a right angle in order for the pattern to become visible [Jones 1997, 10–11]).

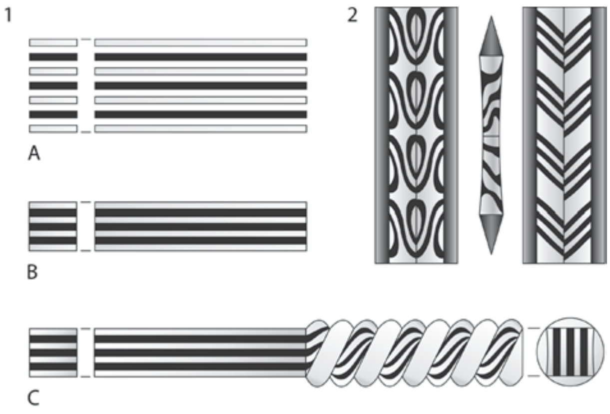

Fig. 2. Consecutive steps of forging a pattern-welded blade. Drawing by P. Kucypera.

There are three pattern types typical of pattern-welded objects: the straight pattern, the perpendicular/herringbone pattern and the curving/rose/star pattern (Fig. 6) (cf. Lang/Ager 1989, 87–88). They all derive from the same technical solution (see Note 3). The first is achieved from an untwisted laminate, the second thanks to twisting (a similar result can also be gained from a homogeneous twisted iron rod). The rose/star pattern can be obtained by either grinding down a twisted laminate or cutting it in half (Fig. 7) (Anteins 1973, Ris. 4–6, 9–15; Jones 1997, Fig. 2).[14] Thermal treatment of pattern-welded objects requires careful attention. Heating the blade too deeply can lead

8 Thålin-Bergman 1979, 117; Piaskowski 1964, 568; Pleiner 2006, 216; Tylecote/Gilmour 1986, 251–252.

9 Personal experience.

10 Recurrence observed on a larger group of analysed sword blades made by R. F. Tylecote and B. J. J. Gilmour (1986, 244–250).

11 There are some early examples of pattern-welded swords with pattern-welded inlays (e.g. Salin 1957, 59, Pl. VI; Ypey 1962/63, 66–69, Afb. 22–25; Ypey 1980).

12 For quenching methods see Williams 1977, 77–78; Williams 2003, 17–18.

13 The pattern can also be seen when the composite is made of homogeneous material, owing to the impurities (slag) of the weld-lines (Anstee/Biek 1961, 71, 78–79, 84–88; cf. Verhoeven/Clark 1998).

14 This was first suggested by Liestøl (1951; cf. Hrisoulas 1994, 58–59; Ypey 1980, 201, Fig. 146; Anstee/Biek 1961, 86–87; Mäder 2001, 195–205, Abb. 59–61).

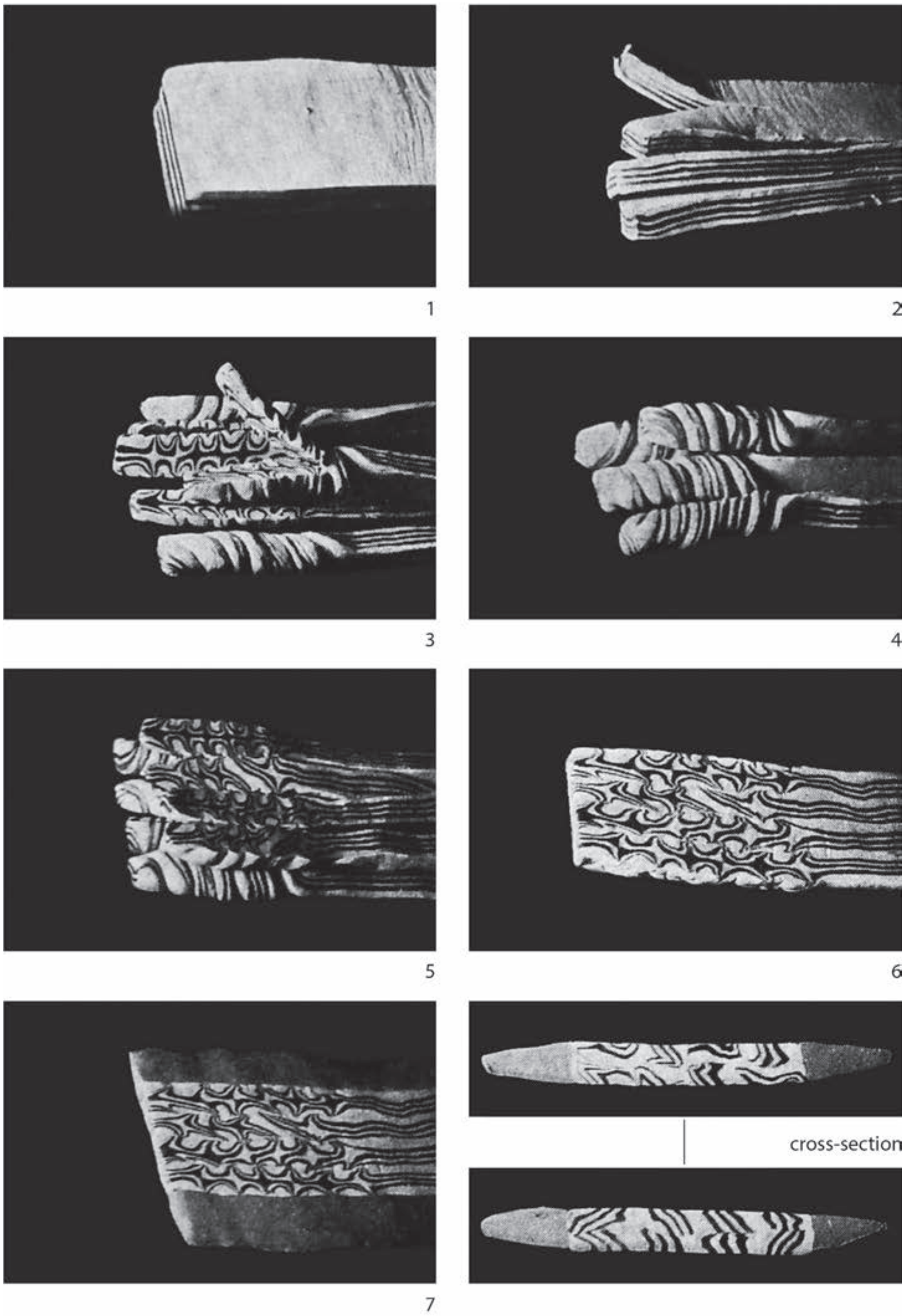

Fig. 3. Wax models representing successive steps of making a pattern-welded blade (Liestøl 1951, Fig. 4; cf. Note 16). Graphic design P. Kucypera.

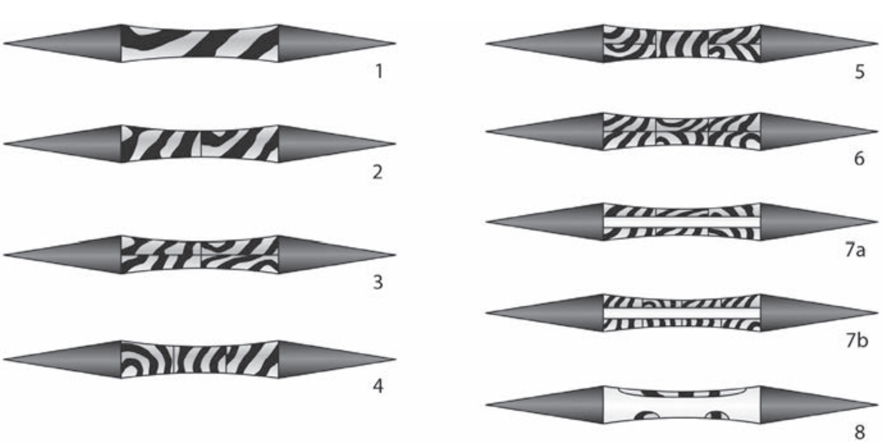

Fig. 4. Pattern-welded blade construction types (cross-sectional view). Drawing by P. Kucypera.

to the diffusion of carbon from the steel layers to the remaining mass of metal, causing the pattern to blur or disappear (although it could be somewhat prevented with a higher content of phosphorous in low-carbon bands and the general presence of impurities) (Piaskowski 1974, 70; cf. Anstee/Biek 1961, 85–86; Verhoeven/Clark 1998). If nothing else, working a pattern-welded material for too long could stretch and disturb its layers' outlines or cause unwanted delamination.[15]

The making of a pattern-welded blade was largely time-consuming and connected with severe material losses. J. W. Anstee determined the amount of material lost during the whole procedure to be as high as 70% (Anstee/Biek 1961, 81, 87). Some old sources give similar proportions: J. J. Perret (1771; *L'art du coutelier*) – 50%, H. R. Herrmann (1802; *Versuche über Damaszener Stahl*) – above 60% (most of the material is lost due to burning, but modern blacksmiths tend to grind down a lot of metal while forming the shape of the blade, as it is easier than forging it, and iron is cheap and readily accessible nowadays). It took 43 hours for Anstee to finish his blade, although he employed modern fuel and tools (coke, box bellows) in his experiment, which made the work easier (Anstee/Biek 1961, 72–74, 80–84, Fig. 26). He commented that while using historical tools and materials this time could go up to more than 200 hours to make a quality sword with modestly decorated fittings (ibid., 88), which has been somewhat confirmed lately by experiments conducted by S. B. M. Pelsmaeker (2010, 16, 49–66) and D. Sim (Sim/Ridge 2002, 93) (respectively 90 and 110 hours; they both made complete swords but without additional accessories). The blade can be inlaid, and it also needs to be fitted; all this requires more time.

Swords forged using twisted bars appear as early as the La Tène period (see Note 7), but the use of fully developed pattern-welding technique is observed since 2nd–3rd century (i.e. numerous votive artefacts found in Danish peat bogs) (Lang/Ager 1989, 87; La Salvia 1998, 40–43; Pleiner 2006, 215). Some comprehensive studies of larger groups of finds allow us to present the amount of pattern-welded swords among the total numbers of known specimens of early medieval chronology from different countries. Among 142 British swords dated to the 5th–10th centuries analysed radiographically by J. Lang and B. Ager, more than half were made using this technique (76 specimens: 5th–6th centuries – 15 examples, 5th–7th centuries – 9, 6th century – 24, 6th–7th centuries – 15, 8th–10th centuries – 10; 9th–11th centuries – 8 swords with pattern-welded inlays) (Lang/Ager 1989, 89–106, Tab. 7.2). In the

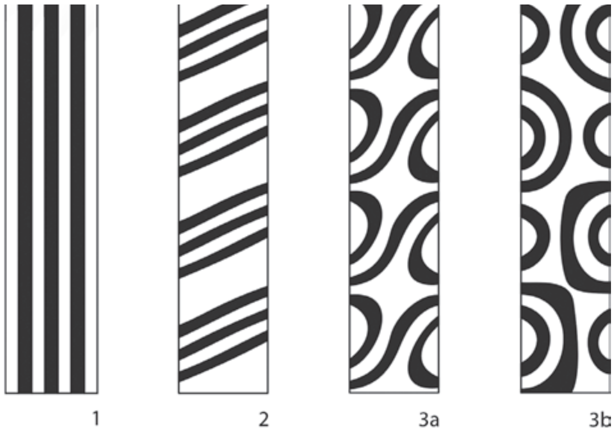

Fig. 5. Sword blade from Tyrväntö, Finland with a pattern-welded inlay (modernly ground down and etched); no scale (Leppäaho 1964, Taf. 2). Graphic design P. Kucypera.

Fig. 6. Types of patterns distinctive to pattern-welded swords. Drawing by P. Kucypera.

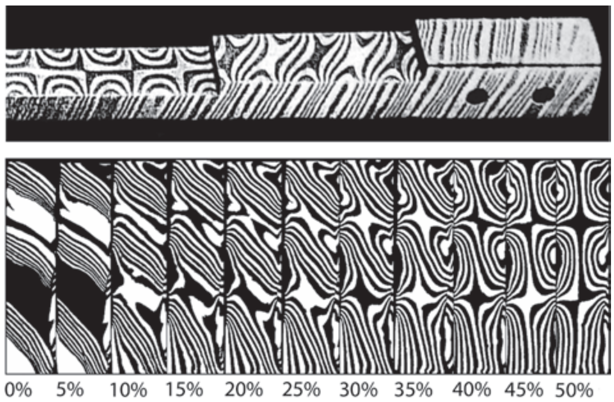

Fig. 7. Changes in the pattern with subsequent grinding of a twisted laminate (further grinding reverses these steps); 7-layered iron-steel model (Westphal 2002, Text Fig. 2c; upper) and 16-layered clay model (Jones 2002, 147; lower). Graphic design P. Kucypera.

15 Personal experience.

group of 104 swords from the Baltic states studied by A. K. Anteins, 41 were made using pattern-welding. Nine (6th–10th centuries) had their central part made entirely of damascened rods, six (9th–11th centuries) had a thin pattern-welded covering over a homogeneous core, 26 (8th–12th centuries) were inlaid using a pattern-welded wire (Anteins 1966, 111–116, 123–125). In his later monograph on pattern-welding across the whole Baltic region he lists 148 pattern-welded swords (3rd–11th centuries) and 116 (9th–12th centuries, one sword dated to the 12th–13th century) specimens with damascened inlays (Anteins 1973, 59–63). Of 220 early medieval swords from Poland (dated to the end of the 8th–middle of the 13th century), 12 were pattern-welded and 8 had inlays with identified use of the same technique (end of the 8th–middle of the 10th century).[16] Swords from the territory of Finland were subjected to macroscopic examination after grinding and etching their blades' surfaces by J. Leppäaho. Among 86 swords dated to the 9th–12th centuries, four were pattern-welded (8th–? centuries), 37 bore traces of pattern-welded inlays (9th–11th centuries, one sword dated to the second half of the 12th century) (Leppäaho 1964, passim; incl. in Anteins 1973). Using similar procedures A. N. Kirpičnikov distinguished 3 specimens with pattern-welded cores (9th century) and four with pattern-welded panels (10th century) out of a total of 183 swords from Kievan Rus' (Kirpičnikov 1966, 74–83, Cat. no. 1–3, 7, 20, 57, 70). Unfortunately, he does not specify how many examples were inlaid using this technique, although he mentions such specimens. Among nearly 300 spathae from the cemetery at Altenerdig, Bavaria (5th–early 7th century), about 80% were pattern-welded (Ankner 1996). A. Geibig's work, which comprises materials dating from the 8th/9th to the 13th centuries from the territory of Germany, lists more than 60 swords with pattern-welded blades (8th–9th centuries); the author does not give any information about how many swords had damascened inlays. He identified 5 specimens with patterned panels welded to a homogeneous core, although he admits that more could have been made using this method (Geibig 1991, 112–113).[17]

As can be seen from the summary presented, the technique in question reached its peak of popularity during the 6th–8th centuries. Starting from the 9th century, occurrences of its use constantly diminish, disappearing at the expense of simpler composite techniques, until its almost total abandonment during the 10th–early 11th century. This process starts in the Western world and the appearance of Ulfberht blades is a good example of that tendency (Kucypera 2009a, 248–249; cf. Stalsberg 2008; Williams 2009). At this time the use of thin pattern-welded panels welded to a homogeneous core is much more frequent,[18] indicating a clearly decorative application of the technique. In terms of sword-making, pattern-welding was used longest for the inlaying of blades, but its use fades as well with the introduction of inlays made of coloured metals (Kucypera 2009a).

Finally, two things should be emphasised: the reason for the abandonment of the application of this technique around the 10th century and the oft-suggested superiority of pattern-welded blades over homogeneous ones or those forged using simpler construction techniques. As was stressed earlier, the development of pattern-welding is strictly tied to restrictions associated with the acquiring and processing of iron at the time. Initially the decorative effect was merely a by-product of the applied technology, but its remarkable aesthetic qualities were soon recognised and keenly sought after (Fig. 8). It is obvious that manufacturers of sword blades with thin pattern-welded panels and with inlays made using the same technique utilised it solely to achieve a desired visual effect. When it comes to blades made with "true" pattern-welding, some scholars believe that a composite forged this way behaves very much like plywood, therefore is characterised by both better elasticity and hardness in comparison with homogeneous products (e.g. Jones 1997, 10; cf. Wadsworth 2000, 10–15). But the same qualities can be achieved using much simpler techniques such as sandwiching, the combination of a soft central part with hard edges or (although a few centuries later) selective, still thorough carburisation and proper heat-treatment (cf. Williams 1977)[19]. Secondly, considering the abundant presence of impurities in the wrought material, modern replicas cannot be treated as a completely objective source for such comparisons, as was repeatedly done in the past. Moreover, practical tests conducted by S. B. M. Pelsmaeker (2010, 67–75) and D. Sim (Williams 2003, 12) as well as J. Lang (2011) with damascened swords (or bars) forged from present-day materials suggest that they had their flaws and advantages, but were

16 Personal communication with colleague P. Pudło, to whom I extend my greatest thanks for this valuable information.

17 It should be emphasised that even in the case of specialised studies the use of this technology can sometimes remain unidentified (cf. Hošek/Košta 2011; Pleiner/Plzák/Quadrat 1956).

18 There are interesting examples of early damask-like platings on, e.g., some Nydam swords (cf. Jones 2002, 146).

19 Some authors suggest that the main role of pattern-welding was to remove an excess of and elongate the remaining slag intrusions through intensive forging (e.g. Anstee/Biek 1961, 86), but this opinion has also been questioned (cf. Edge/Williams 2003, 203; Lang 2011, 268–270).

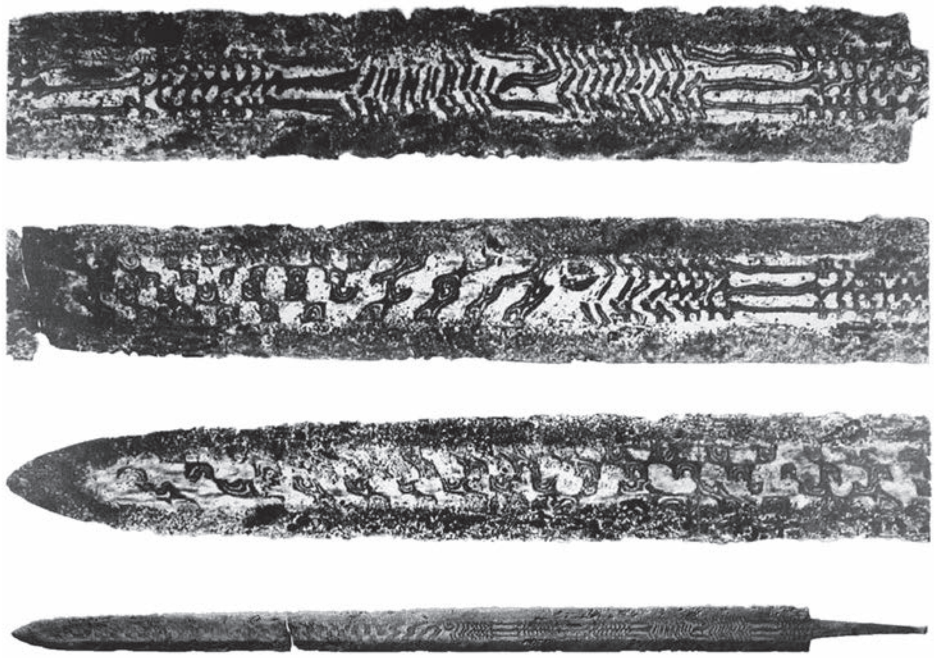

Fig. 8. Pattern-welded sword blade from Vehmaa, Finland (modernly ground down and etched); no scale (Leppäaho 1964, Taf. 31). Graphic design. P. Kucypera).

in no way superior to ones made using the easier, above-mentioned methods. An explanation for the phenomenon of the technique's decline should be discerned in the high costs and long time required to forge a pattern-welded blade. When the possibility of manufacturing weapons of similar quality using other, faster and less expensive methods arose, there had to be a shift towards their exploitation. This occurred earliest in the Franconian Empire and is most probably associated with a profound change of market needs – a slow but clear transition to production on a mass scale (Kucypera 2009a).

Summary

The article discusses the use of pattern-welding in sword blade manufacture in early medieval Europe. This technique, which owes its modern name to H. Maryon (1960), known also as damascening, derives from piled structures dated to as early as Celtic times (Lang/Ager 1989, 86–87; Jones 1997, 7; 2002, 145). Their development introduced the idea of creating alternating soft iron and mild steel welded laminates, which could be further manipulated. It is a process of forge welding alternating iron and steel bundles and their consequent transformation, which in result produces a composite characterised by a peculiar decorative surface (Anteins 1973, 13–19; Jones 1997, 7; Thålin-Bergman 1979, 124).This aesthetic quality, which was quickly observed and keenly sought after, is underlined in written sources, which comment on objects made using pattern-welding (Davidson 1998, 105–109, 119, 132–136, 142–144; Hoyland/Gilmour 2006, 43, 77–79, 153, 157; Collingwood/Stefánsson 1902, 63–64). In the case of sword-making, pattern-welding was used between the 3rd and 10th centuries and reached its peak in terms of complexity and popularity during the 6th–7th centuries (Lang/Ager 1989, 89–106, Tab. 7.2; Anteins 1973, 59–63). Originally it was probably employed to introduce carburised parts deeper into the blade's core and/or to reduce the amount of harmful slag intrusions and elongate the remaining ones, all this to give the weapon a keener edge (although this is still a matter of debate) (cf. Anstee/Biek 1961, 86; Williams 2003, 203; Lang 2011). The decorative effect of pattern-welding seems to play the greatest role in its use in later times, especially as evidenced by the presence of blade variants with patterned panels welded to a homogeneous core (Anteins 1966, 111–116, 123–125; 1973, 28–29). The fading away of its use probably came when economic factors began to play a significant role and swords were no longer reserved for social elites. Another important factor is the development of the smelting industry, which allowed for the use of other, simpler techniques that proved to be more efficient, both material- and time-wise (Kucypera 2009a).[20]

20 This article is aimed at summarising the given subject in a shorter form, without unnecessary (in the Author's opinion) expansions and clarifications of detailed issues, providing results of singular analysis etc. It is also intended to allow the reader not specialised in materials expertise relatively easily to understand its content, without resorting to oversimplification.

Souhrn

Technika svařovaných vzorů oceli v raně středověkém mečířství. Tento článek se věnuje využití svařovaných vzorů při výrobě čepelí mečů v raně středověké Evropě. Tato technika, jenž za své moderní jméno vděčí H. Maryonovi (publikace z r. 1960), je známa také jako damaskování. Je odvozena od mnohonásobně skovaných vrstev oceli, které vznikly přikládáním a opětovným skováním. Tento postup je známý již z keltských dob (Lang/Ager 1989, 86–87; Jones 1997, 7; 2002, 145). Během vývoje této techniky vznikl nápad vytvářet střídáním měkkého železa a oceli svařovaný paket, se kterým by bylo možno dále pracovat. Jedná se o postup svařovaného kování, při kterém jsou střídány svazky železa, oceli a jejich následných kombinací. Výsledkem je kompozit s charakteristickým, osobitým dekorativním povrchem (Anteins 1973, 13–19; Jones 1997, 7; Thålin-Bergman 1979, 124). Tuto estetickou kvalitu, která se brzy stala populární a vyhledávanou, vyzdvihují psané zdroje, které se o předmětech využívajících vzorované svařování zmiňují (Davidson 1998, 105–109, 119, 132–136, 142–144; Hoyland/Gilmour 2006, 43, 77–79, 153, 157; Collingwood/Stefánsson 1902, 63–64). Co se týče mečířství, byl tento vzor využíván mezi 3. a 10. stoletím a vrcholu komplexnosti i popularity dosáhl v 6. a 7. století (Lang/Ager 1989, 89–106, Tab. 7.2; Anteins 1973, 59–63). Původně byla tato technika patrně využívána k tomu, aby se nauhličené části dostaly hlouběji do jádra čepele anebo aby se snížil obsah škodlivé strusky a prodloužily se ostatní části, což mělo pozitivní vliv na ostří (toto je zatím předmětem debat) (cf. Anstee/Biek 1961, 86; Williams 2003, 203; Lang 2011). Pro užívání tohoto vzoru v pozdějších letech hrál zřejmě hlavní roli jeho dekorativní efekt, což dokládá hlavně přítomnost několika variant čepelí se vzorovanými pruty navařenými do homogenního jádra (Anteins 1966, 111–116, 123–125; 1973, 28–29). Na ústupu se ocitá pravděpodobně v době, kdy začínají hrát významnou roli ekonomické faktory a meče již nejsou výsadou společenských elit. Dalším důležitým faktorem je rozvoj tavby, která umožnila využití jiných, jednodušších technik, které se ukázaly jako efektivnější, a to jak materiálově, tak časově (Kucypera 2009a).

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