

Early medieval knives from stronghold of Stará Boleslav, Bohemia – the second stage of metallographic investigation

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Abstract

Stronghold of Stará Boleslav was established about the end of the 9th or beginning of the 10th century by Premyslid family, which ruled the country at those times. In the mid 11th century, the basilica was built on the acropolis and Boleslav became centre of Christianity. Later, in the first half of the 13th century at the latest, the site lost its importance and the stronghold settlement became extinct. Fifteen objects (mainly knives) were already examined and published in 2003. During the second stage of examination, nineteen other 10th to 13th centuries knives were selected from the assemblage and their investigation, by method of lateral blade examinations, has been carried out. The knives appeared to be made of steel (one piece), steel and iron (eight pieces), ten blades revealed more complex construction and rank among luxury items (six striped blades, three wavy-welded and one pattern-welded).

Stará Boleslav – Early Middle Age – knife - archaeomellurgy – metallography – pattern-welded knife - archaeology

Stará Boleslav Stronghold

Stará Boleslav, one of the strongholds of the early medieval Premyslid state and the seat of Premyslid princely family members, was established about the end of the 9th or beginning of the 10th century ca 30km northeast of Prague, at a floodplain of the Elbe River. The stronghold was advantageously located in the spot, where major river route was crossed by the terrestrial long-distance road leading from Bohemia to the Baltic, and where the floodplain with the river and its temporally inundated ox-bows provided a natural protection. The stronghold itself consisted of acropolis and bailey; other settlement points or villages can be proved in surroundings.

The historical development of the site can be divided into three main stages. The first (A – 9/10th to 2nd third of the 10th century) is associated with the beginning of the site, when residential part for a duke alongside a court and church formed a heart of the fortified acropolis. Craftsmen settlement could emerge in the bailey outside the fortification; a burial place was most likely situated at some distance from the settlement. The second stage (B – 2nd third of the 10th century to 11th centuries) is characterised by both ongoing development of the stronghold settlement and building-up of fortification, which was on the acropolis replaced, in the 10th century, by one in stone (first evidenced use of mortar for fortification systems in this part of Europe). In the end of the first half of the 11th century, the basilica was built and chapter-house, first in Bohemia, founded, and Stará Boleslav became the centre of Christianity. This event started off the last development stage (C – roughly 12th century). Many changes such as further building activities, changes in the spatial organisation, changes of the level of material culture and later, for example, demolition of the fortification took place on the stronghold; however, later its importance for the early mediaeval Přemysled Bohemia decreased, and the site was on the decline.

Possibilities and methods of metallographic knife-blades investigation

General manner of knife investigation as well as approach to particular items are among archaeometallurgists, archaeologists and conservator-restorers widely discussed on the present. The traditional morphological evaluation of knives undoubtedly yields only part of the information that can be deduced from these finds. Conservation survey is extremely useful because different kinds of decoration as well as further details can be quite reliably revealed. Even basic blade constructions can be preliminary determined in the course of conservation treatment by means of X-ray and/or by a look of the original blade surface when revealed by sand-blasting. But these methods significantly depend on a surface condition and hence are not reliable for systematic research. Therefore, metallography remains up to date the most powerful method for the blade-construction investigation. Since some time ago, a lateral surface examination is, in comparison with cross-sectional way, often preferred by archaeologists and restores for its slight intervention into object's integrity. When laterally examined, blades can be easily restored in order to hide the affected areas or conversely only varnished to show up the revealed original look and hence construction (in case of pattern-welded knives for instance). However, the method is powerful only in the case of blade-constructions that are identifiable from lateral look of blades. Introduction of the method thus requires foregoing knife-making technique survey for given period and territory. If it is impossible to employ the surface examination, but blade construction and all the related information are yet demanded, then the cross-sectional sampling is approached (but only in well justified cases). Because taken samples are examined non-destructively, it is possible to glue them back into blades or archive them (can be then used for further analyses at a later date). Nowadays is the decision up to the knife owner (usually museum) or its proxy-holder (usually archaeologist responsible for the associated excavation).

Investigation and results

Investigation of knives from Stará Boleslav Stronghold is a part of wider systematic research aimed at a comprehensive study of Bohemian and Moravian early medieval cutlery, as well as a part of systematic archaeological research into this Premyslid stronghold. Knives from Stará Boleslav were investigated in two stages. Thirteen knives from the first group were examined in blade cross sections (see Hošek 2003), nineteen knives of the second stage were examined laterally on blade surfaces (see Fig. 1). Their selection was random (out of ca 150 pieces) with exception of the knife No. 2964 (Fig. 2), which was chosen intentionally (recognized as pattern-welded in advance). The blades were grinded, polished (by adapted polishing machine) and finally etched by 3% Nital (Oberhoffer's reagent was also used, but exceptionally and only when necessary). Hardness was measured by Vicker's method on Wilson Wolpert 401MVD hardness tester. Examined blades were categorized into three main groups: knives of simple construction, knives of welded construction and luxury knives, see also Tab. 1.

{INSERT FIGURE 1 HERE}

Knives of simple construction

Knife No. 9008, 11th-12th century, acropolis, context: 7(trench)/12135(stratigraphic unit)

The blade is entirely of steel, apparently with increased carbon content in the cutting edge. The edge was quenched, the back retained good toughness. The accurate blade-construction was not clearly evidenced but it is obviously high quality blade.

Knives of welded construction

Knife No. 1915, 9/10th -13th century, acropolis, context: ZII/4210

The knife has the cutting edge of effectively quenched steel. The back consists of steel as well as low-carbon iron with increased phosphorus content. Although the back is impressive when

etched, it is impossible to evidence an intentional construction. It was more likely simply made of either scrap or heterogeneous iron. It is an excellent knife.

Knife No. 9854, 11th-12th century, acropolis, context: 7I/0000 (without stratigraphy)

It is a knife of standard welded construction with cutting edge of steel and back of heterogeneous iron. Apparently the only cutting edge was water-quenched and subsequently tempered by heat from the unquenched back. It is an excellent blade.

Knife No. 9309, 11th-12th century, acropolis, context: 7/12154

The blade was provided with quenched cutting edge of steel, the back was made of material being rather steel than iron (it was not hardened). It is an excellent and choicely made knife of standard construction. With regards to the material of the back it can be considered also as all-steel knife.

Knife No. 9484, 11th-12th century, acropolis, context: 7/12324

The blade has steel cutting edge welded onto the iron back (standard construction). The blade was quenched but the cutting edge has insufficient carbon content for effective hardening. Apparently it is a good knife.

Knife No. 94, 11th-12th century, acropolis, context No. 1-B/00036

Cutting edge of steel was apparently welded onto the iron back. It is a quenched blade of excellent quality.

Knife No. 138, 11th-12th century, acropolis, context No. 1-B/0035-0036

The blade has either massive or scarf-welded-on cutting edge of high-quality, back is iron. Excellent knife.

Knife No. 3166, ca 12th century, bailey, context: XVI/6410

Knife of standard welded construction (cutting edge of steel + iron back) with traces of annealing (presumably being affected by fire). From the viewpoint of construction it was a high-quality item, but the preserved cutting-edge is soft and rather of low or medium quality.

Knife No. 3168/2, 12th century, bailey, context: XIX/95/06408

The blade consists of steel cutting edge and iron back (standard construction). The blade is however soft and bears traces of annealing; perhaps it was accidentally affected by fire.

Luxury knives

Knife No. 766, 9/10th-12th century, acropolis, context: A/0000

In this case, blacksmith presumably followed the idea to make a striped blade with steel cutting-edge, mid-strip of phosphoric iron, strip of steel and iron back. The striped blade is provided with quenched and hard cutting edge and it is thus an excellent object.

Knife No. 9570, 10th century, acropolis, context: 14/13462

The blade consists of steel cutting edge, mid-strip of phosphoric iron and back of piled iron with variable both carbon and phosphorus content. It is one of types of striped early medieval blades – excellent knife.

Knife No. 8381, 10th century, acropolis, context: 5/12026

The blade has cutting edge of steel, mid-strip of phosphoric iron and back of ordinary iron. It is thus high-quality and luxury striped blade of standard construction.

Knife No. 7499, 10th – 13th century (based on the blade type), acropolis, context: 3G/11272

It is a striped blade with quenched both steel cutting edge and back, the middle strip is phosphoric iron. It is luxury and high-quality knife.

Knife No. 8704, 10th – 13th century (based on the blade type), bailey, context: LXXXIF-3/6

It is a striped blade provided with both cutting edge and back of quenched steel. The steel of the back varies in carbon content (presumably piled heterogeneous steel) and diverse structure-zones then cause unequal tones being visible to the naked eye. This slightly spoils the general impression. Anyway, it is excellent and luxury knife.

Knife No. 2818, 10th – 13th century (based on the blade type; found along with post-medieval adulterants), bailey, context: XIII/2300

It is a striped blade with mid-strip of phosphoric iron, the back is ordinary soft iron and the cutting edge is either iron or low-carbon steel. Judge from the structure of the blade-edge, the blacksmith made and attempt to quench it but the edge remain soft. The blade is an interesting witness of an attempt to make a good-quality luxury knife. Blacksmith failed in the selection of the cutting-edge material.

Knife No. 8397, 10th century, acropolis, context: 5/12028

The blade is provided with good-quality steel cutting edge, which is attached by wavy-weld onto a mid-strip of phosphoric iron. The back is also of iron with slightly increased phosphorus content. It is wavy-welded luxury blade of excellent quality.

Knife No. 3550, 10th -13th century (based on the blade type), acropolis, context: XXVI-7180A?

It is luxury knife with wavy-welded-on cutting edge of steel. The mid-strip is phosphoric iron, the back was made from inhomogeneous semi-product varying between iron and steel. The most likely water-quenched blade represents an excellent luxury product.

Knife No. 9184, 11th -12th century, acropolis, context: 7/12236

It is knife with wavy-welded-on steel cutting-edge, which is however as-annealed (at temperatures of around 700°C – caused presumably by fire) and thus very soft. The back was made of heterogeneous iron with irregular phosphorus content. As the mid-strip was made of similar material as the back it could evidence difficulties to gain (or choose) more suitable material (in this case the phosphoric iron). Anyway, the knife is from the viewpoint of construction excellent product.

Knife No. 2964, 12th century, bailey, context: XVI-XVII/0000

It is fragment of pattern-welded blade with wavy-welded-on cutting edge, see. Fig. 2. The edge was made of steel being perfectly quenched. Both phosphoric iron and steel were used for the pattern-welded core, the middle wave-strip is phosphorus iron. The back is of iron presumably also with slightly enhanced content of phosphorus. The blade was excellent and luxury product.

{INSERT FIGURE 2 HERE}

{INSERT TABLE 1 HERE}

Interpretation and discussion

The site and its excavation

The assemblage of the examined knives comes from the long-time rescue excavation (1988-2003; Institute of Archaeology CAS in Prague – I. Boháčová and City Museum in Čelákovice – J. Špaček) realised mainly in trenches for reconstruction of engineering nets (power distribution etc.). Therefore, all the basic information about the site development and its framework chronology were gathered during the hitherto rescue excavation. Value of the finds and possibility of their interpretation are naturally influenced by complicated and intense long-term (several centuries) genesis of historical contexts, and by the type of excavation that depended on the circumstances of building activities. With regards to the acquired knowledge about the site stratigraphy, we suppose early medieval origin also in the case of knives that did not come from the early medieval context. The probability of this supposition is high because early medieval strata are directly overlapped by post-medieval layers and 13th and 15th century

finds are encountered very rarely. Dating of knives without any archaeological context must be, however, considered unreliable, with exception of finds that could be roughly dated on the base of ascertained blade constructions (but only in the case of luxury knives). The excavated knives come from collections of the City Museum in Čelákovice.

Single types of knives and their appropriate analogies

Nine out of nineteen knives were found as ordinary. Such knives were usually either simply welded from two rods (the scheme is, as a rule, steel cutting-edge and iron back) or simply made from single piece of metal (which can be both iron and steel). Simply welded knives were presumably in the 10th to 13th century Central Europe very common and among ordinary pieces obviously prevail. Simple one-piece (non-welded) blades are less common, all-iron or heterogeneous inferior pieces were up to date encountered more frequently than all-steel high-quality blades (thus also iron pieces were considered handy). Although similarities can be found even among such simple (both welded and non-welded) knives, often due to a type of heterogeneity of used metal, we did not find any relation among the examined blades, which are therefore useless for any kind of other comparison.

{INSERT FIGURE 3 HERE}

Remaining knives (10 pieces) rank among luxury items. We recognise several variants of luxury early medieval knives but only the types with complex blade-construction (often aggregately considered as pattern-welded) appeared in Boleslav. The simplest type bears plain strip of phosphoric iron placed between cutting-edge and back (so-called striped blades). More complex variant of striped blades bears phosphoric iron strip with wavy lower edge (so-called wavy-welded or serrate-welded blades or blades with wavy/serrated-welds). Blades with patterned strips are the most complex and several sub-types can be discerned with regards to a number of used pattern-welded rods or according to additional decorative strips.

According to the current research it seems that striped and wavy-welded knives were most common types of the 10th to 13/14th prestigious knives in general and they were evidently spread throughout Bohemia, Moravia and Poland. Their appearance was not presumably limited only to these countries because in Great Britain etc. (e.g. Cowgill et al 1987, 16; Koroshec 1965/1966) were similar knives encountered too. The wavy-welded knives from Stará Boleslav are of standard construction with iron- or heterogeneous-back without added strips of steel. All the knives differ in shape as well as constructional details and none relationship can be underlined among them. Concerning the form of decorative strips, the knife 3550 seems to be similar to one of knives from Klecany Stronghold, which is only 20km far, although blade-back of the Klecany knife is steel. Some similarities in form and construction exist also between knife No. 9184 and a 12th century knife No. 221/52 from Polish Ostrówek w Opolu (Bukowska-Gedigowa - Gediga 1986, Fig. 83 p.201). Nonetheless, possibilities of interpretation of such pairs or even groups of mutually similar knives were not yet properly studied and their significance for provenance or trade research was not verified to date.

{INSERT FIGURE 4 HERE}

Pattern-and-wavy-welded knives seem to be less common than other variants of patterned knives, although many such pieces were recently recognized due to progressive current research. In regard to Bohemia and Moravia, analogous knives (but only from the viewpoint of

the basic constructional scheme) come from the stronghold of Malín (1 piece, 1st of the 13th century; Velínský et al 2007, 398, Fig. 9 p. 397), from the town of Olomouc (1 piece, 2nd half of the 13th century; see *Sága moravských Přemyslovců*, p. 233) and emergence of other three Bohemian knives was preliminary announced (D. Perlík, personal communication, June 22, 2007). Pattern-and-wavy welded knives are known also from Poland, namely from Ostrówek w Opolu (2 pieces, end of 11th up to beginning of the 12th century and end of 12th to first half of 13th century; Bukowska-Gedigowa - Gediga 1986, Fig. 129 p. 300; Fig. 65 p. 162), from Gdańsk (1 piece, 14th century; Piaskowski 1960, 104, Fig. 178, 179;) and from Biskupin (1 piece, 12th to 13th centuries; Piaskowski 1964, 562-563, Tab. II p. 562, Fig. 24 and 25 p. 567; Pleiner 1979, p. 562). The last one is interesting for its triple patterned part; the fragment seems to be smaller variant of a blade No. 2892 from Coppergate, late 10th to mid 11th century, (Ottaway 1992, 598, Fig. 246 p. 596), whose construction is nonetheless typical rather for saxes than knives of common size. It could be one of the suggestions that pattern-welded and pattern-and-wavy welded knives were successors of earlier saxes or bigger war knives (of the same look but exploiting also distinct construction with central core and patterned surface panels; see Pleiner 2006, p. 217 Fig. 73, p. 254) and perhaps could be as such spread in many parts of Europe. It is believed to date that pattern-welded knives are associated mainly with the Central and East European countries and British Isles, but their real diffusion in medieval Europe remains unclear owing to lack of appropriate research.

Knives on the stronghold

The spatial and time distributions of the examined knives are plotted in the Fig. 3, 4 and 5. Although knives of all types (with exception of the pattern-welded ones) prevail on the acropolis, their real predominance cannot be evidenced statistically. Therefore all relations being found in the examined assemblage are not demonstrable, though they are certainly useful. It is also rather difficult to find relationships among some of the knife types and certain archaeological contexts. None of the knives can be considered clear grave find (although knives No. 1915 and 7499 could come from graves). Some of the knives could be lost; for example, finds No. 94,138 and 2818 were found in layers overlaying the main route running through the site, knife 2818 was found directly in the route stone-paving (created in course of the stage C). Luxury knives No. 766 and 2964 also came from the same excavated units, but they were not stratified (found during surface prospecting after removal of post-medieval overburdens). Finds No. 9008, 9184, 9309, 9484 and 9854 came from deposits of sizable pits of unknown purpose, which were most likely filled-up at a time, and which could be secondarily used as dump pits. Also knives 3166, 3168/1 (pattern welded knife examined in 2003, see Hošek 2003) and 3168/2 were lifted from top parts of pits associated with residential function of the excavated structures, but which could temporally serve as dump pits as well. Finds such as No. 7499, 8704, 2818 and 3550 have unclear archaeological context and their dating was based on their (1) blade-constructions that are in Bohemia typical for the period of the 10th to early 13th centuries and (2) on the fact that 9th and 13th to 15th centuries finds appeared on the site exceptionally.

{INSERT FIGURE 5 HERE}

During the first and second stage of the site development (i.e. roughly between the 9/10th to 11th centuries) knives of better quality appeared rather on the acropolis and luxury knives of the time were not even evidenced in the bailey at all. Predominance of more luxurious items or items made of superior materials on the acropolis is noticeable in general, and reflects higher rank of inhabitants of the acropolis. Besides of that, notable accumulation of tools and

high-quality items of all kinds in the area east of the basilica presumably evidences an existence of the craftsmen's quarter, in which also smithy activities could hypothetically took place (frequent remnants of heating units, pieces of slag in overburdens /but without direct relationship to the heating units/, whetstones, knives), (Boháčová 2003, p. 293). However, if luxury knives (mainly striped and wavy-welded types) could be produced there remains by nature unclear. During the last development stage (C), when the stronghold was changed in religious place, the luxury knives were found also in the bailey (but, for instance, both pattern-welded knives from bailey could, according to the archaeological context, represent also dumped or lost objects). With regards to the problems with dating of certain knives, we cannot the spatial and time distributions of knives describe more in detail, and the real impact of the changeover from stage B to C on the knife appearance remains indistinct.

Knife quality

Quality of the knife blades can be evaluated from the viewpoint of forging, welding, used materials, heat treatment and finally of the used blade-construction. Accuracy of forging and welding cannot be evaluated properly by lateral blade examinations, failure in selection of suitable material appeared in the case of two knives; No. 9484 and 2818. If we take into account also knives from the first stage of examinations, we can see that knives with good-quality steel cutting-edges obviously (statistically) prevail. Heat treatment of blades is another problem. Investigation of the Stará Boleslav assemblage has learned us that evaluation of unquenched blades must be done carefully. Finds No. 9184, 3166 and both 3168/1 and /2 bear traces of annealing but none of them can be reliably associated with residential contexts and as such revealing 1) the original heat treatment, or 2) secondary annealing in case of a fire accident. However, the excavated pits could serve, at least temporally, as dump pits and the knives could be as dumped objects associated with an accident and fire affecting. The fact that the as-annealed knives could be rather damped is suggested also by the units, containing blades No. 3166 and 3168/1,2, which do not directly indicate any structure collapse caused by intensive fire.

The question of provenance

The location of the stronghold on the long-distance route is reflected in some of the finds, among which are raw materials, morphologies and decoration reflecting the Polish, and more commonly the Baltic, *milieu*. Also among knives from Stará Boleslav, and in fact among Bohemian early medieval knives in general, we can find many parallels with Polish early medieval cutlery. The craftsmen's quarter, mentioned above, indicates a hypothetical possibility of local (perhaps even luxury) knife production, but the hypothesis must be still verified by further research. Luxury knives were obviously traded, perhaps also among Stará Boleslav and Polish (or other Baltic) sites, and if some of them were imported (if at all), we could suppose their northern, most likely Polish, origin.

Stará Boleslav in comparison with other Bohemian sites

Up till now, thirteen luxury items out of the thirty-one 10th to 13th centuries examined knives and among them five luxury items out of the twelve 10th to 11th centuries examined knives were recognized in the Stará Boleslav assemblage. These data can be compared with results of investigation of other Bohemian sites such as Premyslid princely stronghold of Budeč (Pleiner 1993) or other Premyslid stronghold of Malín (which belonged to family of Slavník till the end of the 10th century), (Hošek – Velímský – Šilhová – Ottenwelter 2007). Seven luxury items out of the twenty examined 10th to 11th centuries knives come from Budeč and two luxury items out of the seven 10th to 11th century examined knives were found on the stronghold of Malín. We can see that more-less similar concentrations of luxury knives may be evidenced on Premyslid strongholds in general. Furthermore, recently investigated rural site of

Hrdlovka also revealed high concentration of striped and wavy-welded blades (six luxury knives among twelve 10th to 11th centuries knives, which were examined). Therefore, according to the current research, the accumulation of the prestigious knives does not reflect markedly higher rank of Stará Boleslav in comparison with other Bohemian strongholds. On the other hand, it became apparent that Boleslav ranked among important sites of the early medieval Premyslid state, and as such belonged to the important sites of the early medieval Bohemia.

Conclusion

Nine out of the nineteen examined knives were found as ordinary, ten remaining pieces rank among luxury items (striped, wavy-welded (serrated) and pattern-welded).

Up till the 11th century, when the stronghold served to Premyslid family (based in Prague) as one of spots for control over the land, knives and especially luxury types were discovered rather on the acropolis. Since the 12th century at the latest, when the site was changed in religious place, luxury knives including pattern-welded can be found also in the bailey; however, it remains unclear if this reflects higher level of living of 12th century-bailey inhabitants, because the knives can represent rather dumped or lost (on public areas) objects.

The site is situated in the crossing of two long-distance trade routes, what is partially reflected in the archaeological assemblage. Although Stará Boleslav luxury knives have blade-constructional parallels in Polish finds, it is difficult to prove that also a knife trade took place on the stronghold; nonetheless we suppose that. Local production of the knives can be suggested by emergence of craftsmen's quarter on the acropolis, where smithy activities could hypothetically took place. In case that luxury knives were not produced on the site, we can assume their import from another Bohemian sites or lands situated north of Bohemia, most likely from Poland.

It became apparent that Stará Boleslav belonged to the important strongholds of the early medieval Premyslid state; however, we cannot (on base of the carried-out knife-investigation) evidence its markedly higher rank.

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Tab. 1. Details of metallographic examinations.

Fig. 1. Metallographically examined knives from Stará Boleslav (10th to 13th centuries). Luxury types on the left, ordinary types on the right. Drawings by J. Hošek.

Fig. 2. Pattern-welded knife No. 2964. Photos and drawings by J. Hošek.

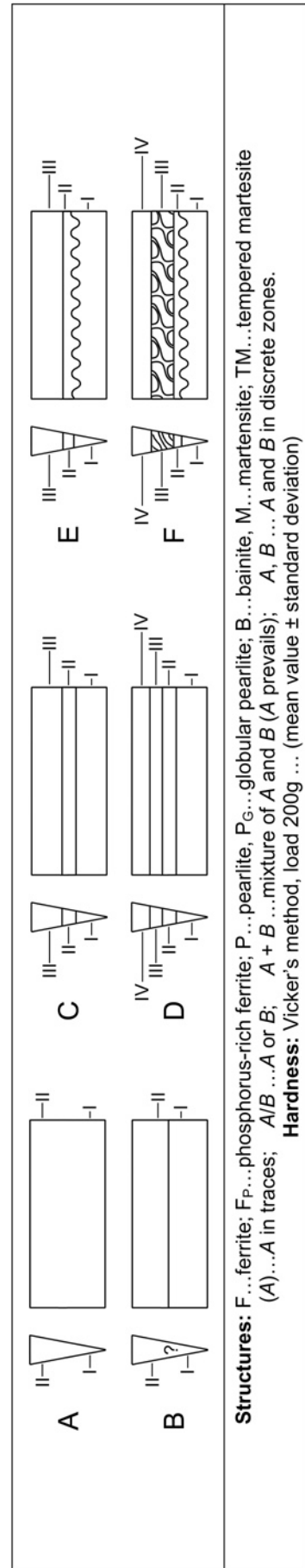
Fig. 3. Distribution of simply made knives and knives of standard welded blade-construction (10th to 12th centuries). Red dots: knives from the second stage of examination; black dots: knives from the first stage of examination. Drawings by J. Hošek.

Fig. 4. Distribution of luxury knives (10th to 13th centuries). Red dots: knives from the second stage of examination; black dots: knives from the first stage of examination. Drawings by J. Hošek.

Fig. 5. Appearance of luxury knives during the 10th to 13th centuries. Red dots: contemporary (or earlier) knives; black dots: earlier knives. Drawings by J. Hošek.

Table 1. Details of metallographic examinations.

Knife No.	Dating (century AD)	From	Basic tech.	Type of construction	Structures and hardness (HV 0,2) in single parts of blades		
					I	II	III
9008	11th-12th	acropolis	simple	entirely of steel	B+M (566±42)	P(B)+F (256±13)	
1915	9/10th-13th	acropolis	welded	steel-and-hetero.metal	M+B (605±14)	F _P +F+B (213±4; 382±14)	
9854	11th-12th	acropolis	welded	steel-and-iron	TM (478±7)	F (174±1)	
9309	11th-12th	acropolis	welded	steel-and-steel	B (542±19)	F+P (230±15)	
9484	11th-12th	acropolis	welded	steel-and-iron	B (287±21)	F (137±4)	
94	11th-12th	acropolis	welded	steel-and-iron	M (578±16)	F (136±3)	
138	11th-12th	acropolis	welded	steel-and-iron	M (747±15)	F (169±14)	
3166	12th	bailey	welded	steel-and-iron	P _G (204±7)	F (115±4)	
3168/2	12th	bailey	welded	steel-and-iron	F+P (153±10)	F	
766	9/10th-12th	acropolis	luxury	striped	M (629±20)	F _P (231±2)	F, F+P/B (158±15)
9570	10th	acropolis	luxury	striped	M (492±9)	F _P (258±14)	F+P, F, (F _P) (198±8)
8381	10th	acropolis	luxury	striped	M+B (496±15)	F _P (215±11)	F+P
7499	10th – 13th ??	acropolis	luxury	striped	C B (335±14)	F _P (181±8)	B (315±7)
8704	10th – 13th ??	bailey	luxury	striped	C B (588±7)	F _P (197±13)	F + P/B, B (225 – 450)
2818	10th – 13th ??	bailey	luxury	striped	C B (185±20)	F _P (259±51)	F (96±5)
8397	10th	acropolis	luxury	wavy-welded	M+B (398±16)	F _P (225±7)	F, (F _P) (204±11)
3550	10th-13th ??	acropolis	luxury	wavy-welded	M (671±20)	F _P (201±9)	F (143±11), F+M, M
9184	11th-12th	acropolis	luxury	wavy-welded	P _G (205±3)	F (156±3)	F (131±7)
2964	12th	bailey	luxury	pattern-and-wavy-welded	B+M (576±34)	F _P (265±21)	M+B (417±76) / F _P (270±32)
							F (169±6)



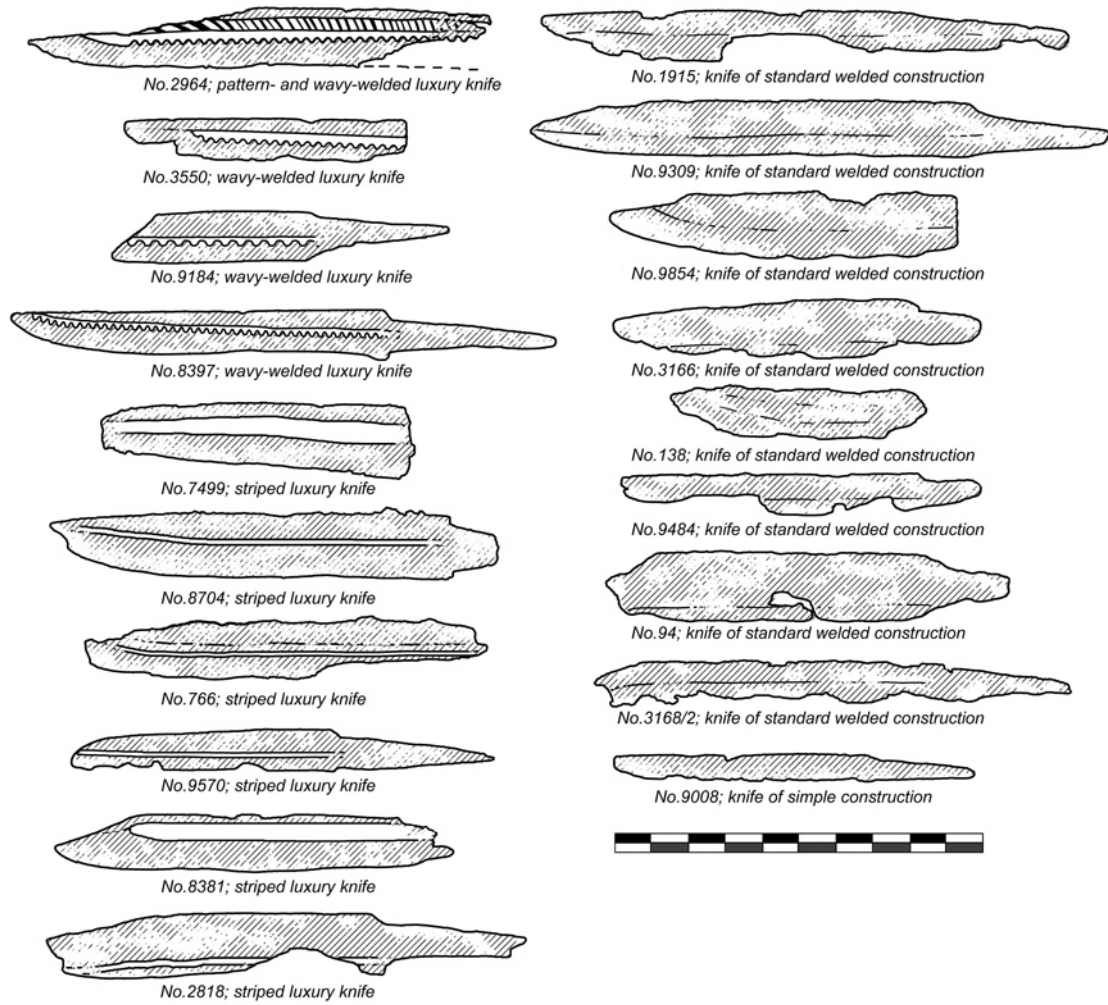


Fig. 1. Metallographically examined knives. Luxury types on the left, ordinary types on the right. Drawings by J. Hošek.

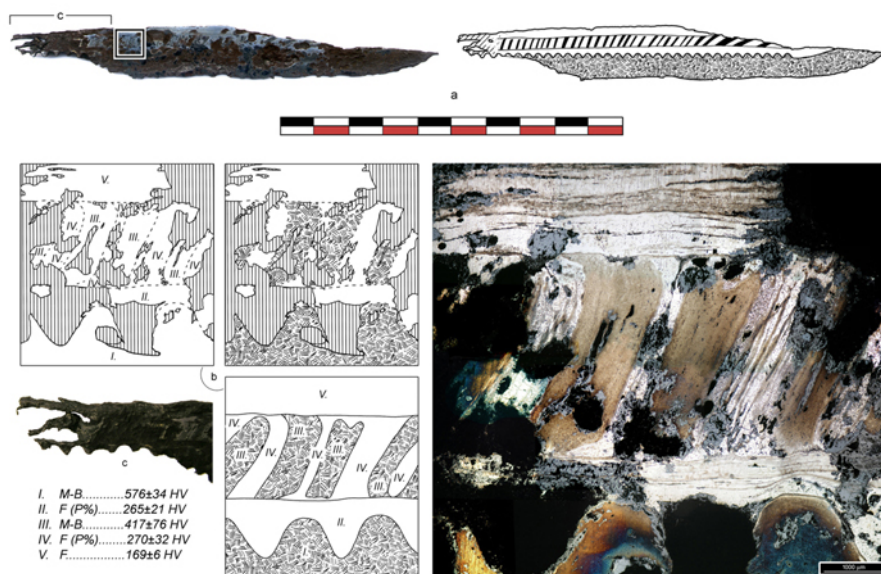


Fig. 2. Pattern-welded knife No. 2964. Photos and drawings by J. Hošek.

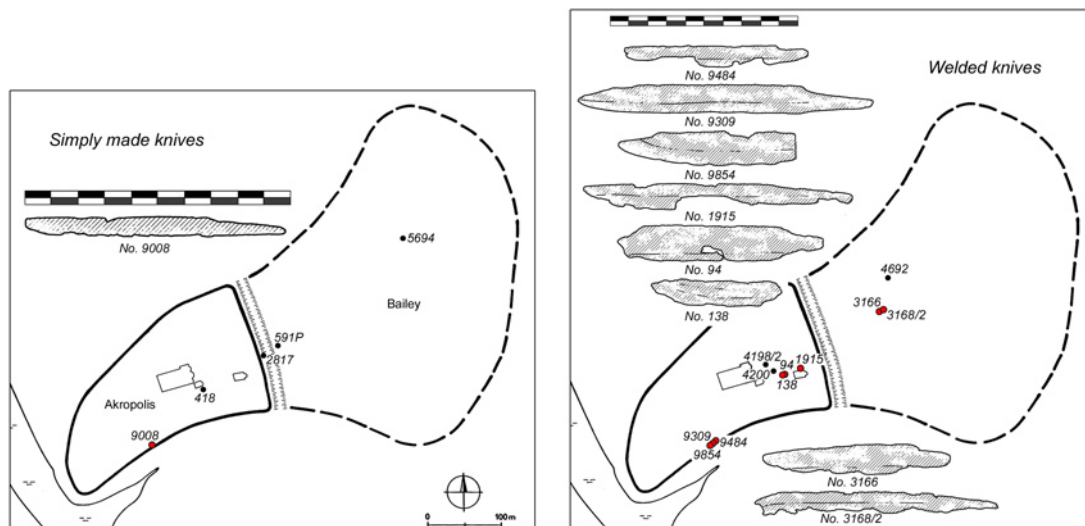


Fig. 3. Distribution of simply made knives and knives of standard welded blade-construction. Red dots: knives from the second stage of examination; black dots: knives from the first stage of examination. Drawings by J. Hošek.

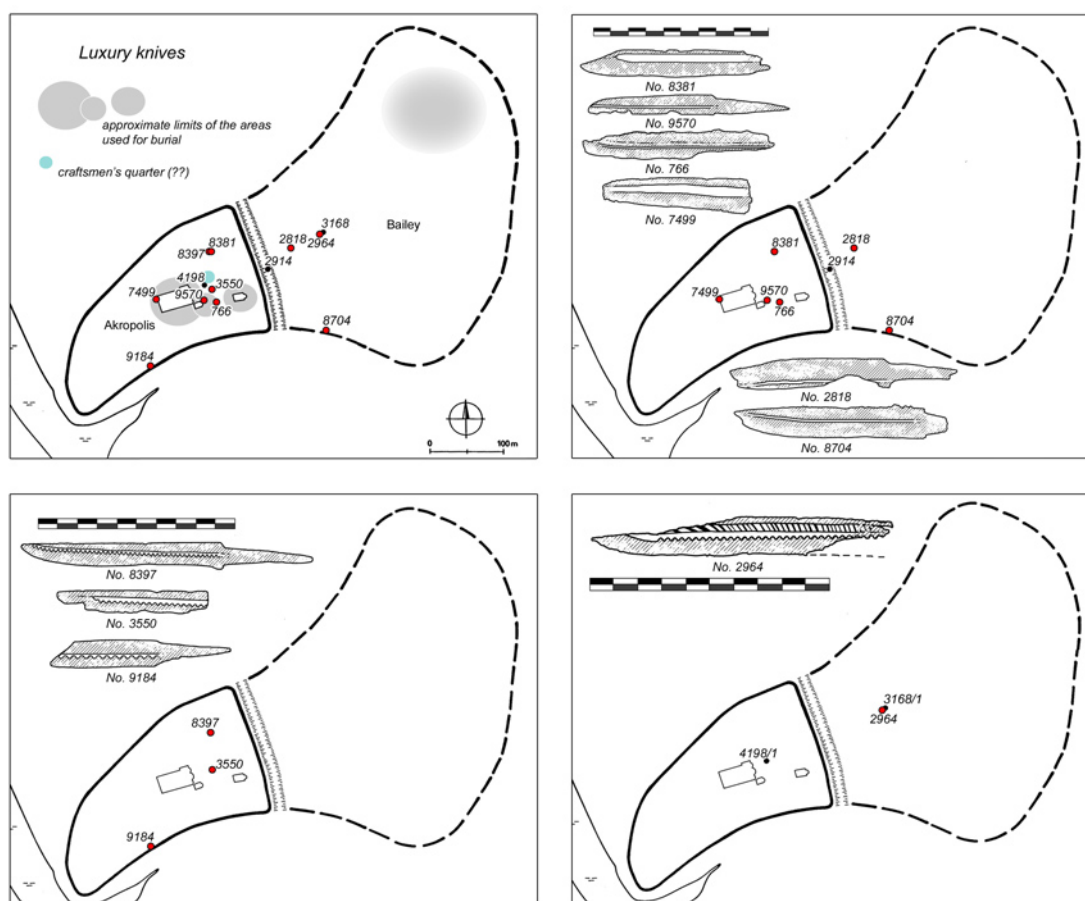


Fig. 4. Distribution of luxury knives. Red dots: knives from the second stage of examination; black dots: knives from the first stage of examination. Drawings by J. Hošek.



Fig. 5. Appearance of luxury knives in the course of the 10th to 13th centuries. Red dots: contemporary (or earlier) knives; black dots: earlier knives. Drawings by J. Hošek.