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CONTENT – OBSAH

EDITORIAL

If you follow the social media accounts of our journal or visit our website, you had a chance to read some of the papers even before this issue was released thanks to the August launch of an online publication process for new forthcoming papers. You may know this format as 'online first', 'in press' or 'first view'. New papers scheduled for publication will now be released in the Forthcoming section of our website. With this feature, we take another step towards more fluent and open dissemination of new research published in *Archeologické rozhledy*.

We live in a rushed world where yesterday's news is hopelessly old and attracts little interest. However, academic publishing lags behind this trend of instant information flow, and for good reason. If done properly, research cannot be hastened into the 'quick 'n' easy' emission of superficially-reviewed and barely-edited papers. Recently revealed cases of serious misconduct and corruption taking place even among journals in renowned indexes should be a warning to all of us. The production of a quality research paper simply requires time not only from the author but also on the journal's side.

You may indeed object that as a journal editor I am obviously biased. Nonetheless, on other occasions, I am also a paper author and I know the flip side of the coin very well. After you finally finish your paper, exhausted but rather proud of that piece of work, you have to wait, sometimes many months. At last, you receive the paper back but completely in stitches after having suffered heavy bombardment by reviewers' inquisitive comments. Even if you pass this test, your paper must withstand the harsh scalpel of editors who never omit the chance to change something. Meanwhile, the merciless grant deadline clock is ticking. Once (and if) you finally have your paper published, is not uncommon for an entire year to have passed since you had that feeling of certainty that your research was sound, complete, and ready to be published instantly.

The worst moment comes when a fresh reader of your paper approaches you with a detailed question regarding your newly published research because by then, you are usually working on a completely different topic and have already forgotten virtually everything about your previous paper. And yet, if that was the worst problem facing academia today, we would be a bunch of very happy people.

At *Archeologické rozhledy*, we work to decrease these waiting times as much as possible. According to the most recent figures, 80% of submissions passed from submission to final approval within 112 days, which I consider to be a good figure in the general context of archaeological journals. By introducing the Forthcoming section, we will be able to decrease the waiting time for a finished edited paper to reach the public.

Let's take a look at those who endured the rigorous process of peer-review scrutiny to be published in this issue. It starts with two papers dealing with early medieval warfare, each from a different perspective. Jiří Košta and his colleagues present a unique new find of a late Merovingian sword from Northeast Bohemia. Although retrieved from a situation that does not allow broader contextualisation within the late 7th and 8th century in Bohemia, the authors have done excellent work on metallographic analyses of the sword. I am sure that the paper will significantly contribute to the studies of early medieval weaponry and its production.

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In the following article by Joanna Witan and her colleagues, readers can learn more about the potential consequences produced by a sword or other weapons. During the excavation of a small rural cemetery dated between the 11th and 12th century in Dolany in Northwest Bohemia, a skeleton featuring numerous injuries was identified. Interweaving multiple pieces of evidence with detailed osteological analysis, the authors consider the individual not to be a victim of a mere skirmish but rather a more serious combat or even a battle. Above all, the study set an example for tracking personhood within early medieval society, when the rural population still largely lived outside the historical record.

With the following two papers, we change our perspective from an individual to a broader scope. Adéla Pokorná and colleagues examined the plant economy in the territory of the Czech Republic during the Bronze Age. The analysis involves data from 39 sites that the authors gathered through years of archaeobotanical research. The diachronic scope of the study makes it possible to identify the major shifts and trends of subsistence strategies in the 2nd and early 1st millennium BC. Therefore, I am certain it provides a good overview and will help to address potential research gaps in the future.

In her topical review, Danuta Żurkiewicz gathered comprehensive evidence of tempering with grog during the production of Neolithic stroke-ornamented pottery in the Polish Lowlands. While this phenomenon has remained out of the research spotlight, Żurkiewicz reveals grog temper to be a potential proxy for tracing the origin of some post-Linearbandkeramik communities in the area. Moreover, she discusses the roots of this practice, arguing for symbolic meaning rather than simply technical utility. New thoughts presented in this review will undoubtedly stimulate the future research agenda.

Václav Vondrovský

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

The sword from Vlčí Pole: A unique find of a late Merovingian weapon in Bohemia

Meč z Vlčího Pole: Unikátní nález pozdně merovejské zbraně v Čechách

Jiří Košta – Jiří Hošek – Filip Krásný – Radek Novák

Finds of early medieval Schlingen-type swords are mostly concentrated in present-day southern Germany, where they are known from a number of graves dating to the end of the late Merovingian period. On the contrary, these swords are completely absent in contexts of the early Carolingian and Great Moravian periods. This paper presents a new find of Schlingen-type sword from Vlčí Pole in the northeastern part of Central Bohemia and its archaeometric analysis. We consider the sword from Vlčí Pole to be the only unambiguous find of a fully preserved long-bladed weapon of the late 7th to 8th century in Bohemia. As it is one of the few late Merovingian swords to have been examined using X-ray computed tomography and metallography, it also contributes to a general understanding of phenomena such as the development of the use of pattern-welded marks and blades with cutting edges of hardened steel.

sword – Bohemia – late Merovingian period – metallography – pattern welding – pattern-welded marks

Nálezy raně středověkých mečů typu Schlingen se soustřeďují především v dnešním jižním Německu, kde jsou známy z řady hrobů z konce merovejského období. Naopak tyto meče zcela chybějí v kontextech časně karolinského a velkomoravského období. Příspěvek představuje nový nález meče typu Schlingen z katastru Vlčího Pole na severovýchodním okraji středních Čech a jeho archeometrickou analýzu. Meč z Vlčího Pole považujeme za jediný jednoznačný nález kompletně dochované zbraně s dlouhou čepelí z konce 7. až 8. století v Čechách. Vzhledem k tomu, že se jedná o jeden z mála pozdně merovejských mečů, který byl podroben rentgenové počítačové tomografii a metalografické analýze, přispívá také k obecnému poznání jevů, jako je vývoj používání damaskových značek a čepelí s břity z kalené oceli.

meč – Čechy – pozdně merovejské období – metalografie – svářkový damask – damaskové značky

Introduction

The paper presents a new find of a Schlingen-type sword from Vlčí Pole in the northeastern part of Central Bohemia. As this type of weapon is characteristic of the area of southern Germany at the end of the Merovingian period, the study focuses particularly on three main issues.

The first can be described as a regional contextualisation emphasising the uniqueness of the find in the Bohemian milieu. A major cultural breakthrough attributed to the arrival of the Slavs occurred in Bohemia in the 6th century. It is generally characterised by a relatively poor material culture and little evidence of social stratification. This notion is influenced by the absence of archaeologically recordable central sites and burial practices (a cremation with very poor grave goods or an undetectable burial rite). Significant progress in knowledge has been made recently from finds of exclusive metal artefacts coming

https://doi.org/10.35686/AR.2024.240

mainly from detector surveys. In the archaeological record, Bohemia of the late 7th to early 9th century is characterised by a gradual rise of the upper classes of society. These were influenced by the culture of the late Avar Khaganate and the European West, which was represented by the Frankish realm and political entities from the eastern periphery of the late Merovingian world. In finds, the upper classes are manifested almost exclusively in the male component, to which we attribute the status of mounted warriors.[1] However, finds of weapons and war gear from this period are rare in Bohemia. A greater amount of archaeological evidence of swords and other long-bladed weapons is available only from the beginning of rich inhumation burials in the 9th century (*Hošek et al. 2019*; *2021*). The oldest early medieval hillforts belong to this period and represent such an important phenomenon for several centuries that the time span between the second half of the 7th century and the turn of the 12th century is referred to as the Hillfort period in traditional Czech archaeological periodisation (*Eisner 1933*; *Bubeník 1994*). The most important hillforts, covering several dozen hectares, became supraregional centres with evidence of specialised production and the presence of mounted warriors (e.g. *Profantová et al. 2020*). The construction and maintenance of the hillforts, which did not come without a considerable labour force, led to an increase in the intensity of social interactions and required persons endowed with authority and extraordinary organisational skills.

The territory of Bohemia comes into regular view of Carolingian written sources after the end of the Avar Wars (specifically in 805 AD). Records from that time onwards continuously show that the inhabitants of Bohemia were perceived (and even perceived themselves) as a single entity (e.g. *Třeštík 1997*, 63–73). In the 9th century, the representation of the Bohemian tribe (*gens Bohemanorum*), the highest elite of Bohemia, consisted of a larger number of dukes (written sources mention up to 14 dukes acting together). The pillar of the tribal structures was the council, which is enshrined in Kosmas' rendering of the Přemyslid dynastic legend. Sources also indicate the existence of the institution of the chief duke, which was hereditarily held by the Přemyslid family from the 880s at the latest (summarised in *Třeštík 1997*; *Kalhous 2012*; *2018*). The baptism of Přemyslid Duke Bořivoj I (c. 883/4 AD), which marks the beginning of the continuous building of ecclesiastical structures, launched the next phase in the transformation of society (e.g. *Třeštík 1997*, 312–347). Christianity became one of the ideological instruments of the legitimacy of power. The means of Christianisation were controlled by the Přemyslid dukes, guaranteeing them a privileged position in communicating with the surrounding Christian powers and also becoming a tool for the definitive breaking of traditional tribal structures. The importance of the rise of the Přemyslid dynasty, which ruled Bohemia until 1306, is reflected in attempts to label the period between the end of the 7th century and the mid-9th century as the pre-Přemyslid period (e.g. *Hasil et al. 2020*).

The second issue examined in this paper concerns the unambiguous classification of the sword from Vlčí Pole; a comprehensive typological analysis has been carried out, including a discussion of the weapon in terms of Petersen's typology. The result is an important expansion of our knowledge of Schlingen-type swords.

[1] The most recent archaeological synthesis of Bohemia before the rise of the Přemyslid dynasty, based mainly on exclusive metal finds, is the subject of studies by *Hasil et al. 2020* and *Profantová – Hasil in print*.

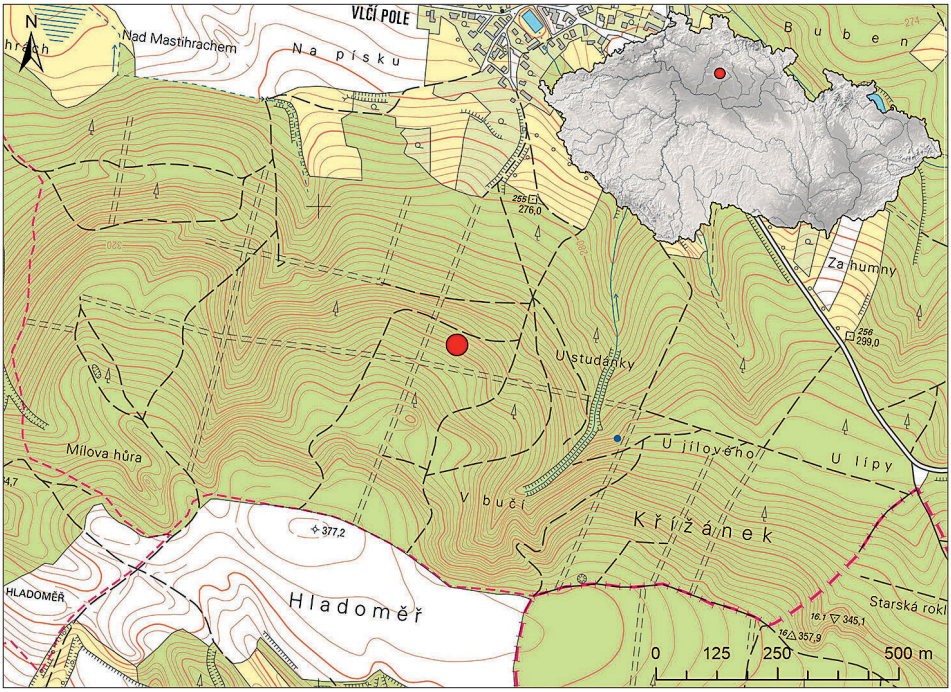


Fig. 1. Discovery site of the sword (©ČUZK, ZTM10; edited by R. Novák).

Last but not least, the paper deals with the importance of the documentation and technological assessment of swords and the contribution of the find from Vlčí Pole to an understanding of the development of swords in the Early Middle Ages. During the heyday of early medieval sword research in Germany, which took place in the last quarter of the 20th century (e.g. *Menghin 1983*; *Geibig 1991*; *Westphal 2002*), archaeometric methods were not as sophisticated as they are today, and some of the then ideas about weapon production are now outdated (c.f. *Stelzner 2016*; *Schreiner 2020*). The analysis therefore has important implications for the understanding of late Merovingian swords in terms of the construction and application of iron inlays.

Find context and analytic methods

Circumstances of the discovery and location of the find

The find was made on 15 August 2020 on land parcel no. 580/1 in the cadastre of Vlčí Pole (Mladá Boleslav district) in sloping wooded terrain at the ‘U Studánky’ site south of the village (*Fig. 1*). Here, the northeast-facing slope rises unevenly from the confluence of unnamed watercourses (258 MASL) feeding the Olšovský Pond near Vlčí Pole, to its highest point at Hladoměř Hill (377 MASL). The place of discovery is situated on a 20-degree slope bounded by a gentler slope above the contour line at 330 MASL and a similar slope

Fig. 2. Discovery site: a – terrain situation in the immediate vicinity of the find (photo by J. Skala); b – original position of the uncovered sword (photo by T. Kverek).

below the 320 m contour line, along which forest roads run (50.4086822N, 15.1340258E; 327 MASL).[2]

The finder, Tomáš Kverek, visually recognised an iron sword-blade point protruding from the forest floor while descending the steep slope. According to the clear tyre tracks, an off-road quad-bike had recently passed there several times, so the shallowly deposited sword (-0.1 m) was obviously deformed and partially uncovered. The finder later excavated the sword (*Fig. 2*), took it home and put it in a bath of water to prevent the corrosion products from drying out and disintegrating. He then contacted archaeologist Radek Novák from the Regional Museum and Gallery in Jičín, who took possession of the find and organised both a geodetic survey of the findspot and an archaeological field survey of the surround-

[2] The site was localised using the Trimble Catalyst device (RTK, subcentimetre).

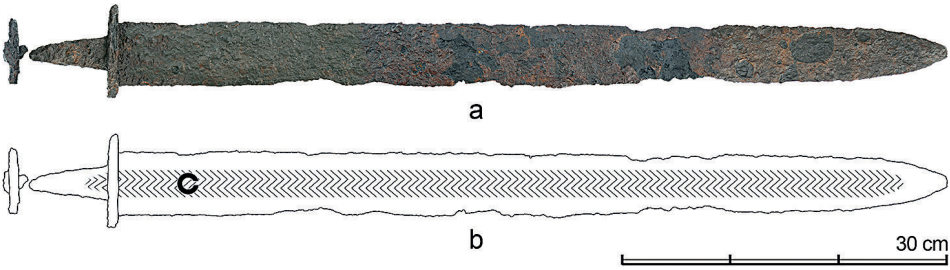


Fig. 3. Reconstruction of the original shape and appearance of the sword from Vlčí Pole (with a non-deformed blade): a – composition of a series of adapted photographs (photo by J. Košta, compiled by J. Hošek); b – schematic representation of the main components and decoration of the sword (drawing by J. Hošek).

ing area. However, no other archaeological finds related to the sword were discovered. The sword was later handed over to the territorially competent museum (the Museum of the Mladá Boleslav Region) and registered there under inv. no. MML-A-40000 (91/2020).

Methods

In order to obtain detailed information on the construction and decoration of the weapon, which is essential for its complete and reliable description and classification, the sword was subjected to radiographic and metallographic examination before standard archaeological documentation methods were applied. As the sword blade was deformed, we also decided to make a photographic and schematic reconstruction (see *Fig. 3*).

The radiographic examination included both standard X-ray imaging and a CT scan. The CT data was acquired using the LometomArc CT software and the Testima X-Test universal X-ray system (equipped with a 200 μm resolution detector) with a primary X-ray generator (set in the mode for a maximum voltage of 225 kV, maximum power of 800 W and focus of 0.4 mm) and a secondary X-ray generator (with maximum voltage of 120 kV, maximum power of 36 W and focus of 50 μm).

Metallography was carried out on a miniature sample of the cutting-edge tip, taken at a distance of 523 mm from the lower guard (*Fig. 4*). The sample was prepared according to standard procedures. It was examined in an unetched state to assess the purity of the metal and after etching with 3% Nital and Beraha I reagent to determine the nature and distribution of the micro-constituents. Metal purity (slag content) was determined (in the tradition of the laboratory of the Institute of Archaeology in Prague) according to the Jernkontoret standard and grain size using the ASTM E112 standard. Microhardness testing was omitted due to the small dimensions of the sample.

Description of the sword

The sword was preserved deformed but almost complete (*Fig. 3*; *Fig. 5*: a). The upper hilt is broken off and a part of the tang is missing, as is a very small part of the point of the blade (less than 5 mm). The blade was bent in two places, first slightly, about 17 cm below the lower guard, and then significantly, 20 cm before the point. These large deformations

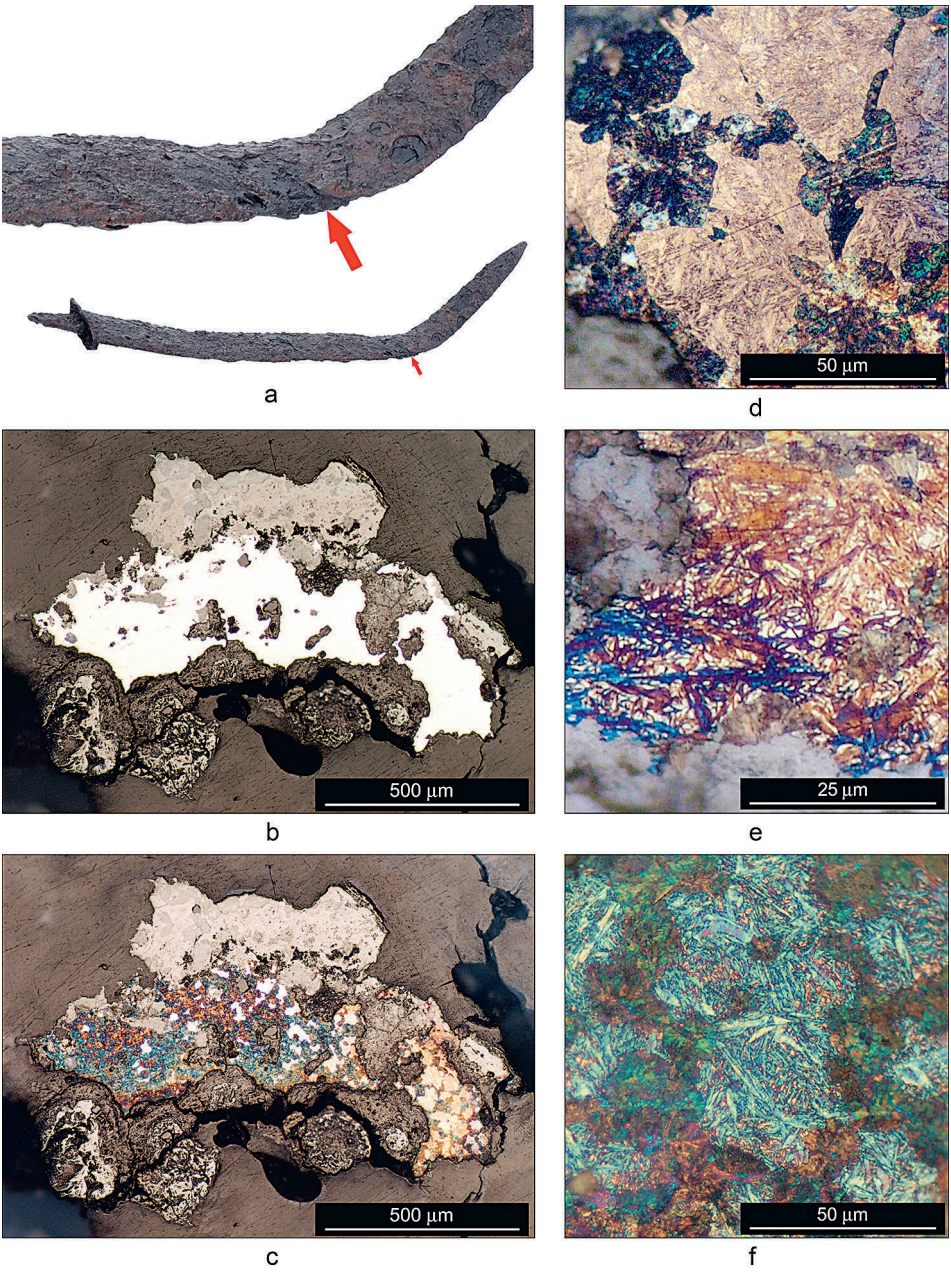


Fig. 4. Metallographic examination of the sword: a – marked place of sampling; b – the examined sample in unetched state; c – the sample etched with Nital; d – microstructure of fine (or even irresolvable) pearlite and martensite; e – detail of the martensitic structure; f – pearlite and martensite; etched with Nital (c–e) and Beraha I (f) (photo by J. Hošek).

Fig. 5. Details of the sword: a – deformed blade; b – upper hilt; c – lower guard and the tang (photo by T. Janek and J. Košta).

occurred after the blade had corroded, so they can be considered the result of recent damage to the sword. The preserved length of the sword is 844 mm, with the original length in the range of 860–870 mm. The surviving parts of the weapon weigh 1009 g. The point of balance could not be precisely measured, but it had to be situated at a greater distance from the guard (about 250 mm). This corresponds to the robust blade and a small upper hilt. The dominant component of the upper hilt is a low and in horizontal view lenticular upper guard that is 60 mm long, 21 mm wide, and 8 mm high (*Fig. 5*: b; *Fig. 6*). There are some indications that its sidewall had a roof-like ridge running along the entire circumference. A small pommel trapezoidal in front view, rectangular in horizontal view, 20 mm long, 13.5 mm wide, and 6 mm high, is attached from above, bringing the total height of the upper hilt to 14 mm. The third individual component of the hilt is the lower guard

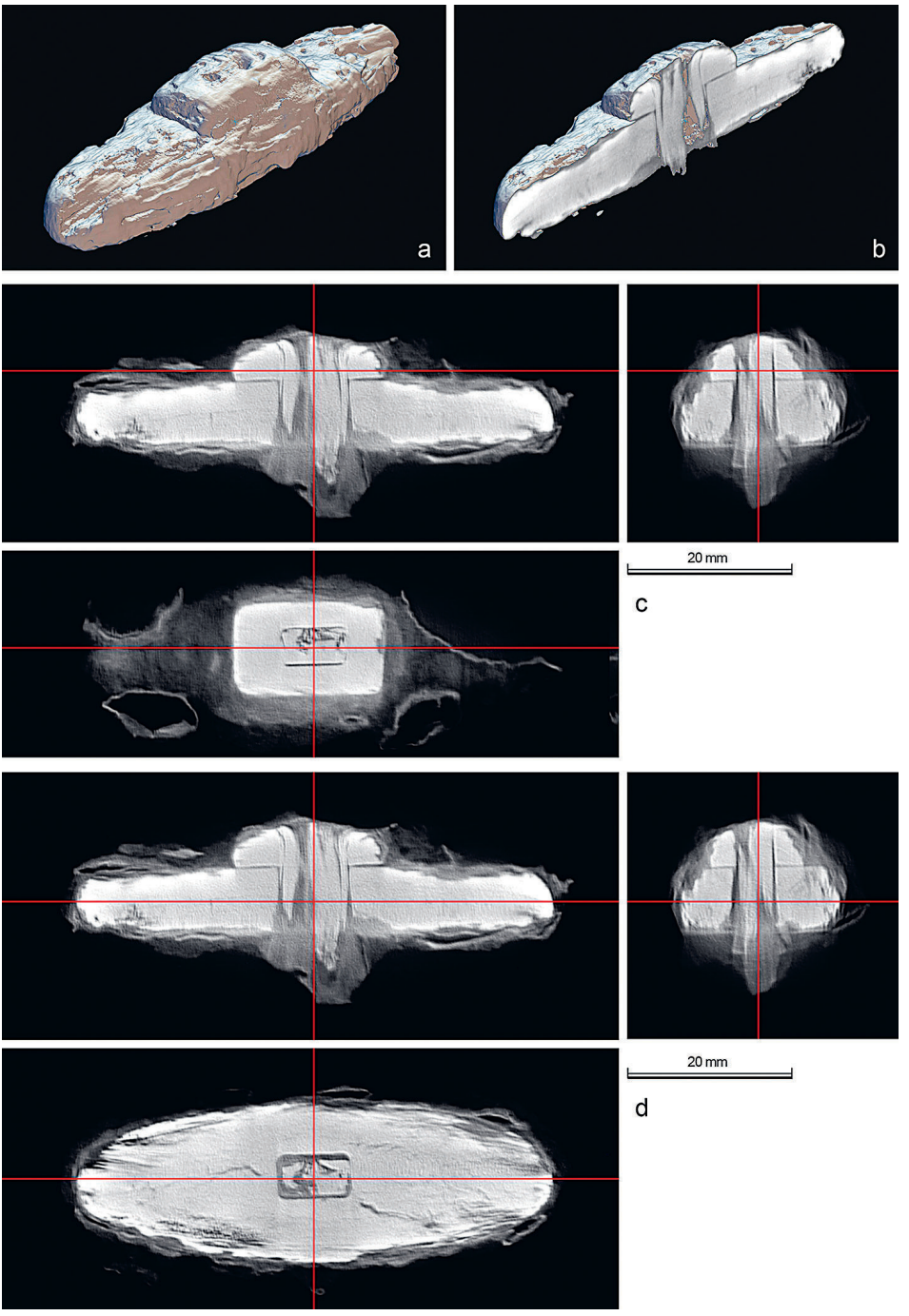


Fig. 6. X-ray CT sections of the upper hilt: a – three-dimensional X-ray CT image; b – longitudinal cross-section of the three-dimensional X-ray CT image; c – sections of the pommel; d – sections of the upper guard (by J. Hošek).

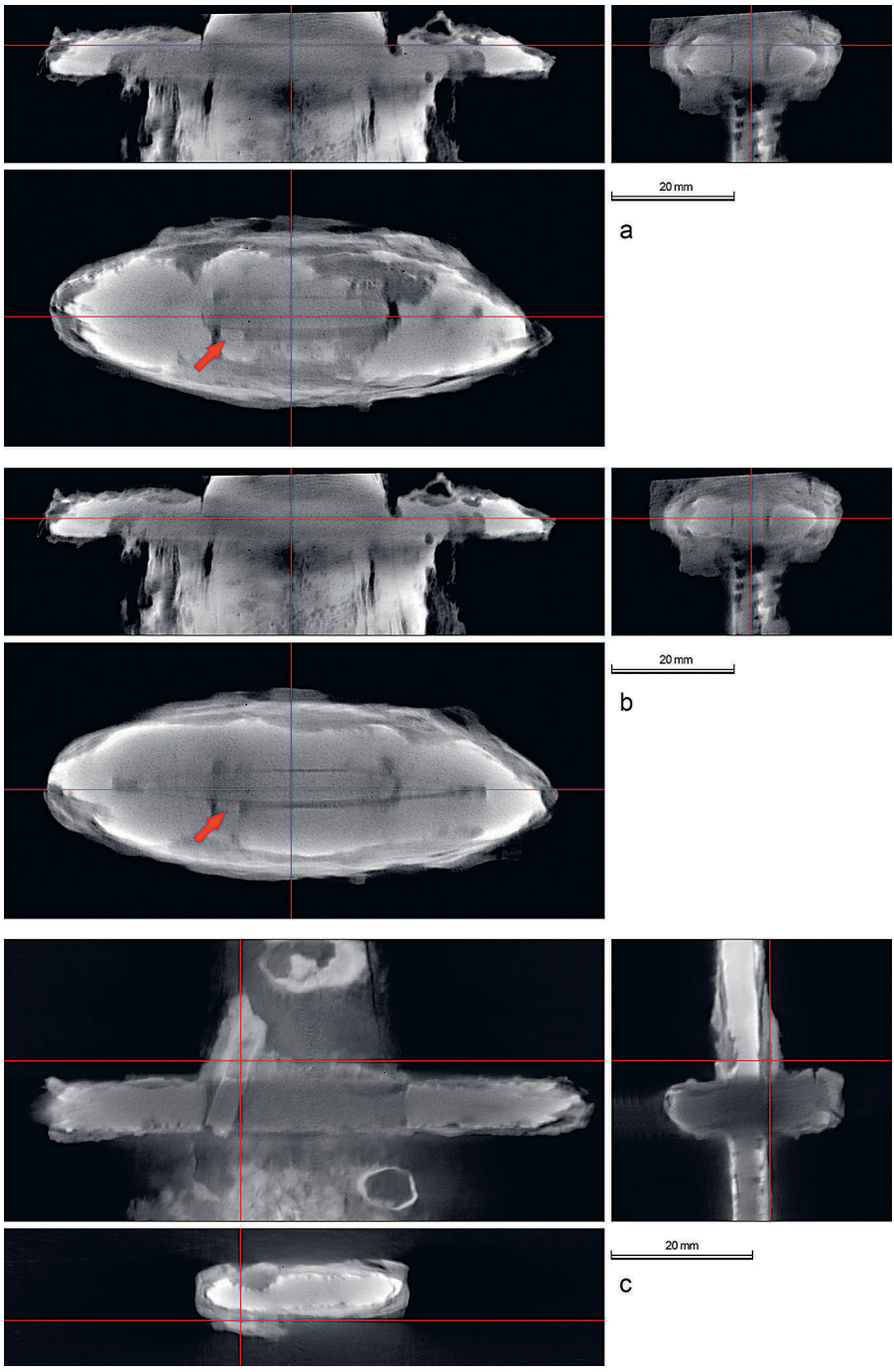


Fig. 7. X-ray CT sections of the lower guard: a – form and size of the opening for the tang; b – form and size of the opening for the blade shoulders; c – detail of a tiny iron prismatic rod fixing the guard in a stable position. The red arrow shows the position of the prismatic rod in the lower guard (by J. Hošek).

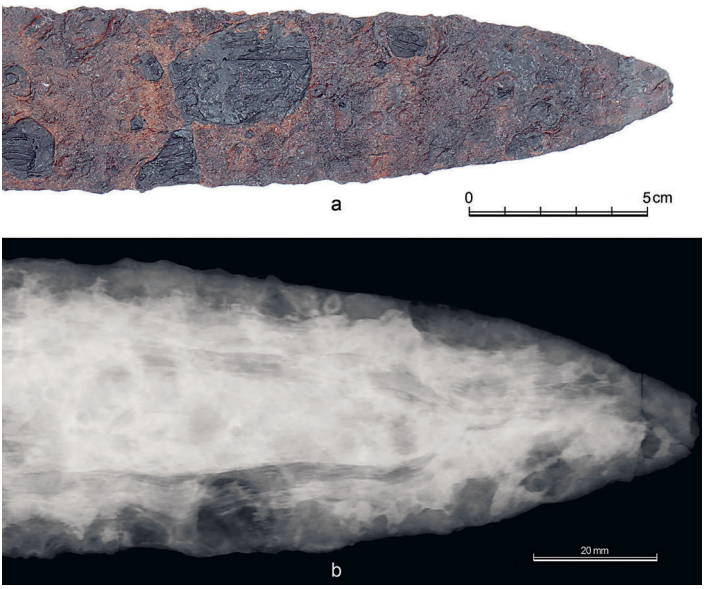


Fig. 8. Photo (a) and X-ray image (b) of the blade point (photo by T. Janek, X-ray image by J. Hošek).

(*Fig. 5*: c, *Fig. 7*), which, like the upper guard, has a long lenticular shape when viewed horizontally. It is 86 mm long and 9 to 10.5 mm high. One of the sides is damaged, so its current width does not correspond to the original state; we should therefore add about 5 mm to the preserved width of 26.5 mm. A tang with a rectangular cross-section passed through rectangular openings in the lower and upper guard as well as the pommel, on the top of which the tang-end was peened (*Fig. 6*). The tang was quite wide (7 to 9 mm) and narrowed considerably towards the upper hilt (from 31 mm to 12.5 mm). While the tang fits perfectly into the opening of the upper hilt, the opening of the lower guard, broadened in step-like fashion, did not precisely match the thickness of the tang or the blade. Therefore, the lower guard was held in a stable position by a tiny iron prismatic rod inserted into the hole from the side of the tang and partially protruding into the gripping part of the hilt (*Fig. 7*). The shape of the grip, delimited by its organic covers, is evidenced by an oval-shaped imprint preserved on the lower guard at a distance of 4 mm from the longer and 2.5 mm from the shorter side of the tang (*Fig. 5*: c). There is a distinct ridge on both shorter sides of the tang documented 1.5 mm below the upper guard, which was probably related to guard fixation (*Fig. 5*: b).

The blade is robust, 765 mm long, and for most of its length of the same width (*Fig. 3*). Up to 400 mm from the lower guard, it is roughly 59 mm wide and at the beginning of the pointed part, it is still 50 mm wide. In the last 100 mm, the blade ends with a significant parabolic taper resulting in a distinct point (see *Fig. 8*). The thickness of the blade decreases continuously from 7.5 mm under the lower guard to 4.5 mm at the pointed part. In cross-section, the blade has an approximately hexagonal shape formed by cutting edges welded onto a prismatic central part. The fuller is practically imperceptible; only in a section 200 mm before the point; traces of a very shallow depression can be observed in the central part of the blade. The middle of the tang is also slightly reduced in thickness in the area above the lower guard. Although remains of pattern-welded decoration can be seen

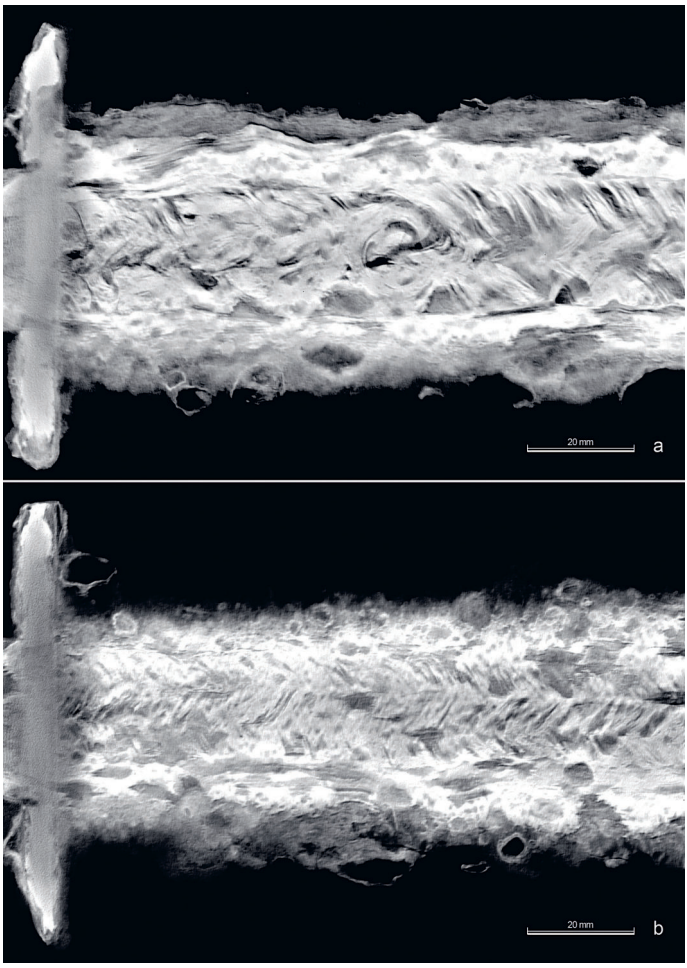


Fig. 9. X-ray CT sections of the blade below the lower guard showing the 'ZSZ' motif of pattern-welding (a, b) and a circular symbol/mark on its front side (a) (by J. Hošek).

in places with the naked eye, the overall reconstruction of its original appearance was only possible thanks to the X-ray CT examination (*Fig. 3*: b), which revealed pattern-welded surface panels with a plain core in between, welded-on cutting edges, and a composite iron inlay.

Each of the pattern-welded panels consists of three rods twisted in the ZSZ pattern. The surface pattern welding was 20 to 24 mm wide and was not set regularly in relation to the longitudinal axis of the blade. The width of the individual twisted rods was also not uniform but varied between 6 and 8.5 mm. In the lower part of the blade the patterning ends 45 mm before the point (*Fig. 8*: b), while in the upper part, the patterned panels continue into the tang.

One side of the blade was provided with a simple symbol (mark), which was located 54 mm below the lower guard. The sign consisting of a 3- to 5-mm-wide, untwisted, pattern-welded bar in the form of a slightly irregular circle that opens towards the point (external dimensions 17.5 × 19 mm; see *Fig. 9* and *Fig. 15*).

As the metallography shows, the edges were (at least in the place of sampling) made of high-carbon steel and were hardened by quenching. Both the preserved matrix and the corrosion products contain single-phase inclusions of medium size. The metal purity corresponds approximately to level 2 on the Jernkontoret scale (good purity). Etching with Nital and Beraha revealed a mixture of martensite (accompanied by some bainite) and very fine (or even irresolvable) pearlite (see *Fig. 4*: c–f).

Typological classification and dating

The weapon from Vlčí Pole is similar to two types of early medieval swords that differ both in the area of their occurrence and in their dating. These are the Schlingen type defined by *Stein* (*1967*, 9) on the basis of finds from the end of the Merovingian period in present-day southern Germany, and the Petersen type F (*Petersen 1919*, 80–84) defined on the basis of Norwegian finds from the early Viking period. Since the dating of the sword from Vlčí Pole cannot be based on its find context, let us examine the two groups of representatives of these types in more detail.

Petersen type F swords

According to *Petersen* (*1919*, 80–84), type F swords are characterised by undecorated hilts with a low solid pommel that is quadrangular in front view (usually rectangular, but in rare cases with bevelled or rounded ends). The lower and upper guards are usually rectangular in horizontal view with distinctly convex walls, or they are narrowly oval. Petersen suggested that some examples of type F swords may have been created by modifying the damaged two-part upper hilts of other types. He included 18 swords in this group, ten of which had a single-edged blade and only seven a double-edged blade. Neither marks nor surface pattern welding were identified on the blades; however, most of the blades have been examined macroscopically, only a few by X-radiography so far. Unfortunately, Petersen's study does not include a complete list of type F swords known to him. As a result, we can only identify a few of the swords he used to define this type. Those that we have been able to review, mainly through the database of archaeological finds from Norwegian museums (*Unimusportalen database*), show a relatively large variability in the shape of the hilt components – there are significant differences in the shape of both the pommels and the guards, as well as in the length and robustness of the guards (for examples, see *Fig. 10*: a–e). In his master's thesis on Viking Age swords from eastern Norway, *Hernæs* (*1985*) mentioned that the number of type F swords increased twofold between 1919, when Petersen's study was published, and 1980 (from 12 to 24, of which he localised 18). It was an average increase compared to other types of swords that were the subject of theses. In any case, we can conclude that type F swords are represented very sporadically among the thousands of swords from Viking Norway.

Outside of Norway, type F has very rarely been attributed to Viking Age swords (*Fig. 11*). In all of these cases, their classification is questionable or blatantly inaccurate. For example, a sword from Eura-Kauttua (Finland) provided with a low circular-segment shaped pommel with a hint of triangular profiling (*Fig. 10*: f; *Kivikoski 1973*, 112, Cat. N. 830) ranks among the early Carolingian weapons that best correspond to Geibig's type 1

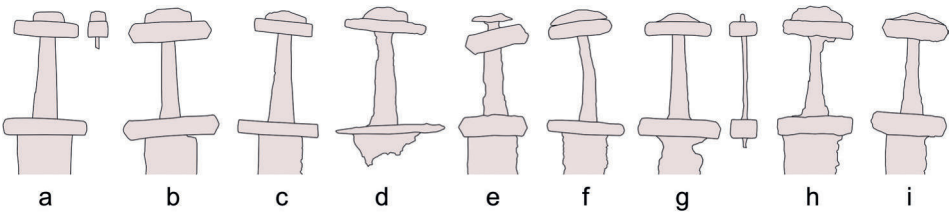
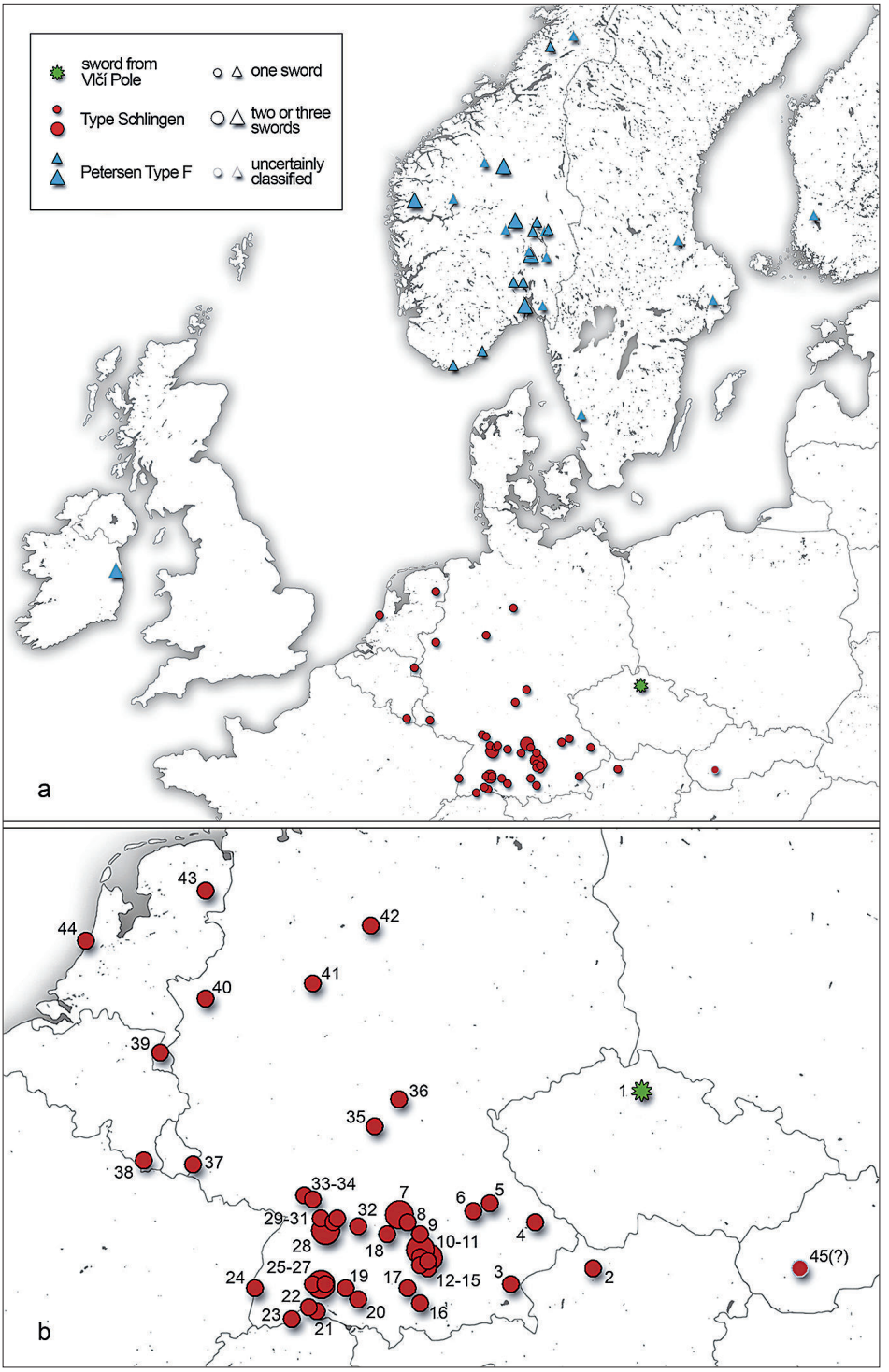


Fig. 10. Examples of Petersen Type F hilts: a – Haberstad, Eisvoll, Akershus, Norway (*Petersen 1919*, Fig. 67); b – Hammer, Grong, Nord-Trondelag, Norway (*Petersen 1919*, Fig. 68); c – Bagn Søndre, Sør-Aurdal, Norway (UNIMUS); d – Vestre Framstad, Gran, Norway; e – Sande, Sogn og Fjordane, Norway (*Norgård-Jørgensen 1999*, Taf. 39); f – Eura-Kauttua, Finland (*Kivikoski 1973*, 112, Cat. N. 830); g – Solna-Ulriksdal, Uppland, Sweden (*Androshchuk 2014*, Pl. 32); h – Kilmainham (D360), Ireland (*Harrison – Ó Floin 2014*, Fig. III.36); i – Kilmainham (D361), Ireland (*Harrison – Ó Floin 2014*, Fig. III.36) (not in scale, drawing by J. Hošek).

(Petersen's type B). Androshchuk registered three specimens of type F swords from the territory of Sweden. The first, a find from Solna-Ulriksdal in Uppland (*Androshchuk 2014*, 55, 436, Pl. 32), has an upper hilt of an atypical construction with the broad peened end of the tang used instead of a pommel to fix the upper guard (*Fig. 10*: g). According to Petersen's scheme, it would be classified rather as a special variant of type M with a low prismatic one-part upper hilt. Similarly, a single-edged sword from Ovansjö – Norrbergs-by in Gästrikland fits the description of the type M (*Androshchuk 2014*, 344–345). The third Swedish specimen, probably of Halland province, was known to Androshchuk only from a brief mention without a description (*Androshchuk 2014*, 352). Finally, two finds of single-edged swords classified as type F come from the Dublin-Kilmainham burial ground in Ireland (*Harrison – Ó Floinn 2014*, 81–82). Buried in the 9th century, these weapons are equipped with short and massive guards and with low pommels, one semi-round and the other triangular in front view. As such, these are also not typical examples of type F swords. Although among the weapons found outside Norway they are the closest to some specimens mentioned by Petersen, their hilts were probably made as imitations of early Carolingian swords (*Fig. 10*: h, i).

Since the introduction of Petersen's typology in 1919, type F swords have not been systematically studied. We are missing information on new finds with well-documented find contexts, and consequently we lack sufficient data to assess the chronology of this type. Still based on Petersen's traditional dating, type F is dated to the first half of the 9th century, i.e. to the beginning of the Viking Age. When Petersen attempted to date the type, he had virtually no swords at his disposal that could be clearly dated based on their archaeological context (by associated grave goods, etc.). The only assemblage that meets these standards comes from a grave in Sande in Sogn og Fjordane (*Fig. 10*: e) and within the evaluation of Scandinavian early medieval graves with weapons it was dated to the beginning of *Nordische Stufe V*, i.e. around the middle of the 8th century (*Norgård-Jørgensen 1999*, 150, 227, Abb. 115, Taf. 39:1). In several cases, type F swords were part of heterogeneous assemblages consisting of finds gathered from a single site (several disturbed graves with artefacts dating to periods either before or after the early Viking Age).

The Petersen type F thus seems to include a wide variety of swords, some of which are probably repairs of Carolingian hilts, and some of which can be imperfect local imitations of more luxurious weapons. Single-edged blades fitted with hilts with metal components


sword from Vlčí Pole
Type Schlingen
Petersen Type F
one sword
two or three swords
uncertainly classified
a
b
1
2
3
4
5
6
7
8
9
10-11
12-15
16
17
18
19
20
21
22
23
24
25-27
28
29-31
32
33-34
35
36
37
38
39
40
41
42
43
44
45(?)

imitating the hilts of double-edged swords (*spathae*) are typical for local production in the Norwegian milieu of the early Viking Age. The occurrence of type F swords remains virtually limited to the territory of Norway, and even there they were rare. Without a detailed revision of the Norwegian finds, it is not even possible to decide whether the type F can be regarded as an intentionally produced group of artefacts, or whether it is a group of randomly sorted swords of comparable shape originating from a broader chronological range.

Schlingen-type swords

Schlingen-type swords (*Stein 1967*, 9) have a low two-part upper hilt, with the pommel considerably shorter and narrower than the upper guard. In horizontal view, the pommel is usually rectangular, with the longer sides sometimes slightly convex (*Fig. 12*). When viewed from the front, the shape varies from rectangular to trapezoidal up to a low circular segment (the given details of the pommel shape are influenced by the state of preservation as well as the method of conservation and documentation). The lower and upper guards are relatively low and in horizontal view usually have a lenticular or sometimes long oval shape. Both parts of the upper hilt are attached directly to the tang. The hilts are almost exclusively undecorated; Stein mentioned only several exceptions: a sword from Rechberghausen (Baden-Württemberg) with bronze plating (*Stein 1967*, 286, Taf. 35: 2) and a sword from Marchtrenk (Upper Austria). The guards of this sword were equipped at their ends with rivets (generally unusual for Schlingen-type swords) whose heads were decorated with rings of a beaded wire (*Fig. 12*: e; *Stein 1967*, 374, Taf. 14 :1; *Hausmair 2006*, 48–56, Abb. 15, Taf. 8: 1). Stein also classified a find from Kreuzhof in Bavaria as a Schlingen-type sword; the bronze pommel in the shape of a low circular segment was decorated with embossed circles (*Fig. 12*: d; *Stein 1967*, 235, Taf. 13: 1). To date, this is the only known example of a sword assigned to the Schlingen type with a hilt component

Fig. 11. Spatial distribution of finds of both Petersen type F and Schlingen-type swords (a) and Schlingen-type swords (b): 1 – Vlčí Pole, Mladá Boleslav; 2 – Marchtrenk, Wels, grave 7 (*Hausmair 2006*); 3 – Trotsberg-Mögling, Traunstein; 4 – Schwarzach, Deggendorf, grave; 5 – Barbing-Kreuzhof, Regensburg, grave; 6 – Kelheim; 7 – Kirchheim am Ries, graves 298 and 324 (*Neuffer-Müller 1983*); 8 – Kleinsorheim, Nördlingen, grave; 9 – Mertingen, grave (*Trier 2002*); 10 – Gablingen, graves 67 and 69a (*Trier 2002*); 11 – Friedberg (Bayern), graves 3 and 16 (*Trier 2002*; *Sauer 2019*); 12 – Augsburg-Göggingen, grave 28 (*Trier 2002*); 13 – Bobingen, grave (*Trier 2002*); 14 – Kissing, grave (*Trier 2002*); 15 – Steindorf, Fürstenfeldbruck, grave '1961' (*Trier 2002*); 16 – Burggen, Schongau, grave; 17 – Schlingen, Kaufbeuren, grave B2; 18 – Giengen an der Brenz, grave 11 (*Paulsen – Schach-Dörges 1978*; *Sauer 2019*); 19 – Ostrach, Sigmaringen; 20 – Weingarten, grave 612 (*Roth – Theune 1995*); 21 – Öhningen, Konstanz, grave 13; 22 – Dornflingen, Schaffhausen; 23 – Lienheim, Waldshut, grave 16; 24 – Munzingen, Freiburg im Breisgau, grave 214 (*Groove 2001*); 25 – Fridingen an der Donau, graves 115 and 265 (*Schnurbein 1987*); 26 – Wurmlingen, Tuttlingen, grave; 27 – Buchheim, Stockach, burial mound; 28 – Sindelfingen, graves (*Ade 2010*); 29 – Weissach, Leonberg, grave 1; 30 – Stuttgart-Feuerbach, grave; 31 – Öffingen, Waiblingen, grave; 32 – Rechberghausen, Göppingen, grave; 33 – Heidelsheim, Bruchsal, grave; 34 – Oberderdingen-Strümpfeläcker, grave 71 (*Banghard 2009*); 35 – Reuchelheim, Karlstadt, grave; 36 – Bad Königshofen, Grabfeld, grave; 37 – Oberleuken, Merzig-Wadern; 38 – Virton (surroundings); 39 – Valkenburg, Limburg, grave 1 (*van Tongeren 2021*); 40 – Walsum, Dinslaken, graves 35 and 38 (*Stampfuß 1939*); 41 – Paderborn-Kiesgrube Siering, water find (*Westphal 2002*); 42 – Anderten, Burgdorf, grave (*Westphal 2002*); 43 – Zweeloo, Drenthe, grave 47 (*van Tongeren 2021*); 44 – Katwijk-Binnen, Zuid Holland, grave 30; 45 – Nitra, grave (*Štefanovičová 2005*, 256, Abb. 2; *Jócsik 2024*). Unless a reference to the source is given, the sword was included in the catalogue in the study by *Stein* (*1967*, 410, Taf. 101) (edited by J. Hošek and J. Košta).

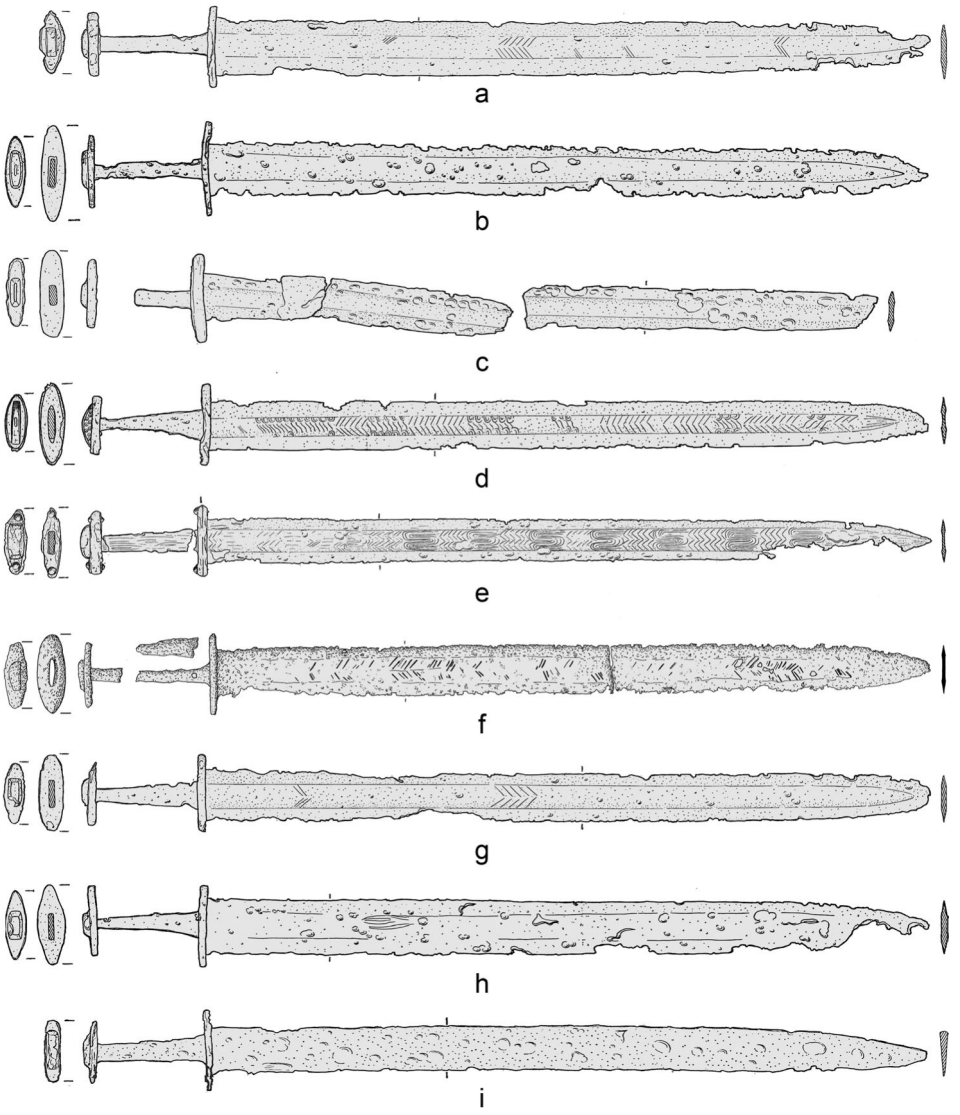


Fig. 12. Examples of Schlingen-type swords: a – Göggingen (*Stein 1967*, Tafel 10: 1); b – Heidelsheim (*Stein 1967*, Tafel 30: 1); c – Konigshofen (*Stein 1967*, Tafel 12: 1); d – Kreuzhof (*Stein 1967*, Tafel 13: 1); e – Marchtrenk (*Stein 1967*, Tafel 14: 1); f – Munzingen 214; g – Reuchelheim (*Stein 1967*, Tafel 19: 29); h – Stuttgart-Feuerbach (*Stein 1967*, Tafel 37:12); i – Finning-Westerschondorf (*Stein 1967*, Tafel 23: 10) (not to scale).

made of non-ferrous metal. The character of the blades corresponds to the Merovingian period *spathae* – the cutting edges run parallel, the fullers are shallow and wide (sometimes almost indistinct), and it is often possible to see surface pattern-welding consisting of various compositions of twisted or alternately twisted and untwisted panels (*Fig. 12*: a–h). Occasionally, the hilt of the Schlingen type was also applied to single-edged blades (e.g. the find from Finning-Westerschondorf, Bayern; see *Fig. 12*: i).

To date, finds of Schlingen-type swords have been systematically studied only by Stein, who also defined the type (*Stein 1967*, 9, 23–26, 104–110, 410, Taf. 101). We succeeded in identifying later examples particularly in southwest Germany, where the number of finds has more than doubled since the 1960s (e.g. *Neuffer-Müller 1983*; *Schnurbein 1987*; *Trier 2002*; *Ade 2010*; *Sauer 2019*). However, the overall distribution of Schlingen-type swords has not changed much since the definition of the type. Most of the swords were found in a distinct west-east strip of land stretching north of the Alps from the upper reaches of the Rhine to Upper Austria (*Fig. 11*). This roughly corresponds to the historical duchies of Alamannia and Bavaria. Towards the north, they usually do not appear beyond the valley of the lower Neckar and the ridge of the Franconian Jura; east of Regensburg, the Danube formed their northern boundary. The exceptions are two grave finds from the central Main basin: Reuchelheim (*Fig. 12*: g) and the more easterly situated Bad Königshofen near Schweinfurt that almost touches the border of Lower Franconia with Thuringia (*Stein 1967*, 234, 245, Taf. 12: 1, 19: 29). Schlingen-type swords are rarely documented in areas west of the middle course of the Rhine. Several finds are also known from northwestern Germany (Lower Rhineland and Westphalia) and the Netherlands (e.g. *Westphal 2002*; *van Tongeren 2021*; see *Fig. 11*).

The vast majority of Schlingen-type swords come from graves, often along with other grave goods, which improves the possibilities of dating based on the archaeological context. They belong to the very end of the Merovingian period, late Merovingian phase III (JM III; see *Ament 1976*; *1977*). Stein correctly distinguished that they represent the earliest type of late Merovingian swords with guards of solid iron, which appeared during the last third of the 7th century. They replaced swords with layered guards (i.e. consisting of layers of different materials; see *Menghin 1983*, 135–137). Swords of the Schlingen type became typical representatives of Stein's combination group A, defined mainly on the basis of war gear, especially the characteristic types of spears and shield bosses, which she dated between 680 and 710/20 AD (*Stein 1967*, 23–26, 104–110). Further research, based on the study of a much larger number of archaeological assemblages, has supported the dating of the Schlingen-type swords to the end of the Merovingian period. It has also made it possible to systematically examine their relationship to groups of other artefacts and features (belt sets, types of decoration, spurs, etc.).

The advent of the Schlingen type is associated with belt fittings decorated with honeycomb-patterned inlays or low variants of Walsum- and Göggingen-type shield bosses (summarised in *Brendle 2017*, 234–284; *Sauer 2019*, 138, 155–166, Beil. 4). It turns out that although the greatest development of the discussed swords dates back to the last quarter of the 7th century and the very beginning of the 8th century, they remained in circulation even in later times, when they were combined, for instance, with high-shaped shield bosses or wide chapes with pointed ends. The latter can be seen, for example, on the sword from grave 28 in Göggingen, which is similar in shape to the weapon from Vlčí Pole (*Fig. 12*: a; *Trier 2002*, 338–339). It is not certain whether swords of the Schlingen type disappeared completely before the end of the late Merovingian period, which essentially corresponds to the end of burials with weapons in most of southern Germany, but it seems that they were already in decline for most of the first half of the 8th century. Their remission before the middle of the 8th century is indicated by the fact that they do not occur along with objects typical of the early Carolingian period (e.g. artefacts decorated in the Tassilo Chalice style). In contrast to other swords of the end of the Merovingian period – the Niederram-

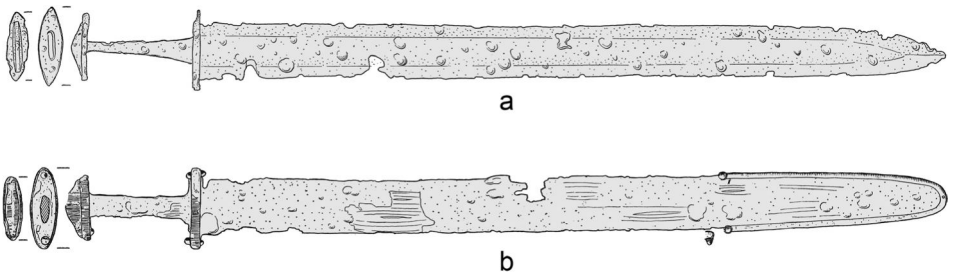


Fig. 13. Examples of swords of other types contemporary with the Schlingen type: a – Niederamstadt-Dettingen-Schwabmühlhausen-type sword from Wurmlingen (*Stein 1967*, Tafel 40:20); b – Haldenegg-type sword from Haldenegg (*Stein 1967*, Tafel 29: 18) (not to scale).

stadt-Dettingen-Schwabmühlhausen type with a low triangular pommel (*Fig. 13*: a) and the Haldenegg type with a low three-lobed pommel (*Fig. 13*: b) – the Schlingen type was not followed by the early Carolingian swords, whose origin is sought in the second third of the 8th century (*Stein 1967*, 9–11; *Menghin 1980*, 252–270, Abb. 26; *Geibig 1991*).

The predominant burial context of Schlingen-type swords raises the question of whether the distribution of the archaeological finds (*Fig. 11*) truly reflects their distribution in the past. In the core of the Merovingian realm, which extended over the areas west of the Rhine as well as in present-day France and Italy, it was no longer customary to bury weapons and war gear in graves at the time Schlingen-type swords were used. The burial rites in the Slavic regions, which were located northeast of the core area of Schlingen-type swords, also did not allow for the preservation of weapons. In the Netherlands and northwestern Germany, weapons were buried as grave goods in the late 7th and early 8th centuries, but double-edged swords (*spathae*) were almost completely absent (e.g., *Kleemann 2002*; *Westphal 2002*).

The only verifiable limit to their occurrence is to the east, towards the Avar cultural sphere, where long-bladed weapons made in the Avar tradition were widely used, while double-edged swords were rare. Worth mentioning is the late Merovingian spatha of the Niederramstadt-Dettingen-Schwabmühlhausen type found at the Avar-period burial ground of Želovce in Slovakia (*Čilinská 1973*, 23–24, 57, 199, Tab. XXII; *Hošek – Haramza 2018*). Another interesting find from the area east of Bohemia is a sword found, along with other late Merovingian finds, at a burial ground in the centre of Nitra, Slovakia. Unfortunately, a simple sketch is the only documentation of this (now probably lost) find. It suggests a hilt construction similar to the Schlingen type or its imitation, and a relatively short, probably single-edged(?) blade. Therefore, it is not possible to classify it with certainty (*Štefanovičová 2005*, 256, Abb. 2; *Jócsik 2024*). We also do not know of any Schlingen-type swords from Thuringia, although 8th-century swords with triangular pommels have been documented there (*Timpel – Spazier 2014*).

All in all, it can be summarised that the distribution of Schlingen-type swords may have originally extended beyond the area of their archaeological record, at least to the west, and that these swords may have been typical for the entire Frankish cultural sphere. Considering the specimen from Vlčí Pole, their occurrence near Bohemia is important, whether along the Upper Danube in the Principality of Bavaria or near the middle Main, through which an important route led to the Ohře River basin.

We consider the sword from Vlčí Pole to be a typical representative of Schlingen-type swords. In addition to the main features, it is similar to swords of this type in a number of details, which include the shape and low height of components of the hilt, the very small dimensions of the pommel compared to the size of the upper guard, the shape of the blade with parallel cutting edges, and the use of surface pattern-welding. Besides the formal features, this determination is also supported by the small distance between Bohemia and the core area of Schlingen-type swords (see *Fig. 11*).

Decoration and construction of the blade

A detailed X-ray CT examination of the sword revealed that the blade has cutting edges welded onto a central part consisting of a plain core to which three-row pattern-welded panels (with rods twisted in the ZSZ scheme) were attached from either side (*Fig. 3*: b; *Fig. 9*). The blade can therefore be classified as the E-C3$(PW3)_{III}$ construction type as defined by *Hošek et al.* (*2021*, 16–18). The construction of the blade, with the cutting edges welded onto a middle portion, corresponds to the long-standing traditions of bladesmithing. Pattern-welded blades also enjoyed long-term popularity, but the time of the appearance of Schlingen-type swords was a turning point, after which this popularity began to wane. It is also a period in which we can still see a continuation of the long-term trend towards the less frequent use of pattern-welded blades with a non-pattern-welded core between the cutting edges (i.e. E-C3(PW3) blades according *Hošek et al. 2021*, 28–33). It seems that about a third of the patterned blades of the time had such a core, but then their popularity began to increase significantly. Non-patterned blades were then generally in the minority, but their actual proportion may have varied from place to place. For example, their incidence was relatively higher in the southern part of Germany compared to the northern part (*Westphal 2002*, 165–167, 268). The majority of such blades that may have been in circulation at the same time as the Schlingen swords were either of the type with cutting edges welded to a plain core, or were made from a single piece of metal. Unfortunately, in most cases it is difficult to reliably distinguish between the two constructions, when they were assessed only by X-ray CT (see *Stelzner 2016*, 107–109, 204–206).

Hardening of at least one of the cutting edges by quenching was evidenced by transverse cracks (see *Fig. 14*) documented by X-radiography in the place of the more significant bend of the blade. This was subsequently confirmed by metallography. No other cracks were observed in the softer material of the core or the other cutting edge in the bent section.

Metallography confirmed the quench hardening of cutting edges and revealed that they were made of a single steel piece, i.e. no combination of iron and steel in one of the construction systems was used. However, it is not possible to have a meaningful discussion of the cutting-edge construction or the heat treatment of the blade, as there are only a few metallographically examined swords from the period in question. Nevertheless, the vast majority of the edges were made from just a single piece of metal in this period, although surface pattern-welded blades may have cutting edges of their own construction (usually a sandwich construction). It seems that the first half of the 8th century was the turning point, after which blades with edges made from a single piece of steel subjected to quench hardening began to dominate in Europe.

The shape of the blade and the use of pattern welding are consistent with dating the sword to the late Merovingian period, although the combination of pattern-welded surface

Fig. 14. X-ray image showing cracks in the cutting edge in the section where the blade is bent (by J. Hošek).

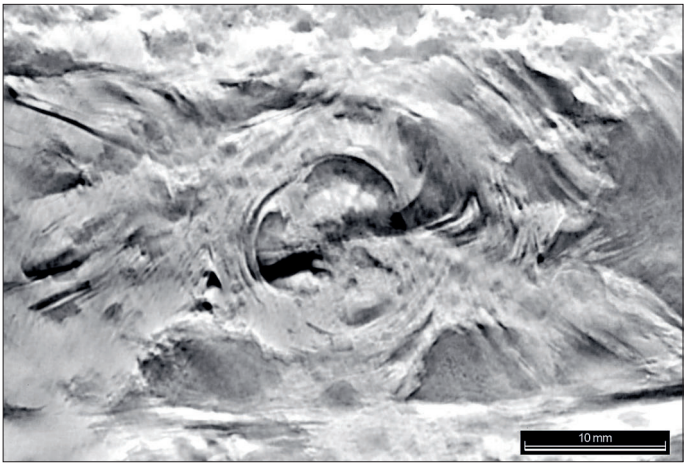


Fig. 15. X-ray CT section showing the detail of the blade with the circular mark (by J. Hošek).

panels with a plain core does not rule out production in later centuries. However, the presence of a single circular mark may raise questions (*Fig. 15*). Contemporary evidence suggests that the popularity of the use of pattern-welded composite marks gained ground at the beginning of the Carolingian period, during which pattern welding of blades gradually declined and was replaced by the application of marks. The use of simple symbols and their simultaneous appearance with pattern welding (generally *Hošek et al. 2021*, 109–112) is characteristic of the early stage of the development of Carolingian marks; we can also see this feature on the sword from Vlčí Pole. The question arises as to whether and to what extent the massive quantitative and qualitative development of marks from the second half of the 8th century was a continuation of earlier development.

Simple marks, including the symbol of an open circle, have been found on Merovingian swords dated already to the 6th century, even though the number of known finds is relatively small. In the region of southern Germany, from where the sword in question is thought to have originated, blades decorated with marks from pattern-welded composites were in circulation (summarised in *Westphal 2002*, 158–159, 166). In the Merovingian period, marks

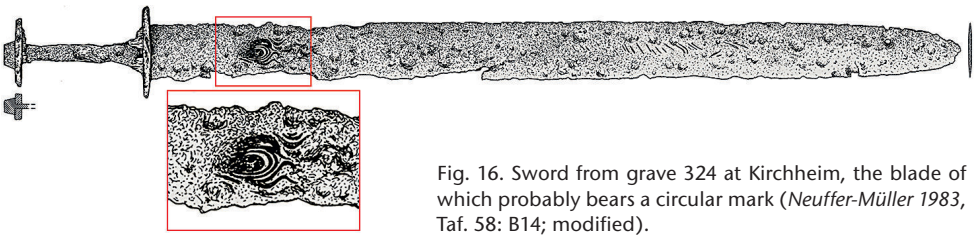


Fig. 16. Sword from grave 324 at Kirchheim, the blade of which probably bears a circular mark (*Neuffer-Müller 1983*, Taf. 58: B14; modified).

were usually applied to fullers of pattern-welded blades (which dominated at the time), i.e. on patterned backgrounds. However, marks applied to a patterned surface are difficult to detect using standard 2D radiography, because the projections of both patterned sides of a blade overlap in the resulting image. X-ray CT examination is therefore more suitable for documenting such blades, as in the case of the sword from Vlčí Pole. X-ray CT was used, for example, to identify an almost identical mark in the shape of an open circle on the pattern-welded blade of a sword from grave 11 at Dortmund-Asseln dated to the last third of the 6th century AD (*Lehman 2016*, 158, 395–396, fig. 166). Traces of a simple mark are most likely to be found on another Schlingen-type sword from grave 324 at the Kirchheim burial ground (*Fig. 16*; *Neuffer-Müller 1983*, 171, Tafel 58). Simple marks could therefore have appeared on pattern-welded blades before the early Carolingian period, from which marks are recorded already as a standard element of blade decoration, and even before the end of the Merovingian period, to which the sword from Vlčí Pole is typologically dated.

Discussion – the find in the context of pre-Přemyslid Bohemia

Based on the typological assessment, the sword from Vlčí Pole was identified as a weapon of Frankish, Alamanic, or Bavarian provenance from the late Merovingian period. In southern Germany, where most of the finds come from, such weapons occurred in the last third of the 7th century and disappeared from the material culture before the mid-8th century. We have pointed out that the presence of a simple mark on a pattern-welded blade cannot be taken as a reliable indicator of a relatively later dating, although the number of known signed blades increased significantly from the early Carolingian period onwards. It is of course possible that a long period of time could have passed between the production of the sword and the events that ended its use. In areas on the periphery of the occurrence of such prestigious products, where they represented a valuable import, much less cultural pressure can be assumed for their replacement induced by western European fashion trends. An example of such processes can be the atypical, most likely later modified swords found without a metal pommel and guards in exceptionally rich graves 55 and 120 at Stará Kouřim. These swords were, according to the grave goods and the context, deposited during the first half or rather the first two-thirds of the 9th century (*Košta – Hošek 2012*; *Hošek – Košta 2013*; *Hošek et al. 2019*, 125–126; *2021*, 101–102, 252–253). On the other hand, Schlingen-type *spathae* are no longer found in graves of the Great Moravian period, which began at the latest in the early 9th century. We can therefore assume that the sword from Vlčí Pole reached Bohemia in the late 7th or 8th century.

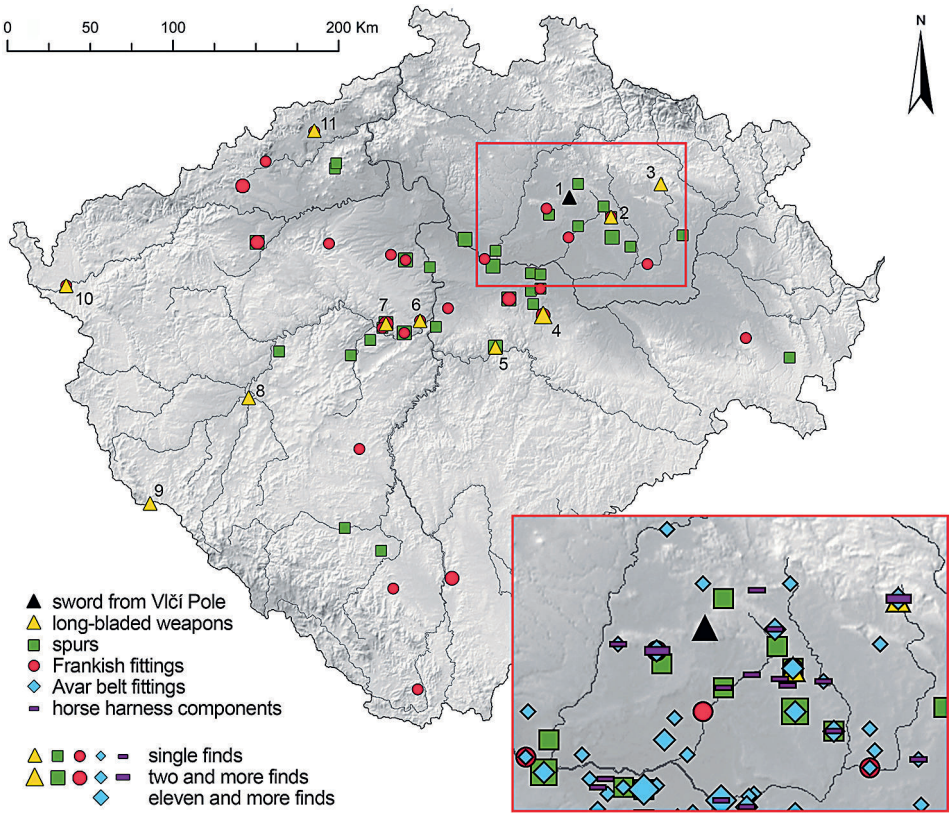


Fig. 17. Finds of long-bladed weapons or their parts, spurs and Carolingian fittings from the late 7th to the mid-9th century in Bohemia. 1 – Vlčí Pole, double-edged sword, Schlingen type; 2 – Češov, seax (?), lost (*Profantová 2012*, 315); 3 – Kal-Valy, pointed part of slender blade (*Kalferst – Profantová 1999*, fig. 8: 18; *Profantová 2023*, 27, fig. 5: 7); 4 – Kouřim – Stará Kouřim, two double-edged swords without a hilt, one long with asymmetrically set tang from grave 55, the other with a later shortened pattern-welded blade from grave 120 (*Hošek – Košta – Žákovský 2019*; *2021*); 5 – Senohraby, guard of a sabre (*Profantová – Hasil in print*); 6 – Kosoř, pointed part of a double-edged (?) sword blade (*Profantová 2017*, fig. 4: 19; *Profantová – Hasil in print*); 7 – Svatý Jan pod Skalou, inlaid crossguard of a sword (*Profantová – Hasil in print*); 8 – Plzeň-Doudlevce, double-edged sword, type Immenstedt/Petersen B (*Hošek et al. 2019*; *2021*); 9 – Horní Folmava, long seax (*Profantová 2020*); 10 – Jindřichov u Chebu, long seax (*Hasil 2018*, 180–191; *2019*); 11 – Teplice region?, long seax (*Hošek et al. 2021*, 18).

The sword is an isolated find; no other archaeological artefacts were found during subsequent archaeological investigation of the site. There is no evidence of either settlement or burial activity in the immediate vicinity that would correspond to the dating of the sword (i.e. early medieval). Although the circumstances under which the use of the sword ended remain unclear, the wider archaeological and geographical context can shed some light on the matter.

The site where the sword was discovered is located at the western edge of the north-eastern Bohemian concentration of pre-Přemyslid finds (i.e. from the late 7th – mid-9th century), which attests to the presence of warriors or cavalrymen (*Fig. 17*; *Fig. 18*). Such evidence of upper classes includes a number of finds that unfortunately almost exclusively lack

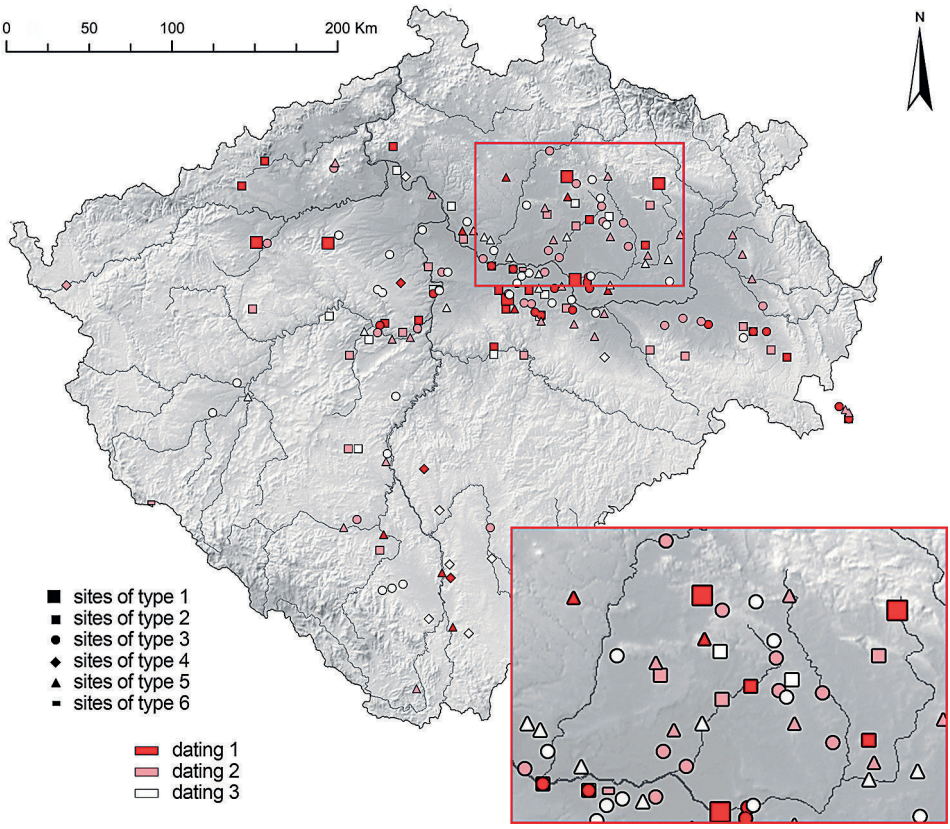


Fig. 18. Sites of the pre-Přemyslid period reconstructed on the basis of the corpus of significant metal artefacts: 1 – agglomerations with a central function, usually in elevated or otherwise specific locations; 2 – hillforts/elevated sites or finds from their narrow spatial context; 3 – finds from areas with conventional evidence of settlement activity; 4 – sites with burial activity; 5 – finds of metal artefacts outside the areas with conventional evidence of settlement activity, i.e. hypothetically lost items, hoards or new evidence of settlements; 6 – reliable evidence of hoards; points in red – finds of artefacts dating from the late 7th to mid-8th century; pink – finds generally dated to the 8th century and first half of the 9th century; white – finds from the second half of the 8th and the first half of the 9th century (according to *Hasil et al. 2020*, modified and supplemented).

a clear archaeological context: hook spurs, cast fittings of belts and horse harnesses made in the late Avar style, and less frequent finds of late Merovingian or early Carolingian fittings (*Hasil et al. 2020*; *Hasil – Profantová in print*). The intensity of settlement in the region is evidenced by the network of sites known from the conventional archaeological record, which is based mainly on finds of pottery fragments (*Hasil et al. 2020*, fig. 8). This concentration of objects is also accompanied by fortified or hilltop settlements with a presumably central, refuge or guard function, dating back to the Early Hillfort period (approximately from the late 7th to the early 9th century; summarised in *Čtverák et al 2003*; *Profantová 2016*). The discussed area was located mainly in the Jičín region, in the basin of the Cidlina and Mrlina rivers. It was bordered in the north by the hillforts of Kal-Valy and Vesec u Sobotky – Poráň, in the west by Chlum Ridge in Jizera River basin, and in

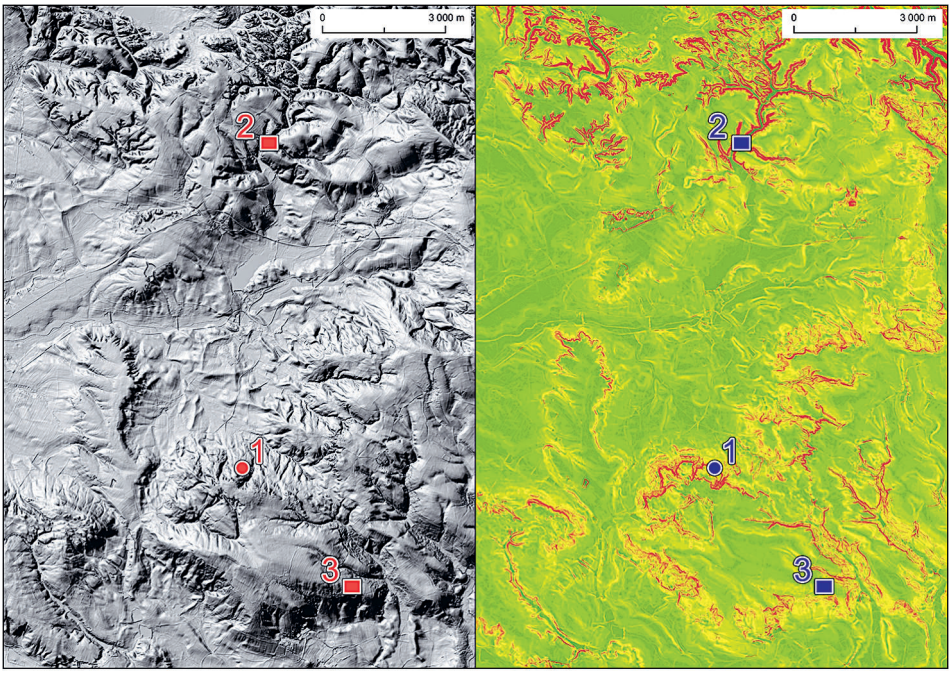


Fig. 19. Terrain relief of the area where the sword was found: a – shaded landscape relief (Z-factor 10); b – slope gradient; 1 – site of sword discovery; 2 – the early medieval hillfort of Poráň near Vesec u Sobotky; 3 – the undated hillfort of Lično-Kvíčalka (©ČUZK, digital relief model DMR 5G).

the south by the most significant area with evidence of important centres and significant metal artefacts of the Early Hillfort period in Bohemia, which spread along the Elbe in central-eastern Bohemia, especially in the area of the Kolín and Nymburk districts.

The site of the discovery lies on the northern slope of the terrain block, which is bounded by steep slopes above watercourses. This part of the Jičíněves Upland is characterised by a slightly undulating plateau (Markvartice Plateau), which rises 100–150 metres above the surrounding landscape and is bordered for most of its extent by ravines and furrowed valleys formed by a number of small watercourses. The summit plateau consists of a larger southeastern part with the highest point Kopanina (374 MASL) and a smaller northwestern part known as Hladoměř (377 MASL). From the summit of Hladoměř, on whose northern terraced slope the sword was found, it was possible to control the important pass between the Petkovy Plateau and the eastern edge of the Chlum Ridge to the west and the Markvartice Plateau to the east (*Fig. 19*).

The plateau is situated on a local watershed between two tributaries of the Elbe – the streams on its eastern and southern sides flow into the Mrlina River, which flows into the Elbe at Nymburk, while from the north and northwest the plateau is bounded by watercourses that flow into the Klenice River, which empties into the Jizera River in Mladá Boleslav (*Demek – Mackovčin et al. 2006*). A south-northern route could pass through this landscape, connecting the Elbe with the Poráň hillfort near Vesec u Sobotky, which is situ-

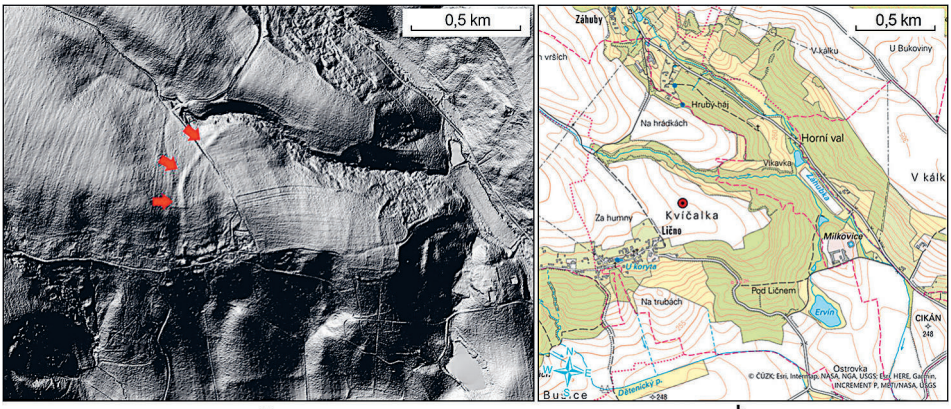


Fig. 20. Lično-Kvíčalka hillfort: a – location of the site (©ČUZK, ZTM10); b – shaded landscape relief (©ČUZK, DMR 5G, Z-factor 10), red arrows indicate the course of the fortification (supplemented by R. Novák).

ated 8 km north of the place where the sword was found. Poráň hillfort is the closest site, which is assumed to have had a central function in the Early Hillfort period (summarised in *Čtverák et al. 2003*, 338–339; *Profantová – Waldhauser 2007*). Another west-east route could have passed through the area along the Chlum Ridge to the surroundings of Jičín. Remnants of a fortification of an unknown dating were also identified on the promontory at Lično-Kvíčalka, situated at the southeastern edge of the plateau 4 km from the place where the sword was found. Nonetheless, its possible early medieval dating will have to be confirmed by further research (*Fig. 20*; *Novák 2024*).

The archaeological survey did not yield any evidence of the deliberate deposition of the sword, and a burial context is highly unlikely. Evidence of burials is very rare in the Early Hillfort period and is limited to cremation burials in mounds documented in some Bohemian regions, including Northeast Bohemia. Close barrow burial grounds are known from Bojetice and Vinařice on the Chlum Ridge, from Prachov Rocks, Nadslav and Mužský-Hrázka (*Hejhal et al. 2023*; *Lutovský et al. 2023*, 258, 273, 277–279, 288). Cremation burials in these mounds were generally very poor in finds and war gear is almost absent. This notion has been modified to some extent by recent metal-detector surveys in southern Bohemia, during which exclusive metal clothing accessories were found in the subsurface layers or immediate vicinity of some large mounds (*John – Ciglbauer 2023*). However, the deposition of these types of artefacts, for which we have no evidence in Northwest Bohemia so far, cannot be considered a general phenomenon (*Lutovský 2023*, 47). The improbability of the burial context of the sword is underlined by the fact that neither human remains nor surface traces of burial mounds have been documented in its vicinity.

The most likely answer to the question of why the sword was found there lies in the aforementioned strategic importance of Hladoměř, where we can assume the existence of an (archaeologically unrecognised) guard point. The sword found just below the surface on the northern slope of the hill could then be seen as evidence of combat, whether it was lost directly at the site or was carried there by erosion from the edge of the slope.

Finds of weapons are rare in contexts of the late 6th to the mid-9th century Bohemia, when the inhumation burial rite, accompanied in the earlier stage by a variety of grave

goods, began to spread.[3] So far, only a few, mostly typologically insignificant sword fragments could be assigned to the 7th and 8th centuries (see *Fig. 17* with references to publications of individual finds). For this period, the connection with the late Avar milieu is evidenced by the increasing number of finds of decorative fittings of warrior belts, the suspension system of which was originally designed for Avar weapons. The only find of a sabre crossbar comes from a hilltop site near Senohraby in the Prague-East district (*Profantová et al. in print*; *Profantová – Hasil in print*). As far as long-bladed weapons of western origin are concerned, there are two weapons recorded from Bohemia which hypothetically do not rule out a dating to the 8th century, but could also have been deposited/lost or even made in the early 9th century. Apart from a sword of the Immenstedt type (Petersen type B) from Plzeň-Doudlevce, to which we find close parallels in Austria and at the Great Moravian stronghold of Břeclav-Pohansko (*Hošek et al. 2019*, 205–206, plate III:a; *2021*, 118, 284–285), there is also a newly found inlaid crossguard from Svatý Jan pod Skalou (*Profantová – Hasil in print*). It is also worth mentioning the finds of long seaxes from the western peripheries of Bohemia (Jindřichov u Chebu, Horní Folmava, and perhaps a specimen without an archaeological context held in the Regional Museum in Teplice; *Fig. 17*). Although the finds of seaxes, at least those from Folmava near the Vyšší Brod Pass, indicate contacts between Bavaria and Bohemia (*Hasil 2019*; *Profantová 2020*), they cannot be taken as evidence of the penetration of these weapons into the local cultural milieu. However, the proof of the use of seaxes is complicated, as fragments of these weapons, their straps, and sheaths are not sufficiently morphologically conclusive. On the other hand, the use of *spathae* in pre-Přemyslid Bohemia is repeatedly proven by rare finds of characteristic fittings of sword-belt sets, which, based on stylistic assessment, can usually be dated to the Carolingian period.

In the 8th and early 9th centuries, more frequently than prestigious weapons and parts of their belts we encounter equestrian equipment, especially hook spurs and horse harness fittings. Not only these groups of artefacts, but also the beginning of the construction of hillforts, clearly testify to the growing importance of mounted warriors, who formed the elite of early medieval Bohemia.[4] Their equipment shows a dominant orientation toward western militaria (most of the weapons, spurs), which can be proven already deep in the pre-Přemyslid era. On the other hand, there is also a strong influence of late Avar fashion manifested not only in horse harnesses, but especially in the variability of decorative belt fittings. Their popularity in Bohemia clearly stems from the Avar warriors. The dominance of single finds unfortunately mostly does not allow a reconstruction of the detailed arrangement of individual belts. Typical warrior equipment, corresponding to the aforementioned spectrum of finds, is best represented by the famous find from Hohenberg (Styria, Austria) featuring a luxurious early Carolingian sword and a belt set in the late Avar style

[3] The description, detailed analysis, and evaluation of war gear and other significant metal finds from pre-Přemyslid Bohemia is the subject of a study by *Profantová – Hasil in print*.

[4] To highlight the sites where significant metal artefacts chronologically close to the sword were found, we have attempted in *Fig. 18* to distinguish sites with finds dating approximately from the late 7th to mid-8th centuries (late Merovingian period and late Avar period I-II finds) from those containing only late Avar period III-IV and early Carolingian finds, as well as finds from the early stage of the Carolingian plant style, i.e. dating from the second half of the 8th century and the early 9th century. Sites with finds dated only generally to the 8th and the first half of the 9th century are displayed separately.

(*Nowotny 2005*). A similar find with a seax from Grabelsdorf (Carinthia, Austria) indicates a lower social status and therefore a higher incidence of this phenomenon (*Szameit – Stadler 1993*; *Eichert 2010*, 112–113, 121–122, Taf. 17–18). Examples from Bohemia and Carantania suggest that the described way of adopting cultural patterns may have been more widespread in areas where Avar and Frankish influences overlapped.

Conclusion

The sword from Vlčí Pole was identified as a typical representative of the Schlingen type from the end of the late Merovingian period. It was found to the northeast of the main concentration of finds of these swords, which are known mainly from Alamanic and Bavarian burial grounds in southern Germany. Within the typological assessment, we updated our knowledge of Schlingen-type swords, which have not been the focus of scholarly attention since their definition by Stein. The addition of new finds and the incorporation of later dating perspectives has not brought about a fundamental change in the view of the sword type under discussion; we date its occurrence to the late 7th and early 8th century, with a possible overlap to the middle of this period.

Archaeometric analysis of the sword blade revealed pattern-welded surface panels and welded-on cutting edges made of high-carbon steel hardened by quenching. Pattern-welded swords dominated at the time. At the end of the Merovingian period, the construction of blades with pattern-welded surface panels was less frequent compared to the variant with a fully pattern-welded middle portion but was gradually becoming the standard. The first half of the 8th century was most likely the turning point after which blades with edges of steel subjected to quench hardening eventually outnumbered the blades with iron edges. What is important is the identification of the simple circular mark on the blade. The application of the marks to sword blades is recorded to a greater extent from the early Carolingian period, i.e. from approximately the second half of the 8th century, but new research suggests that their occurrence may have been more frequent in the Merovingian period as well. Small marks applied to blades decorated with surface pattern welding may have been reliably recognised only when X-ray computed tomography was used. In summary, we can conclude that the sword from Vlčí Pole had a high-quality blade for its time and must have been a valuable weapon despite its simple hilt design.

It is quite possible that the sword from Vlčí Pole entered the society of the forming Bohemian elite as a valuable western import and reached the place of discovery during some local conflict. Of course, we cannot rule out the possibility that it was brought there by foreign forces. The absence of written sources and the weakness of the late Merovingian Frankish realm speak against a large-scale military campaign; less improbable is a smaller military intervention, which could be carried out, for example, by Bavarian elites or a skirmish of small armed groups, like merchant or diplomatic expeditions. In any case, the specific events surrounding the end of the life of this weapon, which is extraordinary in the Czech context, will remain shrouded in a fog of uncertainty.

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RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Victim of an armed conflict? A case study of an adolescent with multiple perimortem trauma from an early medieval cemetery in Northwestern Bohemia

Oběť ozbrojeného konfliktu? Případ mladého jedince s mnohočetnými perimortem zraněními z raně středověkého pohřebiště v severozápadních Čechách

Joanna Witan – Barbara Kwiatkowska – Jacek Szczurowski – Milan Sýkora

During rescue excavations at a rural cemetery in Dolany (NW Bohemia) dating to the 11th–12th century, the skeleton of a young male featuring numerous wounds (n=10) of perimortem sharp force trauma was excavated. Nine of the injuries were localised to the postcranial skeleton and one to the skull. An analysis and interpretation of the wounds showed that at least eight blows were inflicted with a slashing weapon, which could have directly contributed to his death. The observed pattern is most consistent with injuries inflicted during armed conflict. Based on historical sources, it is known that there was no warfare in the immediate vicinity of Dolany during the period under review. Therefore, it has been suggested that the male may have been the victim of a fight or battle, and his body was transported and buried in the place where he probably came from. The discovery provides new information on the funerary practices of victims of early medieval armed conflicts in Bohemia.

violence – weapon-related trauma – skeletal injury – Bohemia – Dolany

Při záchranném výzkumu venkovského pohřebiště v Dolanech (SZ Čechy) datovaného do 11.–12. století byla objevena kostra mladého muže s četnými poraněními (n=10) po perimortálním úrazu ostrým předmětem. Devět zranění bylo lokalizováno na postkraniálním skeletu a jedno na lebce. Analýza a interpretace zranění ukázala, že nejméně osm jich bylo způsobeno sečnou zbraní, což mohlo přímo přispět ke úmrtí jedince. Zjištěný vzorec nejvíce odpovídá zraněním způsobeným během ozbrojeného konfliktu. Na základě historických pramenů není známo, že by se ve sledovaném období v blízkém okolí Dolan válčilo. Proto lze předpokládat, že se muž mohl stát obětí boje nebo bitvy a jeho tělo bylo převezeno a pohřbeno v místě, odkud pravděpodobně pocházel. Nález přináší nové informace o pohřebních praktikách obětí raně středověkých ozbrojených konfliktů v Čechách.

násilí – úraz způsobený zbraní – kosterní zranění – Čechy – Dolany

Introduction

Only the effects of violent acts left on the bones in the form of injuries can be observed in anthropological studies of historical communities. Therefore, it is important to interpret trauma in its historical and biocultural contexts as well as the social-ethnographic background (*Martin – Harrod 2015*). This allows the trauma to be studied not only as the result of a single act of violence but as part of a whole range of factors and motives that led to such behaviour.

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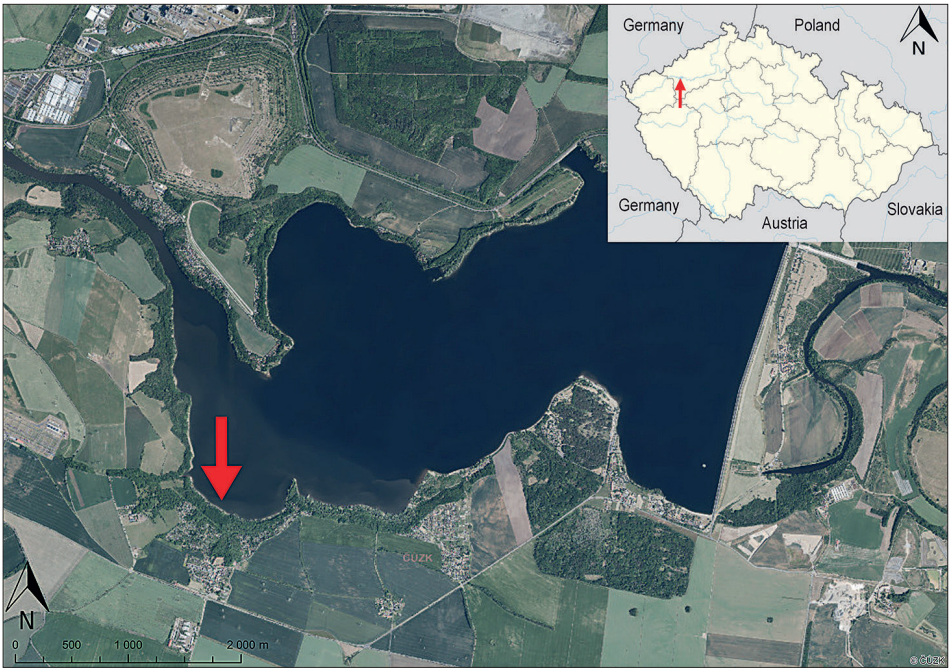

Fig. 1. Geographical location of the archaeological site of Dolany in Northwestern Bohemia.

In the analysis of human remains, bone fractures are the most common cases and therefore the use of the words trauma and fracture are often synonymous. Their differentiation depends on the mechanism of injury, which can be direct, i.e. the result of stress, or indirect, i.e. a result of pathological changes (*Lovell 1998*). By analysing and interpreting the fractures on an individual scale, it is possible to determine their potential causes (e.g. a fall from a height, violence-related injury), and the time of their occurrence (ante-, peri- and postmortem injuries). Analysis of injuries on a population scale, on the other hand, provides information about patterns resulting from certain social behaviours, such as exposure to the dangers of everyday labour and the type of work most likely to cause injury, as well as the prevalence of interpersonal violence and the intensity of conflict (*Walker 2001*; *Agnew et al. 2015*; *Martin – Harrod 2015*; *Collier – Primeau 2019*; *Dittmar et al. 2021*).

Injuries characteristic of intentional violence are considered to be wounds inflicted by weapons, perimortem trauma, multiple injuries to a single individual, as well as trauma to the cranial vault and face (*Šlaus et al. 2012*). Forensic anthropology studies suggest that cranial injuries located above the hat brim line are generally associated with violence (*Kremer et al. 2008*). Weapon-related injuries can be divided into three types: sharp-force trauma, blunt-force trauma, and penetrating trauma, where sharp-force trauma is an injury resulting from the use of an instrument with at least one sharp edge. The inflicted wound is characterised by an elliptical/linear fracture outline, the edges are clear and ‘clean’, while the edge opposite the incision is often irregular and rough (*Knüsel 2005*; *Boylston 2006*). Blunt-force trauma is caused by a blunt object or a collision between a body and a flat or

Fig. 2. Excavation of the cemetery on the shore of the Nechranice Reservoir (photo by J. Šály).

rounded surface. Very often, it can appear as a single fracture line or a compound fracture with numerous fracture lines. Importantly, due to its elasticity, the bone first collapses at the point of strongest stress and fractures laterally or concentrically (*Wedel – Galloway 2014*). For penetrating trauma, the appearance of the injury depends mainly on the tool, e.g. the shape of a gunshot wound usually mimics the shape of a bullet (*Knüsel 2005*; *Forsom – Smith 2017*). However, the appearance of any trauma depends on a great many factors, such as the type of tool, the force applied, the angle, the location on the body, and the type and thickness of the tissues on the exact spot to which the blow was inflicted (*DiMaio – DiMaio 2001*). Nevertheless, it should be emphasised that the number of traumas observed on the skeleton may not represent the total number of wounds that were present on the soft tissues (*Knüsel 2005*).

All of the aforementioned types of injuries occur in archaeological material. They are most abundant at sites of collective armed conflicts such as battles, raids, etc. (*Kjellström 2005*; *Durrant 2011*). They can also occur in the context of massacres or ethnic cleansing (*Harrod 2018*). Numerous studies of trauma in late antique and medieval Europe show that, on average, traces of trauma potentially related to violence can be found on a dozen individuals per cemetery (*Novak – Šlaus 2010*; *Šlaus et al. 2012*; *Krakowska 2017*; *Collier – Primeau 2019*; *Tumler et al. 2019*; *Dittmar et al. 2021*, while individuals with clear evidence of intentionally inflicted injuries are few or non-existent.

The purpose of this study is to comprehensively analyse and interpret the injuries of the young male buried in the early medieval cemetery of the now-defunct village of Dolany in Northwestern Bohemia. Efforts were made to reconstruct the circumstances of the incident as well as the type of tool used to inflict the injuries. Moreover, we aim to gain

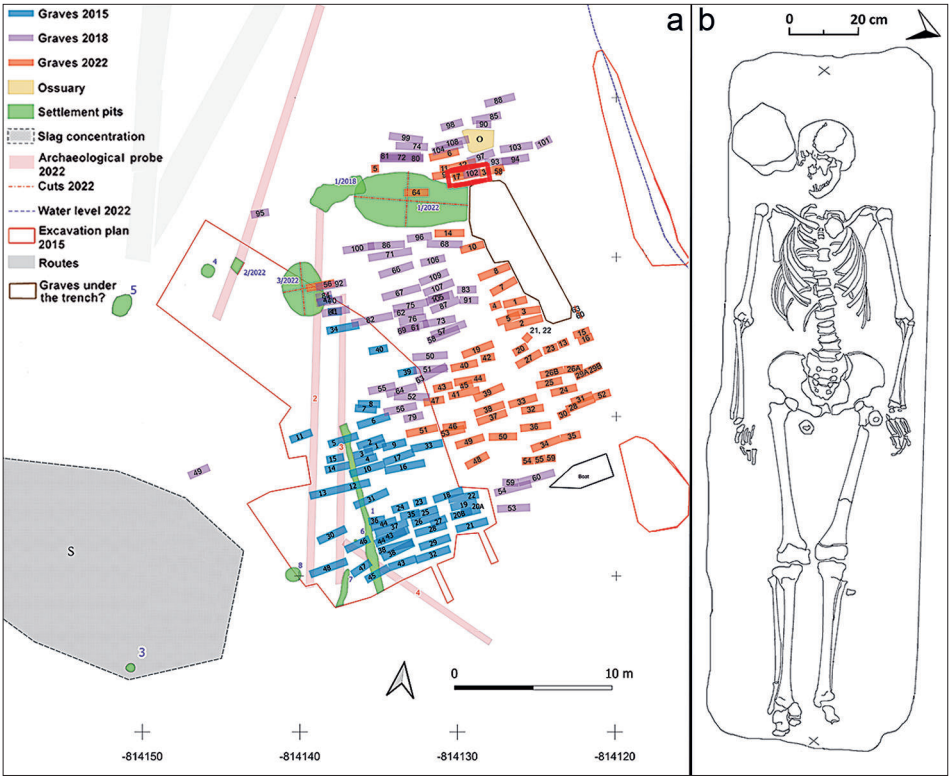

Fig. 3. Plan of the early medieval cemetery in Dolany with grave H17/22 marked (a) and a detail of grave H17/22 (b).

deeper insight into the role and involvement of representatives of rural and provincial populations in conflicts in early medieval Bohemia.

Materials and methods

Site and Burial Description

Dolany is a defunct village in Northwestern Bohemia (Chomutov District, Ústí nad Labem Region). It was demolished in 1967 during the preparation of the site for the construction of the Nechranice Reservoir. The remains of the village are currently located underwater in the southern part of the reservoir (*Fig. 1*). Periods of drought and dike repairs resulted in a significant drop in water levels in 2015, 2018, and 2022, when a heavily eroded cemetery dating to the 11th–12th century was exposed (*Fig. 2*). It is situated about 500 m northwest of the centre of still-standing village of Poláky and 200 m southwest of the former centre of Dolany. A total of 187 regular graves and an ossuary comprising the remains of at least 23 individuals (MNI=23) were uncovered over three seasons of excavations.

Fig. 4. Belt buckles in grave H17/22 (photo by J. Witan).

The grave of the young male with multiple skeletal injuries (grave no. H17/22) was investigated in the autumn of 2022. H17/22 was a single burial without a coffin, located in the western part of the cemetery (*Fig. 3*: a). The grave pit was oriented in the west-east direction and measured 180 × 60 × 33 cm. The skeletal remains of the H17/22 individual were almost complete and in a very good state of preservation; only the arrangement of the foot bones had been disturbed by the excavation of a grave below (*Fig. 3*: b). The supine position of the deceased with head oriented to the west and the upper limbs placed along the body corresponds to the burial customs characteristic of the Early Middle Ages in this region. The equipment of the individual consisted of two iron belt buckles (*Fig. 4*) found below the pelvis.

Methods

Age at death and the sex of the individual were assessed according to standard methods used in physical anthropology (*Buikstra – Ubelaker 1994*; *White – Folkens 2005*). The order of fusion of bone epiphyses and measurements of long bones were considered in the age assessment (*Baker et al. 2005*; *Schaefer et al. 2009*). Sex was determined by pelvic and cranial morphology (*Buikstra – Ubelaker 1994*; *White – Folkens 2005*).

The trauma was assessed macroscopically and with a magnifying glass. The type of injury, its location, and likely time of occurrence were determined. The nature of the injury was identified based on the categories of violence-related trauma (*Redfern – Roberts 2019*), where the category of sharp force trauma was differentiated into cutting and chopping marks (*Humphrey – Hutchinson 2001*; *Lynn – Fairgrieve 2009*). In addition, the injuries were described according to the characteristics proposed by *Lewis* (*2008*). These features include length, shape, flaking, feathering, cracking, breaking, shards, and aspect (or angle of entry of the weapon).

The timing of injuries was determined by the characteristics of antemortem, perimortem, and postmortem injuries. Antemortem injuries were considered those in which healing processes were evident. The differentiation between perimortem and postmortem injuries was based on multiple features (see *Tab. 1*).

Feature	Perimortem	Postmortem
Plastic deformation	Yes	No
Colouration	Uniform or very close to the bone surface	Fracture surface lighter than the rest of the bone
Edges	Sharp and clean without roundings	Sharp, often occurred as jagged/stepped-in fracture surface
Fracture line	Radiate outward from the point of impact	Perpendicular/horizontal
Hinging	Yes	Seldom
Area adjacent to the fracture site	Small bone fragments adhere to the fracture site	Tendency to break into a number of pieces

Tab. 1. Differentiating features of peri- and postmortem trauma (adapted from *Kimmerle – Baraybar 2008*; *Ubelaker – Montaperto 2013*; *Galloway et al. 2014*; *Byers 2017*; *Łukasik et al. 2019*; *Tumler et al. 2019*).

Results

Individual description

Individual H17/22 was a 16–18-year-old male whose body height was estimated to be approximately 168.8–174.0 cm (on the basis of various authors collected in *Piontek 1996*) and around 170.8–171.5 cm according to equations created for a relatively close Polish early medieval population from Giecz (*Vercellotti et al. 2009*). Part of the epiphyses of his long bones (i.e., heads of the humerus, the distal epiphyses of the forearm bones, the distal epiphyses of the femurs, the proximal epiphysis of the left fibula) was not fully fused to the bone shafts. Twenty-four teeth were preserved in the individual's dentition, while the third molars had not yet erupted. The teeth of the upper arch were characterised by light crown attrition in phase D, while the teeth of the lower arch showed attrition typical of phase E (*Lovejoy 1985*). There were small deposits of tartar on the teeth at the first grade of severity according to *Brothwell* (*1981*). The edge of the mandibular alveolar processes was rounded and porous. A single hypoplastic line was present on the right mandibular canine.

Porotic hyperostosis was found in the area of the labdoidal suture, with the largest cluster on the right parietal bone located parallel to the suture. Porosities were also observed on the occipital bone. The male also had a malformation of the second cervical vertebra in the form of the failure of the posterior lamina of the right transverse process to fuse with the vertebral arch (*Fig. 5*). Furthermore, many skeletal lesions were observed, clearly suggesting that the individual was suffering from an infectious disease. However, the aetiology of this disease requires additional research and is not analysed in this study.

Trauma

A total of 10 trauma marks were observed on the skeleton (*Fig. 6*), one on the skull and nine on the postcranial skeleton. None showed signs of healing, so the timing of their formation was determined as perimortem. Wound features such as a distinct kerf, smooth walls, and sharp edges were present in all 10 wounds, classifying them as sharp force trauma. Accurate descriptions were made according to the classification by *Lewis* (*2008*) (*Tab. 2*).

The length of the trauma marks visible on the bones varies from 11 to 32 mm, and the dominant part of the damage was elliptical. Only trauma no. 4 was characterised by a triangular shape. The morphology of most of the traumas (no. 3–6 and 8–10) indicated that

Fig. 5. Malformation of the second cervical vertebra of individual H17/22 (photo by J. Witan).

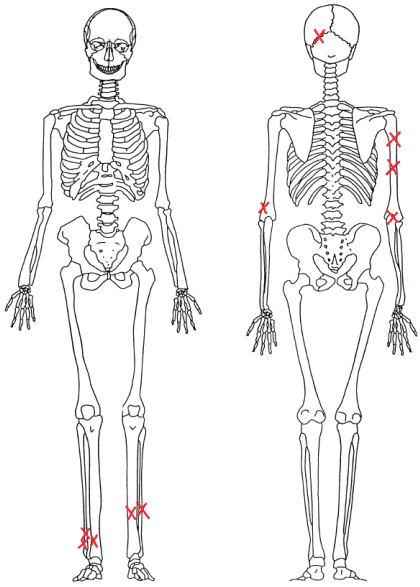

Fig. 6. Location of perimortem trauma of H17/22 individual. Modified from *Buikstra* and *Ubelaker* (*1994*).

they were caused by cutting; however, the cranial injury (no. 1, *Fig. 7*), one of the three traumas to the right humerus (no. 2 and 3, *Fig. 8*: a), and one of two injuries to the right fibula (no. 7, *Fig. 9*: a) show attributes of chop marks due to their length, depth, and distinctly elliptical shape.

Trauma occurring on both shins (no. 6, 8, 7, and 10) are most likely the result of a single blow. This is evidenced by the same height at which the injuries occur, as well as the identical angle of their placement on both bones. In the case of the right lower limb, the blow was delivered at a 45-degree angle from above and mainly affected the fibula. The total length of the injury on the right lower leg bones was 25 mm. On the left shank, in contrast, the deeper wound was on the tibia and, passing laterally to the fibula, became increasingly shallow (*Fig. 9*: b). The total length of this injury was 37 mm.

Unilateral flaking and feathering occurred in half (5 out of 10) of the injuries. Feathering was more common (6 out of 10), as the injury on the left tibia was characterised by bilateral feathering. Cracking injuries were present in three cases (no. 1, 2, and 4). Trauma no. 1 and 2 were the deepest and were classified as chop marks. The evaluation of a breakage injury (no. 8) remained unclear because, although the colour of the breakage was similar to the rest of the bone shaft, its edges were not smooth. It cannot be ruled out that this bone was fractured from sharp-force trauma and the pressure of the water in which the bone rested after the reservoir was built (i.e. the bone broke postmortem). Most of the traumas (7 out of 10) were inflicted at an angle (glancing), and only three injuries (including one combined on the left lower leg) resulted from perpendicular blows. The right humerus, which was most affected by the sharp-force trauma, sustained both impact types – two wounds appeared to be glancing type and one was perpendicular.

There was no significant dominance in the occurrence of trauma related to the body side, although 6 out of 10 traumas occurred on the right, and four on the left side. However, the distribution of traumas in the anterior-posterior axis draws particular attention.

Fig. 7. Perimortem sharp-force trauma on left parietal and occipital bone (photo by J. Witan).

The wounds located on the front side of the body occurred only in the area of the lower extremities on the tibiae and fibulae (no. 6, 8, 7, and 10) and were caused by single cuts, meaning that only three blows were inflicted in the lower extremities. The five other skeletal injuries inflicted above the waist, i.e., three injuries on the right, one on the left humerus (*Fig. 6*: b), and one on the skull, were located on the posterior side of the body.

Discussion

Perimortem trauma and interpersonal violence

The multiple perimortem traumas found on the H17/22 individual are clearly related to the use of a weapon. Based on the preserved trauma marks, it can be concluded that the individual received at least eight blows. Such deep injuries, which left marks on the bones, must have been combined with soft tissue injuries and caused significant bleeding. It cannot be ruled out that the blow inflicted on the left shin may have damaged the anterior tibial artery. Such type of injury, which is an immediate threat to life, could have been a potential cause of death (*Huber – Manna 2023*; for anatomical structures that are potentially damaged in this type of injury, see *Tab. 3*).

It is noteworthy that individual H17/22 did not show trauma (stabbing wounds) in the thoracic region (ribs, sternum, vertebrae), which are often found on victims of interpersonal violence (*Manso et al. 2021*; *Handlos et al. 2023*), as reported by archaeological sources (*Tumler et al. 2019*; *Zeppilli et al. 2023*). Also, no traces of trauma were found on the hands and forearms, where traumas are usually linked with defensive reflexes of the victim (*Bohnert et al. 2006*; *Novak 2007*; *Judd 2008*). However, it cannot be ruled out that the injuries in the area of the distal epiphyses of both humerus bones resulted from attempts to shield with the arm. Analysis of the angle of injury to the right humerus epiphysis (no. 4) shows that the cut was inflicted during maximum flexion of the upper limb at the elbow joint, as evidenced by the absence of injury marks on the ulnar process.

Fig. 8. Perimortem sharp-force trauma on right humerus (a) and) left humerus (b) (photo by J. Witan).

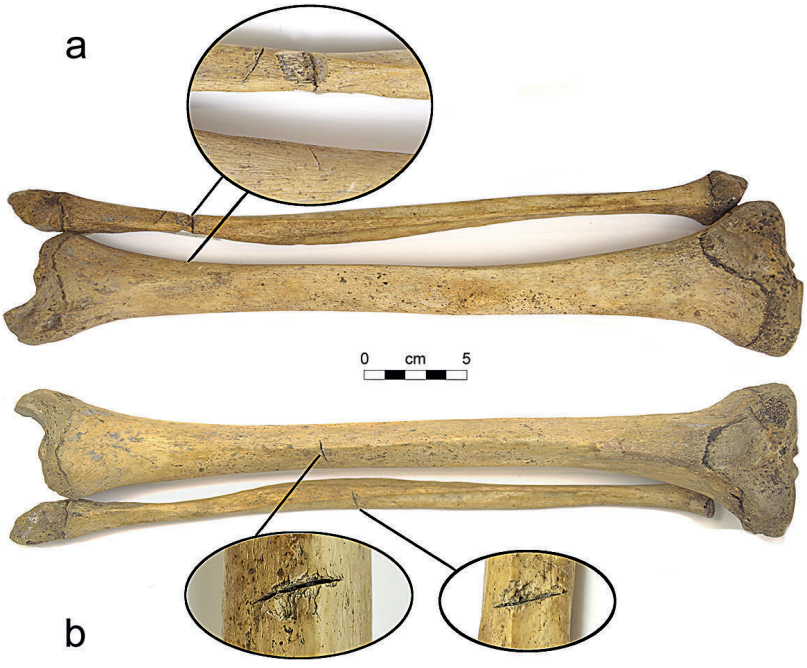

Fig. 9. Perimortem sharp-force trauma on right tibia (a) and fibula left tibia and fibula (b) (photo by J. Witan).

Wound	Bone	Side	Location	Length (mm)	Shape	Flaking	Feathering	Cracking	Breakage	Shards	Aspect
1	Parietal/ Occipitalis	L	On the lambdoid suture, injury passes through the left parietal bone and occipital-it lies 33 mm to the left of the lambda anthropological landmark.	32	Ellipse	Unilateral	Unilateral	Present	Absent	Absent	Glancing
2	Humerus	R	Anterolateral surface to posterior surface. At the height of the upper edge of the deltoid tuberosity.	25	Ellipse	Unilateral	Unilateral	Present	Absent	Absent	Glancing
3	Humerus	R	Anterolateral surface, at the height of the lower edge of the deltoid tuberosity.	15	Ellipse	Unilateral	Unilateral	Absent	Absent	Absent	Perpendicular
4	Humerus	R	Posterior surface of trochlea, up to the olecranon fossa.	14	Triangle	Absent	Unilateral	Present	Absent	Absent	Glancing
5	Humerus	L	Above lateral supracondylar crest.	11	Ellipse	Absent	Unilateral	Absent	Absent	Absent	Glancing
6	Tibia	R	Interosseous surface in ⅓ of the shaft height above distal epiphysis.	11	Line	Absent	Absent	Absent	Absent	Absent	Glancing
7	Tibia	L	In ⅔ of the shaft height- from interosseous surface up to anterior crest.	13	Line	Absent	Bilateral	Absent	Absent	Absent	Perpendicular
8	Fibula	R	In ⅓ of the shaft height above distal epiphysis, on the lateral surface.	11	Ellipse	Unilateral	Unilateral	Absent	?	Absent	Glancing
9	Fibula	R	In ⅓ of the shaft height above distal epiphysis, on the lateral surface, right below lesion no. 8	12	Line	Absent	Unilateral	Absent	Absent	Absent	Glancing
10	Fibula	L	At mid-height of the shaft, it passes through the anterior border, lateral border and surface.	11	Line	Unilateral	Absent	Absent	Absent	Absent	Perpendicular

Tab. 2. Description of perimortem trauma on individual H17/22.

Wound	Bone	Side	Muscle	Blood vessels	Nerves
1	Parietal/ Occipitalis	L	Epicranial aponeurosis, occipitalis muscle	Occipital artery	Occipital
2	Humerus	R	Deltoid, infraspinatus, teres major, triceps brachii-lateral head	Posterior circumflex humeral artery, cephalic vein	Axillary, superior lateral cutaneous nerve of arm
3	Humerus	R	Triceps brachii- lateral and medial head	A collateralis radialis v. cephalica)	Radial
4	Humerus	R	Distal tricep brachii tendon, elbow joint capsule	Rete articulare cubiti	Radial
5	Humerus	L	Triceps brachii- medial head, brachioradialis	Radial collateral artery, cubital anastomosis	Ramus profundus radial nerve, ramus radial nerve
6	Tibia+fibula	R	Extensor hallucis longus, distal fibularis longus tendon, fibularis brevis, extensor digitorum longus	Fibular artery Fibular veins	Superficial fibular
7	Tibia+fibula	L	Tibialis anterior, extensor hallucis longus, fibularis longus, extensor digitorum longus	Anterior tibial artery Anterior tibial veins Fibular veins	Deep fibular nerve, superficial fibular

Tab. 3. Anatomical structures of muscles, blood vessels and nerves likely to have been damaged by a blow penetrating the body of individual H17/22 to bone depth.

According to the observation of trauma on skeletal material, the occurrence of skeletal injuries related to the use of weapons is also found at archaeological sites not directly associated with armed conflicts. In assemblages from medieval Sweden, the incidence of such cases ranged from 2.1% (Striguna) to 4.3% (Västerhause) (*Kjellström 2014*). In Turin, six skeletons from the medieval and Renaissance periods were found with various head injuries (*Giuffra et al. 2013*). In early medieval South Tyrol, weapon-related injuries were observed on seven individuals (*Tumler et al. 2021*), but the most notable was individual SK63, who was found to have 26 perimortem traumas (*Tumler et al. 2019*). At the 15th-century Croatian site of Čepinin, the incidence of violence-related injuries was as high as 15% (*Šlaus et al. 2010*), which researchers link with the invasion of the Ottomans. In all of the above examples, cranial injuries dominate extracranial injuries by a significant margin, indicating that in small-scale conflicts and violence, the easiest (and most lethal) target for attack was the head of the opponent. In contrast, the distribution of individual injuries on the postcranial skeleton varied widely and it is difficult to observe specific injury patterns in this case.

Interpretation of trauma pattern

Intentional and direct violent behaviour during historical armed conflicts creates a specific pattern and distribution of trauma on the skeleton. In their analysis, *Kjellström* (*2005*) and *Novak* (*2007*) show that cranial injuries predominate in organised warfare. Cranial traumas are most characteristic of organised violence, as is confirmed by other authors who analysed the victims of such events dating from the Middle Ages to the modern period (*Zoffmann 1982*; *Fiorato et al. 2007*; *Dziedzic et al. 2011*; *Eickhoff et al. 2012*; *Boucherie et al. 2017*; *Constantinescu et al. 2015*; *Łukasik et al. 2019*; *Nicklisch et al. 2017*). However, a different picture emerges from research conducted by *MacKinnon* (*1997*, after *Knüsel 2014*). Among individuals buried at the Fishergate Parish cemetery, between 59% and 82% of all injuries occurred on the postcranial skeleton. These people were likely participants of the Battle of Stamford Bridge or the Battle of Fulford, which followed the Norwegian invasions of Britain in the 11th century. Analysis of the remains of the victims of the Battle of Wisby by *Ingelmark* (*1939*) also showed the dominance of postcranial injuries (60% of all injuries). Moreover, the most commonly affected bones were the tibiae. Single cases of tibia trauma also appear in studies by other authors (*Cunha – Silva 1997*; *Kjellström 2005*; *Boucherie et al. 2017*). The strategy of mutilating the lower limbs was often used by early medieval combatants due to the type of armour at that time, which left these parts exposed, while the parts of the body above the knees were more difficult to access. There was apparently also an effort to restrict the movement capabilities of the opponent, making it easier to deliver a fatal blow to the head (*Boucherie et al. 2017*; *Constantinescu et al. 2015*; *Forsom et al. 2017*).

The injuries observed on the described H17/22 individual are most similar to the patterns of battle injuries. Although the presence of traumas to the shoulder bones raises some doubts about this interpretation, it cannot be ruled out that their presence is related to the type of armour the male was wearing, which did not cover the upper and lower limbs, but covered the upper parts of the torso. Such a scenario would explain the absence of trauma in the chest area. Nevertheless, the wounds on the lower limbs were very similar to those observed on skeletons from Wisby and Fishergate (*Ingelmark 1939*; *MacKinnon 1997* after *Knüsel 2014*). The predominance of the trauma locations on the posterior side of the body

allows us to conclude that the opponent inflicted blows while standing behind the victim's back. Injuries located on the left side near the back of the skull, as in the case of individual H17/22, are also characteristic of organised conflicts. A concentration of skeletal injuries in this area has occurred on skulls from Uppsala (*Kjellström 2005*) and Sandbjerget (*Boucherie et al. 2017*). According to *Ingelmark* (*1939*) and *Šlaus* (*2010*), such altercations also indicate that blows were dealt from behind to a person who was on the run or who was not in a standing position (*Brødholt – Holck 2012*). A high percentage of upper limb injuries among all postcranial skeletal injuries, with the dominance of those located on the right side (60%), also occurred among individuals from the Towon mass grave (*Novak 2007*). The author of the study interprets the right arm as the 'leading hand' of the weapon, making it a possible target for an enemy counterattack. When interpreting the inequality of injury incidence between the right and left upper limbs, consideration should still be given to the additional protection of the left limb that the shield provided (in most cases for right-handed people). Also relevant is 'ultimate defence', in which the only possibility of protecting oneself is the reflex of covering the body with the forearm or arm of the dominant hand against a blow. Injuries on the distal epiphyses of the humerus, which with some probability can be regarded as wounds of a defensive nature, occur in all the aforementioned types of conflicts. Therefore, they can only be regarded as a general identifier of violence-related behaviour.

Weapon characteristics

The criteria presented by *Lewis* (*2008*) were used to determine the tool presumably used to injure the H17/22 individual. Features such as the length, depth, shape, cracking as well as glancing aspect of all injuries on the body were consistent with the image of injuries that can be inflicted by cold steel. Features such as unilateral flaking and feathering injuries and a tangential angle of blow infliction, which occurred only in an injury at the centre of the shaft of the right humerus, are characteristic of many blade types. However, it cannot be ruled out that this specific injury was inflicted with a different weapon than the other ones.

The final appearance of the injury depends on a great many factors. Tool features such as weight, edge sharpness, and size also matter. The injury at the proximal epiphysis of the right humerus was relatively deep, and its appearance was similar to some of the injuries presented by *Lynn* and *Fairgrieve* (*2009*), so it cannot be ruled out that it was caused by an axe blow.

In the Early Middle Ages, axes and swords were the primary equipment of most warriors, often accompanied by secondary weapons such as spears, lances, or daggers. According to the sword typology by *Geibig* (*1991*), types 4 and 5 were the most widespread in Europe in the 11th century. These swords had blades reaching 80–90 cm in length, with a relatively short handle. The parameters of such weapons allowed only for one-handed use. Furthermore, according to the group division of swords found in Bohemia created by *Hošek et al.* (*2022*), group b blades (72 to 82.5 cm long and 4.5–5.4 cm wide) were in common use in the late 10th and probably during the 11th century. Although it is not possible to directly relate the trauma features to the blade types presented above, it is clear that the skeletal injuries that occurred on the H17/22 individual were characteristic for cold steel weapons, particularly a sword and/or axe.

The H17/22 individual in the context of the Dolany population and early medieval Bohemia

Individual H17/22 stands out from the early medieval inhabitants of Dolany. Injuries were common in this population, but mostly as a result of labour. Sharp force trauma related to violence occurred in only three cases out of 120 skeletons examined (*Witan – Sušická 2024*), but all were isolated and inflicted antemortem. The low number of sharp-force traumas and the lack of skeletal injuries to other individuals from the cemetery make it possible to rule out the hypothesis that H17/22 was the victim of an attack on the village unleashed, for instance, to destroy infrastructure or obtain supplies. Attacks of this type, according to *Gassmann* (*2018*), were relatively common in the Early Middle Ages.

The individual was also unique from a bioarchaeological point of view. Based on the male's skeleton, it can be concluded that he was rather massive in stature. The fact that individual 17/22 reached an estimated body height above the mean height of males from the Dolany population, which was 164.4–167.4 cm (*Witan – unpublished data*), even before full skeleton ossification, strongly suggests his higher social status.

Moreover, he was the only one among the males buried in the cemetery equipped with buckles around his pelvis. Although buckles are a common find in graves from the Early and High Middle Ages in Bohemia (*Mazáčová 2012*), it is problematic to determine their specific use. Finds from Dolany were simple iron round buckles measuring c. 3.3 cm in diameter, in which spikes were not preserved. This type has been found at other cemeteries including Lažany (graves L016, L117; *Frolík 2019*, 38), Klecany I (graves H5/37, H47, H11; *Profantová et al. 2015*, 121), Levý Hradec (graves ŽAP-47/2013, ŽAP-9/2003, ŽAP-32/2005; *Tomková et al. 2020*, 152–154), Zeleneč (graves H74, H89; *Lutovský – Špaček 2020*, 60), and Praha-Lahovice (graves 41/57, 46/60, 54/60; *Krumphanzlová et al. 2013*, 110, 158, 160). Additionally, a list of individual buckles found in Northwestern Bohemia can be found in the master's thesis by *Podhorský* (*2019*). However, it should be noted that within a single cemetery, metal buckles are present in only a few graves, so it is possible that the buckles were not a standard item of clothing the individuals were buried in. A notably similar case to grave H17/22 from Dolany was found in the Tasov cemetery (*Unger 2011*). Here, in grave 129, two round buckles made of coloured metal were found in almost identical locations. Based on the positioning of the buckles and iconographic references, the author concludes that they were used to fasten the hosiery.

Interestingly, a significant number of buckles were discovered at the site of the Battle of Wisby. In the three mass graves, buckles were found along with 26.1–53.3% of buried individuals. Some of them were used to fasten armour, but the vast majority belonged to clothing (*Thordeman 1939*, 118). The most common type were round iron buckles arranged in pairs in the pelvic area (*Thordeman 1939*, 119). Their precise function is difficult to determine. However, the author suggests that they served as belt buckles or as part of the hosiery.

Nevertheless, the artefacts excavated from grave H17/22 could be considered belt buckles due to the manner in which they were placed *in situ*. While the buckle near the pubic symphysis could be assumed to be the main buckle, the buckle near the greater trochanter of the femur may have been used to attach weapons or other objects. As is well known, belts were a basic and multifunctional part of clothing in the Middle Ages and they played an important role on a symbolic level (*Hoch 2021*) as an indicator of the social status of their owner (*Šlancarová 2016*). Therefore, based on biological features and the equipment

of the deceased, it can be suspected that the young man in grave H17/22 may have belonged to a social stratum called '*milites*', i.e. to the administrative apparatus of the leading member of the Přemyslid dynasty, which ruled Bohemia in the Early Middle Ages and was responsible for military and administrative affairs. Many of these warriors were stationed in various regions of Bohemia, not only in castles but also in manors and villages. The latter, in particular, were referred to as '*milites secundi ordinis*', or second-order warriors, because of their background. They were united with the others by their military service, but in terms of wealth and social status, they lagged far behind the primary warriors of the Přemyslids (*Choc 1967*, 36–83; *Žemlička 1997*, 171–172).

Two significant battles took place in the area of northwestern Bohemia in the 11th and 12th centuries. The first took place in the area between the city of Most and Bílina in 1040 (*Žemlička 1997*, 59–60; *Krzemieńska 1999*, 268–287; *Synek et al. 2013*, 110–113), while the second was fought near the village of Chlumec in 1126 (*Choc 1967*, 389; *Žemlička 1997*, 221–222). Individual H17/22 cannot be directly linked to any of the aforementioned events, and the number of potential conflicts in which he may have died is much larger, as many minor skirmishes accompanied the Holy Roman Empire army's incursions into Bohemia in the 11th–12th century. Also, it cannot be ruled out that the buried individual died at a greater distance from the burial site, i.e., in other parts of Bohemia or Moravia. Moreover, it should be taken into account that the H17/22 individual may have fallen not as a result of the invasion of foreign armies, but by the internal wars between members of the Přemyslid dynasty, which particularly intensified in the second half of the 12th century (*Choc 1967*, 36–83; *Žemlička 1997*, 171–172).

As the study by *Krejsová et al.* (*2008*) shows, the incidence of weapon-related perimortem trauma in early medieval cemeteries in Bohemia was not high. The aim of the research was to verify the hypothesis proposed by *Choc* (*1976*), who explained the low number of skeletons with traces of mortal injuries by leaving the bodies of the fallen in graves near battle sites. Using historical and archaeological sources, the number of armed expeditions was compared to the number of individuals with battle injuries from 74 medieval cemeteries in Bohemia, Silesia, and Moravia. In a group of 1,839 adult men, only 23 were found with weapon-related trauma. The vast majority (19 out of 23) suffered between one and three injuries, and in two cases, the number exceeded to five. Skeletal injuries were most common on the skull (19 out of 23), and limb bone injuries were not observed. The lack of documented battle graves from the early medieval period in Bohemia, as well as the small number of case studies (*Blajerová et al. 2010*), greatly limits the possibility of developing a complete pattern of injuries in the Early Middle Ages and comparing it with the presented case of a male from the Dolany cemetery.

Conclusion

The results of the analysis of multiple injuries observed on individual H17/22 provide new information on violence in early medieval Bohemia. The distribution of cranial and limb trauma observed on the male skeleton indicates that they occurred during a large-scale conflict rather than as a result of direct interpersonal violence. Analysis of the nature of the skeletal injuries suggests that a cold steel weapon was used in the attack, i.e. possibly a sword and/or an axe.

The exceptional grave equipment as well as the very good biological condition of the individual compared to other individuals of the early medieval Dolany population, suggests that he may have belonged to the '*milites secundi ordinis*'. According to historical data, numerous armed conflicts took place in the region of Northwestern Bohemia during the 11th–12th century. Therefore, the hypothesis that the young male buried in grave H17/22 may have died in battle and, due to his rank in the local community, the body was transported to his hometown, is plausible.

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RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Changes in spectra of cultivated and gathered plants in the Bronze Age: A study based on archaeobotanical data from the Czech Republic

Změny v sortimentu pěstovaných a sbíraných rostlin v době bronzové: Studie na základě archeobotanických dat z České republiky

Adéla Pokorná – Petr Kočár – Tereza Šálková

The Bronze Age (BA) in Central Europe witnessed significant transformations in various aspects of human activities. This study focuses on changes in subsistence strategies during the BA, represented by the assortment of edible plants. We examined charred macroremains from 39 archaeological sites in the Czech Republic. Our aims include providing an overview of crop records, determining the dating of new crop introductions, and identifying spatial patterns of the assortment changes. The results indicate a complex agricultural transformation. Emmer and einkorn dominated in the Early Bronze Age (EBA), while the broomcorn millet was widespread in the Middle Bronze Age (MBA). The Late Bronze Age (LBA) saw increased cereal and pulse diversity, whereas the Final Bronze Age (FBA), characterised by coexisting cereals, represented a terminal stage of the process of gradually evolving subsistence strategies. The study highlights the sudden introduction of broomcorn millet in the MBA and expanding the range of crops, which allowed more flexible responses to local conditions and a better distribution of field work throughout the year.

archaeobotany – Bronze Age – millet – Central Europe – agriculture

Doba bronzová byla obdobím velkých změn, které se projevily v různých aspektech lidské činnosti. Tato studie se zaměřuje na změny sortimentu jedlých rostlin v době bronzové. Zjištěné poznatky jsou postavené na analýzách zuhelnatělých rostlinných makrozbytků z 39 archeologických lokalit v České republice. Cílem bylo vytvořit přehled nálezů pěstovaných a sbíraných rostlin a určit, od kdy se na zkoumaném území objevují. Neméně důležité bylo rozpoznat případné prostorové rozdíly v nalezeném sortimentu. Výsledky naznačují, že v průběhu doby bronzové prošlo studované území složitou zemědělskou transformací. Zatímco ve starší době bronzové dominovaly pluchaté pšenice (dvouzrnka a jednozrnka), od střední doby bronzové se po celém území rozšířilo proso. Od mladší doby bronzové zaznamenáváme zvýšenou diverzitu obilovin a luštěnin. Terminální fázi zkoumaného procesu představuje pozdní doba bronzová, charakteristická vzájemně koexistujícími obilninami. Studie vyzdvihuje význam náhlého rozšíření prosa ve střední době bronzové, a také poukazuje na postupné obohacování sortimentu pěstovaných plodin, které umožnilo pružněji reagovat na místní podmínky a pravděpodobně také lépe rozložit polní práce v průběhu roku.

archeobotanika – doba bronzová – proso – střední Evropa – zemědělství

Introduction

In Central Europe, the Bronze Age was a dynamic period associated with the rise of European civilization, the development of crafts and agriculture, as well as intensive contacts among human communities. The communities across Eurasia were connected via long-distance trade and migration routes (see e.g., *Anthony 2010*; *Harvig et al. 2014*; *Allentoft*

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et al. 2015; *Frei et al. 2015*; *Haak et al. 2015*; *Long et al. 2017*; *Wang et al. 2019*). Raw materials (e.g. copper, tin, silex, amber, salt) and products were the objects of trade (*Goldenberg 2004*; *Grabner et al. 2007*; *Ernée 2012*; *Tisucká – Ohlídalová 2013*; *Zápotocký 2013*; *Přichystal – Šebela 2015*; *Chvojka et al. 2017*; *Powel et al. 2018*), and all sorts of innovations (especially bronze technology), ideas, cult and religion also spread along the trade routes (*Jockenhövel 2012*). From the economic point of view, the period can be divided into two phases (*Primas 1997*): 1) the phase when raw materials, i.e., copper and bronze were used as a medium of exchange (the Early and the Middle Bronze Ages); and 2) the phase when the cultural networks have changed and the circulation of bronze ingots and scrap metal was typical (the Late and the Final Bronze Ages; *Primas 1997*).

It has been hypothesized that innovations in agricultural practices may also have been stimulated by using bronze tools (*Jiráň et al. 2013*). However, among the most striking changes taking place in the Bronze Age was increasing the number of cultivated crops. This trend has been documented in plant macroremains in different regions of Central Europe (*Gyulai 1993*; *Rösch 1998*; *2013*; *Jones et al. 2011*; *2016*; *Hajnalová 2012*; *Dreslerová – Kočár 2013*; *Stika – Heiss 2013*; *Šálková et al. 2019*). The reasons that led to the diversification of the crop assortment have not yet been fully understood. An increase in extensive landscape exploitation (*Tserendorj et al. 2021*; *Šálková et al. 2022*) and colonisation of higher altitudes and less fertile soils (*Šálková et al. 2019*; *Kolář et al. 2022*) was observed during the Bronze Age. In addition to environmental factors, it has recently been shown that cultural factors, specifically socio-economic contacts with neighbouring regions, have also influenced decisions on which crops to grow (*Šálková et al. 2019*). A study focusing on the southern part of the Czech Republic (South Bohemia) has shown that the cultural relationship between South Bohemia and the Danube region was reflected in the selection of crops especially in the Early Bronze Age (EBA) and to a lesser extent also in the Middle Bronze Age (MBA). Later, during the Late Bronze Age (LBA) and the Final Bronze Age (FBA), an autonomous agricultural area developed in the South Bohemian region, with a crop composition more related to the central part of the Czech Republic (i.e., Central Bohemia; *Šálková et al. 2019*).

We selected the Czech Republic area as a good model territory to study in detail the assortment changes during the Bronze Age. The transformation of agriculture in the Bronze Age in this area was quite complex (*Dreslerová – Kočár 2013*; *Dreslerová et al. 2013*; *Šálková et al. 2019*; *2022*). Emmer (*Triticum dicoccon*) and einkorn (*T. monococcum*) with pea (*Pisum sativum*), lentil (*Lens culinaris*), flax (*Linum usitatissimum*) and poppy (*Papaver somniferum*) were grown there since the Neolithic (5600–4200 BC), whereas barley (*Hordeum vulgare*), mainly the hulled variety, became widespread in the Eneolithic (4500/4400–2300 BC). Glume wheats (*Triticum dicoccon* and *T. monococcum*) with an admixture of barley remained the staples in the EBA. Then, from the MBA onwards, the range of cereals increased to include broomcorn millet (*Panicum miliaceum*), foxtail millet (*Setaria italica*), spelt (*T. spelta*) and free-threshing wheats (*T. aestivum/turgidum*). Besides, enrichment of the range of legumes with faba bean, common vetch, bitter vetch and grass pea (*Vicia faba*, *V. sativa*, *V. ervilia* and *Lathyrus sativus*, respectively) was observed in this period. Also, the diversity of wild-growing plants (e.g. weeds, ruderal plants and grassland species) increased markedly during the Bronze Age (*Pokorná et al. 2018*; *Pyšek et al. 2022*).

The arrival of the C4 cereals, i.e., the broomcorn and foxtail millets were among the most prominent assortment changes in the Bronze Age. Multiple studies confirmed that broomcorn millet started to spread in the Czech Republic since the MBA (*Kočár – Dreslerová 2010*; *Dreslerová – Kočár 2013*; *Dreslerová et al. 2017*; *Pokorná et al. 2018*; *Šálková et al. 2019*). The oldest evidence of broomcorn millet in the country comes from a bog core in Zahájí in northwest Bohemia (*Bernardová 2009*; *Pokorný et al. 2015*). The waterlogged spikelets of *P. miliaceum* were ^{14}C dated to the Tumulus culture (1461–1383 BC) of the MBA. This date is in accordance with other ^{14}C dates based on charred millet grains from various sites of this country (*Filipović et al. 2020*). The pattern described above, evidenced by the analysis of plant macroremains, is consistent with the results of stable isotope analyses of animal and human bones (*Kaupová et al. 2018*), suggesting a striking change in diet between the early and late 2nd millennium BC, with C4 cereals contributing significantly to the LBA diet.

Our aims were to:

(i) bring an overview of macroremain records of cereals, pulses, oil plants and gathered fruits and nuts from various sites in the Czech Republic area dated to the Bronze Age;
(ii) determine the exact timing of the beginning of broomcorn millet and other new crops cultivation in the area;
(iii) identify changes of the spatial patterns of the assortment of crops over time;
(iv) examine relationships of the assortment changes with sites' locations, altitudes, and archaeological cultures.

Materials and methods

The original intention was to include in the study all available Bronze Age data that are included in the Archaeobotanical Database of the Czech Republic (Institute of Archaeology CAS 2017, referred to as CZAD; *Dreslerová – Pokorná 2015*). Instead, we decided to work exclusively with the data analysed by the authors of this study. In this way we wanted to overcome the problems associated with the unbalanced quality of data analysed by different authors over a longer period, especially before vs. after the 1990s. Until the mid-1990s, the samples for macroremain analyses were mostly taken non-systematically and processed without flotation (*Dreslerová – Kočár 2013*; *Beneš et al. 2022*). Consequently, the broomcorn millet grains were often absent in data being analysed before 1990. In addition, there are also finds of broomcorn millet grains older than the Tumulus culture, which were mostly negligible numbers of grains, now considered as contamination. Radiocarbon dating of individual grains is necessary in these controversial cases, especially if we want to draw conclusions from these findings. Unfortunately, the material from older analyses is often no longer available, so it is not possible to verify the findings.

Only precisely dated samples were included, which means that a reliable classification of archaeological cultures or at least main phases of the Bronze Age was available (for absolute dating of phases and cultures of the Bronze Age in the Czech Republic, see *Tab. 1*). The classification of the Věteřov culture was somewhat problematic, because there is no clear consensus among Czech archaeologists as to which phase of the Bronze Age it should belong. Some authors consider the Věteřov culture to be part of the EBA, while

Abbr.	Period	Dating
EBA	**Early Bronze Age**	**2300/2200–1600/1550 BC**
br.une	Únětice culture	2300/2200–1600 BC
br.vet	Věteřov culture	1700–1500 BC
MBA	**Middle Bronze Age**	**1700/1600–1250 BC**
br.tum	Tumulus culture	1700/1600–1300/1250 BC
br.mdt	Middle Danube Tumulus culture	1650/1600–1250 BC
br.c	Bronze Age C	1500–1250 BC
LBA	**Late Bronze Age**	**1300–1000/950 BC**
br.lus	Lusatian culture	1300–1025 BC
br.vel	Velatice culture	1300/1250–1000 BC
br.kno	Knovíz culture	1250–1025/950 BC
br.mil	Milaveč culture	1250–1025/975 BC
FBA	**Final Bronze Age**	**1025/950–800/750 BC**
br.l-f	Late to Final Bronze Age	1300–800/750 BC
br.slp	Silesian-Platěnice culture HaB	1100–800/750 BC
br.sti	Štítary culture	1025/950–800/750 BC

Tab. 1. List of Bronze Age archaeological cultures mentioned in the text. Abbr. – abbreviations of archaeological periods; Dating – absolute dating of the archaeological periods in the Czech Republic (based on *Jiráň et al. 2013*).

others place it in the MBA (for archaeobotanical context see *Hlásek et al. 2023*). We do not intend to solve this dilemma, however, we decided to include, in our study, the Věteřov culture into the EBA. We mainly followed the consistency of macroremain data, especially absence of broomcorn millet from most assemblages in our dataset dated to the Věteřov culture.

Data for our study were collected from 39 Bronze Age archaeological sites analysed by the authors of this study (PK and TS) between 2000 and 2021. Because several of the selected sites were multicultural, we obtained 51 assemblages (if a site contained data from multiple cultural phases, each phase was counted separately), which were later reduced to 46 to meet our criteria of each assemblage containing at least 15 cereal caryopses. The numbers of assemblages for individual phases of the Bronze Age were as follows: 12 phases (from 7 sites) for EBA, 7 sites for MBA, 19 sites for LBA, and 13 sites for FBA (list of all sites and phases used in our study is given in *Tab. 2*). In all sites, the macroremains were extracted from deposits using tank flotation and sieves with the minimum mesh size of 0.25 mm or smaller. All data were inserted into CZAD.

The spectrum of plants considered in the study includes cultivated crops (cereals, legumes/pulses, and oilseeds) and gathered (wild growing) fruits and nuts. All plant material was carbonized. To ensure homogeneity and comparability of the data between sites, we included only the findings of cereal caryopses, but not the findings of chaff and other threshing remains. The 'storage' finds i.e. higher concentrations of given crops were not excluded from the calculations. The data were expressed as absolute values of NISP (number of individual specimens) by site and phase (*Tab. 2*). The grain numbers of the indeterminate cereals (*Cerealia* and *Triticum* sp. in the original dataset) were not included in the calculations but were recorded (see *Tab. 2*). In some cases, the taxa were merged into clearly defined broader categories. For example, all records of cultivated barley were attributed as *Hordeum vulgare*. Most of the barley caryopses were hulled barley, while naked barley was represented only in a small admixture. Free threshing wheat (tetraploid and hexaploid varieties) was also merged into one category: *Triticum aestivum/compactum/durum/turgidum*. The combined taxon emmer/spelt was maintained separately because these records

were relatively common in our data. For pulses, the category *Lens*/*Pisum*/*Vicia* includes all finds of cultivated legumes with uncertain identification. For gathered plants, we considered only taxa with edible fruits and nuts that can be interpreted with certainty as gathered plants. However, we did not consider taxa that are only suspected to have possibly been gathered for edible seeds, such as *Fallopia* and *Chenopodium*, which are also field weeds and their deliberate collection for food is a matter of debate (*Behre 2008*).

The ubiquity of individual taxa was calculated as percentage of sites/phases with the occurrence of the taxon in each Bronze Age phase. The Representativeness Index (RI) was calculated using the approach of *Stika – Heiss* (*2013*). The pie charts on the map (*Fig. 1*: a–d) show the representation of cereals in each Bronze Age phase at the spatial scale (the numbering of sites in *Fig. 1* corresponds to the numbers in *Tab. 2*). For sites with multiple phases, the data were summed for the pie chart within a single Bronze Age period. However, in some cases, when sites were too close to each other, we have not shown all sites on the maps for clarity (the sites with missing numbers in *Tab. 2*).

Results

The Early Bronze Age

Emmer was the most important cereal in the EBA, with quantitative dominance in all studied sites (*Fig. 1*: a; *Tab. 2*). Einkorn and hulled barley were also important. The difference in barley abundance between the western and eastern parts of the studied area is striking, with barley being more common in the west part of the area (see *Fig. 1*: a). Spelt and free threshing wheats (*T. aestivum*/*compactum*/*durum*/*turgidum*) were also documented but only in a low extent. Legumes were present only in a form of individual fragments which were not possible to identify precisely (*Lens*/*Pisum*/*Vicia*), with the exception of one bulk find of faba bean (*Vicia faba*) in Vrchoslavice – Na dílech site. No oilseeds were encountered in the dataset from this period. Gathered plants were documented at most sites, particularly hazelnut (*Corylus avellana*). Cornelian cherry (*Cornus mas*), blackthorn (*Prunus spinosa*) and elderberry (*Sambucus nigra*) were also present in several sites. The Vrcovice site (Věteřov culture) contained an exceptionally wide range of gathered fruits and nuts, in addition to the above-mentioned also wild strawberry (*Fragaria vesca*/*viridis*) and blackberry (*Rubus* sp.) (see *Tab. 2*).

The Middle Bronze Age

A significant change in the composition of cereals was observed in the MBA (*Fig. 1*: b; *Tab. 2*). It was identified as the first period with widespread cultivation of broomcorn millet. While the proportion of emmer decreased, broomcorn millet became dominant, or at least subdominant in many sites. Frequency and concentration of barley remained similar as in the EBA, whereas individual sites, mainly those in the southern part of the country, contained a high proportion of spelt. Finds of free threshing wheats were still only rare in this period, documented only from one site (Řepčín – Horní nivy). Rare finds of lentil (*Lens culinaris*), faba bean and unidentified legumes were also documented. Gathered plants were represented by several finds of elderberry and a single find of hazelnut.

Num	Site Name	Period	Alt.	Samp.	Cereals								Non-cereals						Gathered						
					Hor_vul	Pan_mil	Tri_dic	Tri_mon	Tri_spe	Tri_free	Tri_di/sp	Indet	Len_cul	Pis_sat	Vic_fab	Le/Pi/Vi	Lin_usi	Pap_som	Cor_mas	Cor_ave	Fra_ve/vi	Pru_spi	Rosa	Rubus	Sam_nig
EBA																									
1	Praha-Miškovice	EBA	240	7	2		7					95								1					
2	Vrchoslavice – Na dílech	EBA	210	2								3			261										
2	Vrchoslavice – Na dílech	br.une	210	2			129	27		2		153								1					
2	Vrchoslavice – Na dílech	br.vet	210	41	4		14	3	3	4		158				1			1						
3	Vrchoslavice-Vitčice	EBA	215	17	1		353	5			1	221													
3	Vrchoslavice-Vitčice	br.vet	215	92	27		422	4			3	297				1									
4	Hulín	EBA	195	168	68	2	1298	30		10	59	904				2				6					
4	Hulín	br.une	195	61	230		147	9	2	1	14	210								1					7
4	Hulín	br.vet	195	147	25	5	6756	107	5	4	25	840				3						1			
5	Pravčice	br.vet	196	14	1	1	251	10	5	9	1	117							9			7			1
6	Vrcovice	br.vet	420	36	11		6					228				4				20	13	5		82	15
7	Kučeř	EBA	458	15	3	1	5	5				5													1
MBA																									
8	Horní Počaply	MBA	150	4		22	1	1			3	28													
9	Brandýs	br.tum	230	2	16	5	16	1	1			38													
10	Medlov – Za školou	br.mdt	264	1		26	3					2													1
11	Slavonín – Horní lán	MBA	240	12	1	16	3				2	22	1			1				1					111
12	Řepčín – Horní nivy	MBA	230	39	1660	9	611	23	356	6		45													
13	Planá	MBA	400	16	1660	99	5		4381			3758	3		3	9									1
14	Dobřany	br.c	340	1	377	468		1	37			0				1									
LBA																									
	Brandýs	br.kno	230	49	589	649	120	18	155	4		720	41	20		8									
15	Drahelčice	br.kno	370	73	327	432	124	15	97	9		550	14			8					13	1	1	1	
16	Kněževes	br.kno	344	6	53	159	1746	55				440			1										
17	Tuchoměřice	br.kno	325	23	49	32	144	2	7	5		268	25	1	1	1				5					
18	Tuchoměřice-Kněžívka	br.kno	302	80	37	1029	85	4	19	4		201	22	4		13									2
19	Praha-Smíchov	br.kno	197	12	12	105	9	2	3			176	8			3									
	Praha-Bubeneč	br.kno	215	32	8	83	25	3	7			152	1	7		1									

Num	Site Name	Period	Alt.	Samp.	Cereals								Non-cereals						Gathered						
					Hor_vul	Pan_mil	Tri_dic	Tri_mon	Tri_spe	Tri_free	Tri_di/sp	Indet	Len_cul	Pis_sat	Vic_fab	Le/Pi/Vi	Lin_usi	Pap_som	Cor_mas	Cor_ave	Fra_ve/vi	Pru_spi	Rosa	Rubus	Sam_nig
21	Nebovidy	LBA	220	2	1	2	1		3			10				2									
22	Medlov – Za školou	br.luz	264	10	8	231	8		14			30	2			1									
	Vrchoslavice – Na dílech	LBA	210	2			1		1			35													
23	Vrchoslavice – Za Hróbňó	LBA	210	6	3	3	4		2	1		14													
24	Blučina-Cezavy	br.vel	236	39	1823	4118	2785	580	1073			1130	1	2		1									
25	Obory	LBA	370	3	11	341	2					72	1	1		5								1	
26	Zhoř	LBA	428	5		1	2					25	420	1		12				2					
27	Černýšovice	LBA	420	4	2	23	2	1	2		1	32	7	1		18									
28	Hvožďany	LBA	451	103	50	277	11	1	3	3	2	98	26	2		6		1		1				2	
29	Přeštice	br.mil	349	21	5	7	1					3													2
30	Zdice	br.kno	270	39	42	353	109	2		3	42	405	24	1	2	6				1					
FBA																									
31	Brandýs	br.sti	230	55	137	334	43	10	65	3		534	10			16									
32	Dřevčice – Na výsluní	br.l-f	229	9	1	2	18	2				24													
33	Praha – Dolní Chabry	br.sti	295	25	438	323	1433	404	168	5		1171	34	2		4									
34	Nebovidy	br.sti	220	5	4	241	292	4	7			276	21												
35	Medlov – Za školou	br.slp	264	4	15	11	18		7			30	1	2		1							1		
36	Hulín	FBA	195	94	514	529	1219	34	14	1	152	1163	35	4		26		57		1			1		2
37	Březnice – U Františka	FBA	445	6	41	7	4		1		12	52	18	1	2	7									
38	Bošovice u Čížové	FBA	440	20	16	11						56	5	1	1	6		1						12	
39	Písek-nemocnice	FBA	399	7	13	2	3		4	7	5	73	2	1											4
40	Rataje	FBA	400	14	47	13	5			2		38	3					2							
41	Klatovy – Pod borem	br.l-f	420	5	1	1	3					12												1	1
42	Ostrov u Stříbra	FBA	482	1	51	6						44	10												2
43	Bavoryně	br.l-f	300	183	2965	3846	1048	63	1048	90		1871	478	24		92	1						6		1

Tab. 2. List of sites and macroremains of edible plants. Num – numbering of the sites in maps shown in *Fig. 1*; Site Name – usually cadastre; Period – for abbreviations of archaeological periods and cultural phases, see *Tab. 1*; Alt. – altitude (metres above the sea level); Samp. – number of samples analysed and included in the study; Cereals – sums of charred caryopses of cereals; Non-cereals – sums of charred seeds of pulses and oilseeds; Gathered – sums of charred macroremains of gathered fruits/nuts (NISP in all cases; abbreviations of the plant names in *Tab. 3*). Indet – sums of charred caryopses which were not possible to identify (not included in the study).

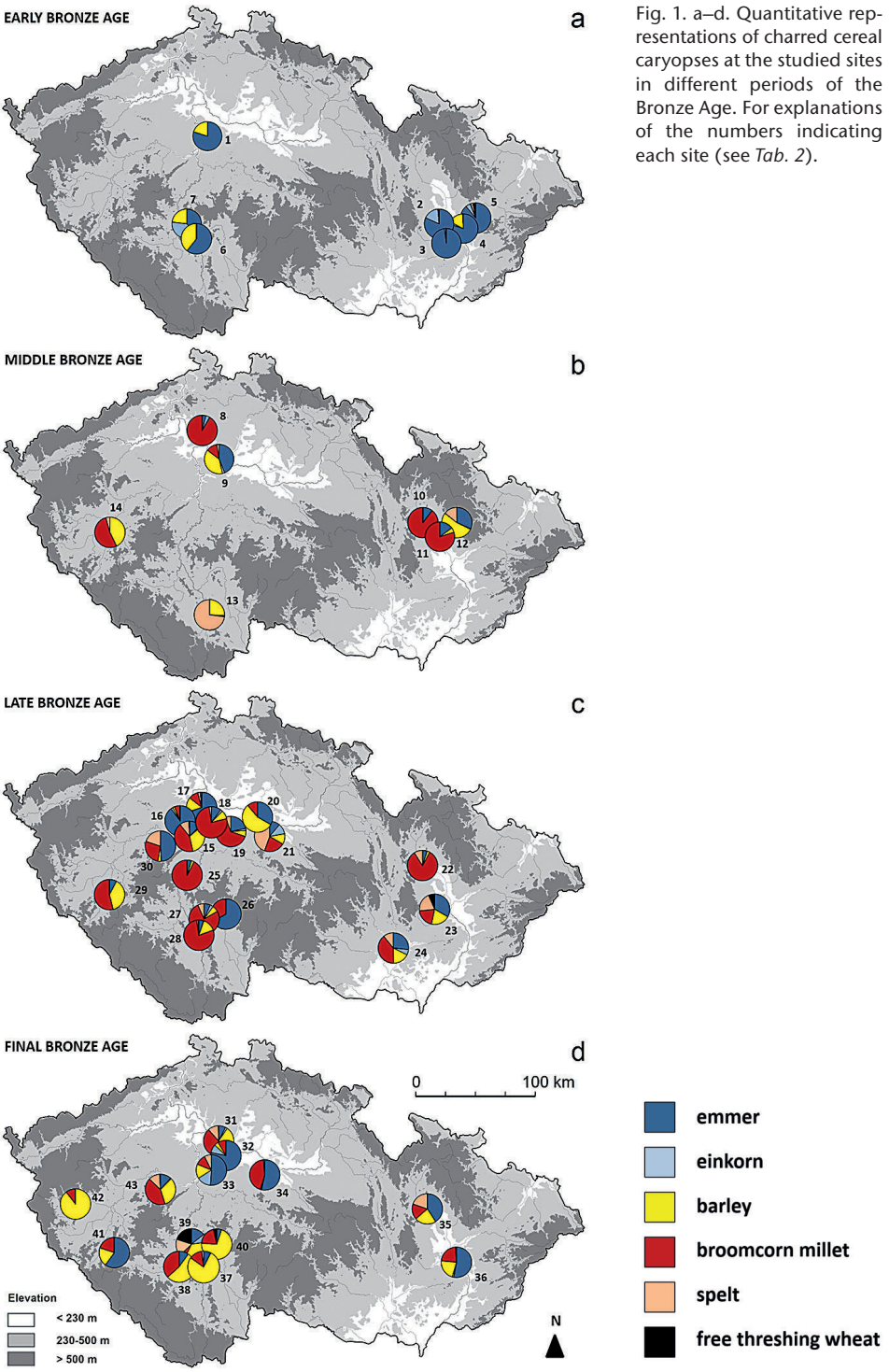

Fig. 1. a–d. Quantitative representations of charred cereal caryopses at the studied sites in different periods of the Bronze Age. For explanations of the numbers indicating each site (see *Tab. 2*).

The Late Bronze Age

The broomcorn millet culminated in the studied area in the LBA (*Fig. 1*: c; *Tab. 2*). Not only was the taxon documented in 95% of the investigated sites, but its RI (Representativeness Index) reached the maximum value (93) of all studied crops and periods (*Tab. 3*). RI of barley and emmer were also high (61 and 59 respectively). Also spelt became widespread (ubiquity 68; *Tab. 3*). Finds of pulses became widespread, lentil and pea (*Pisum sativum*) were documented in more than half of the sites (ubiquity 68 and 53 respectively), while faba bean was rare. One poppy seed (*Papaver somniferum*) was found at Hvožďany site. Wild growing edible plants, i.e., hazelnut, wild strawberry, blackthorn, rose (*Rosa* sp.), blackberry, and elderberry were present in many sites, but only in small quantities (*Tab. 2*).

The Final Bronze Age

All the cereals encountered in previous phases (emmer, einkorn, barley, spelt, free threshing wheat and broomcorn millet) were present in FBA, many of them co-occurring (*Fig. 1*: d; *Tab. 2*). Free threshing wheats were still rare. The sites were highly diversified, so that it seems as if the crops were selected deliberately to fit the local conditions. The most prominent pattern was a prevalence of emmer in fertile lowlands and of barley in higher elevations of the SW parts of the studied area (*Fig. 1*: d; *Tab. 2*). Lentil became more widespread, along with pea and faba bean, also poppy seeds were documented more frequently (*Tab. 2*). Gathered plants, mainly rose, blackberry and elderberry, represented only a small admixture.

Discussion

Representativeness of data

Although we evaluated data from 39 sites with more than 56,000 macroremains, our results are far from being representative enough. The sites differed greatly in the quantity of identified macroremains, from a few individual grains to more than ten thousand at the LBA Blučina-Cezavy site (*Tab. 2*). Unfortunately, the MBA, although the most important for understanding the BA transformation, was the least represented of all the periods studied. The maps in *Fig. 1* should only be viewed as indicative, since the pie charts do not take into account the amount of data. Nevertheless, we consider them useful to visualise the results and to recognize spatial trends.

In addition to the quantitative proportions of macroremains, we also expressed the results using ubiquity (*Tab. 3*). Ubiquity (frequency of occurrences within a period) can be, in some aspects, a better measure than quantitative proportion of macroremains, although it does not take into account the dominance of individual species, and it can also be biased in phases that contain very little data. Therefore, we also expressed the results using RI (*Tab. 3*), which takes into account both the quantity and dominance of individual species, as well as the total amount of macroremains and the number of examined samples at the site. Note the generally low RI values and concurrently high ubiquity values in MBA with the lowest number of sites (*Tab. 3*). On the contrary in LBA, the RI values of nearly all taxa are generally higher than in other periods, because of the highest number of sites.

Taxa	Scientific names	Category	Quantity of macroremains				Ubiquity				Representativeness Index (RI)			
		Period	EBA	MBA	LBA	FBA	EBA	MBA	LBA	FBA	EBA	MBA	LBA	FBA
Cereals														
Hor_vul	*Hordeum vulgare*	barley	372	3714	3025	4243	83	71	89	100	32	18	61	50
Pan_mil	*Panicum miliaceum*	broomcorn millet	9	645	7846	5326	33	100	95	100	12	9	93	51
Tri_dic	*Triticum dicoccon*	emmer	9388	639	5182	4086	92	86	100	85	80	9	59	55
Tri_mon	*Triticum monococcum*	einkorn	200	26	683	517	75	57	58	46	31	5	31	22
Tri_spe	*Triticum spelta*	spelt	15	4775	1386	1314	33	57	68	62	14	11	37	28
Tri_di/sp	*Triticum dicoccon/spelta*	emmer/spelt	103	5	45	169	50	29	16	23	22	2	8	10
Tri_free	*Triticum aestivum/compactum/durum/turgidum*	free threshing wheat	30	6	29	108	50	14	37	46	25	2	22	17
Non-cereals														
Len_cul	*Lens culinaris*	lentil		4	592	617		29	68	85		2	31	28
Pis_sat	*Pisum sativum*	pea			40	35			53	54			24	16
Vic_fab	*Vicia faba*	faba bean	261	3	4	3	8	14	16	15	2	1	5	3
Le/Pi/Vi	*Lens/Pisum/Vicia*	lentil/pea/vetch	11	11	85	152	42	43	74	54	20	3	31	19
Lin_usi	*Linum usitatissimum*	flax				1				8				5
Pap_som	*Papaver somniferum*	poppy			1	60			5	23			5	7
Gathered														
Cor_mas	*Cornus mas*	cornelian cherry	10				17				5			
Cor_ave	*Corylus avellana*	hazelnut	29	1	9	1	42	14	21	8	13	1	10	4
Fra_ve/vi	*Fragaria vesca/viridis*	wild strawberry	13		14		8		11		2		5	
Pru_spi	*Prunus spinosa*	blackthorn	13		1		25		5		8		4	
Rosa	*Rosa* sp.	wild rose			1	8			5	23			4	10
Rubus	*Rubus* sp.	blackberry	82		4	13	8		16	15	2		10	3
Sam_nig	*Sambucus nigra*	elderberry	24	113	4	10	33	43	11	38	8	4	6	12

Tab. 3. Importance of individual taxa of edible plants according to the main Bronze Age phases. Taxa – abbreviations of taxa (used also in *Tab. 2*); Quantity of macroremains – totals of all charred macroremains (NISP) for each period; Ubiquity – percentages of sites, within a period, containing a given taxon; Representativeness Index – relative numbers (calculated according to *Stika – Heiss 2013*).

Therefore, to evaluate the changing importance of individual species, we recommend using as many different approaches as possible (in our case combining *Fig. 1*, *Tab. 2*, and *Tab. 3*).

Cereals

Emmer was the most important crop in EBA (RI 80; *Tab. 3*), dominating almost all sites (*Fig. 1*). However, it lost its dominant position in MBA and was replaced by other crops (mainly broomcorn millet). It became important again in LBA (RI 59), but only in some sites. Finally, in FBA, emmer was dominant or subdominant mainly in lowland sites on fertile soils, while in higher elevations it mostly formed only a limited proportion of cereal grains (*Fig. 1*: d). Einkorn always represented only an admixture, without any clear spatial pattern (*Fig. 1*) and with gradually decreasing values of ubiquity (from 75 to 46; *Tab. 3*). Free threshing wheat was present in all BA phases, but only as an insignificant admixture.

Spelt has been documented in the studied area since the Eneolithic (*Dreslerová – Kočár 2013*), similarly as in Austria, southern Germany and Switzerland (*Akeret 2005*; *Kohler-Schneider – Caneppele 2009*). In our data, spelt was initially documented with uncertainty (mostly as emmer/spelt in EBA; *Tab. 2*; *Tab. 3*). The reliably identified spelt became more frequent in MBA, while in Planá site, it was exceptionally dominant with more than four thousand grains and more than 70% of identified cereal grains (*Fig. 1*: b; *Tab. 2*). This exceptional site is in a good accordance with previously demonstrated cultural relationship of South Bohemia with the Danube region in EBA and MBA (*Šálková et al. 2019*). In younger periods of the Bronze Age (LBA and FBA) the importance of spelt was higher than in EBA, with ubiquity values above 60 and RI values around 30 (*Tab. 3*).

Barley was a subdominant cereal in some sites, whereas in other sites it formed only a limited share. In the EBA, it seems to be more important in the western part of the studied area compared to the easternmost sites (*Fig. 1*: a). However, this pattern may be the result of a bias caused by generally low amounts of identified grains in the westernmost sites (Praha-Miškovice, Vrcovice and Kučeř). The ubiquity of barley gradually increased in BA from 83 in EBA to 100 in FBA. In the FBA, barley became dominant (or subdominant) in nearly all sites in the south and west of the country, which is a territory with generally higher elevation and lower quality soils compared to the fertile lowlands in the north and east (*Fig. 1*: d).

The arrival of broomcorn millet in the study area is expected in the MBA (*Filipović et al. 2020*). However, broomcorn millet grains were already documented in some EBA sites in our dataset. These finds are assumed to represent a younger intrusion, as they are mostly linked to polycultural sites with well-developed younger phases, for example, Hulín (14 pcs.) and Pravčice (1 pc.); or these were single grains with an uncertain identification as in Kučeř (*Tab. 2*). On the other hand, it was our decision to include the Věteřov culture into EBA (see above). The dating of the Věteřov culture (1700–1500 BC) partly overlaps with the older phase of the Tumulus culture (1700/1600–1300/1250 BC), so we cannot rule out that these findings are correct, however, only a direct ^{14}C dating of the grains can answer this question reliably.

Only in the MBA, the evidence of broomcorn millet cultivation is considered reliable. The grains of *Panicum miliaceum* represented a dominant portion of cereal grains in many sites (*Fig. 1*: b) and also its ubiquity reached 100. This is in a good agreement with other

finds from the country, like the earliest ^{14}C dated evidence from the waterlogged site Zahájí (1461–1383 BC; not included in this study; *Bernardová 2009*; *Pokorný et al. 2015*) and with other mass finds from the Tumulus culture (*Kočár – Dreslerová 2010*; *Dreslerová – Kočár 2013*; *Dreslerová et al. 2017*; *Šálková et al. 2019*). It is evident that the beginning of broomcorn millet cultivation in MBA was sudden and intense. In LBA, it reached the maximum RI (93), whereas its importance slightly decreased in FBA (RI 51).

Non-Cereals

Legumes were rarely documented in EBA and MBA, except for the single mass finding of faba bean in EBA (Vrchoslavice – Na dílech site). However, in younger periods faba bean was represented only by single seeds and its RI never exceeded 5 (*Tab. 3*). Although pea and lentil have been known in the Czech Republic already since the Neolithic (*Kočár – Dreslerová 2010*), their finds have expanded in our data only since LBA, with lentils being generally more dominant. The ubiquity of lentil gradually increased from 29 in MBA to 85 in FBA, while its RI reached around 30 in LBA–FBA (*Tab. 3*). Other less important legumes known in the Czech Republic since LBA–FBA (*Kočár – Dreslerová 2010*), such as common vetch (*Vicia sativa*) and bitter vetch (*Vicia ervilia*), were not represented in our data.

No oilseeds were encountered in our data until the end of MBA, while in LBA–FBA, poppy (*Papaver somniferum*) and linseed (*Linum usitatissimum*) were only sporadically recorded. Although flax has been documented in the study area since the Neolithic (*Kočár – Dreslerová 2010*), we have only one linseed from FBA Bavoryně site on our dataset. Also, poppy cultivation in the area is probably even older than BA, however, we recorded only one seed at the LBA Hvožďany site and three other records in FBA, the most remarkable of which are 57 seeds from the Hulín site (*Tab. 2*).

Finds of gathered fruits and nuts were relatively rare in the dataset, however, it is evident that they still played a certain role in the Bronze Age economy. Hazelnut and elderberry were among the most frequent finds. Cornelian cherry was found only in EBA, while wild strawberry and blackthorn were documented in both EBA and LBA. Blackberry was found in all periods except for MBA, and wild rose in LBA and FBA. The importance of individual taxa seems to have declined slightly over time, which is best seen in the example of hazelnut (*Tab. 3*). The wild rose, on the contrary, increased its importance towards the end of the BA. An unusually rich collection of gathered fruits and nuts was found in the EBA Vrcovice site, containing hazelnut, wild strawberry, blackthorn, blackberry and elderberry (*Tab. 2*). With a total of 135 seeds from five species of gathered plants, it is the richest site in the entire collection. This is the highest point of the Věteřov culture (420 m above sea level). Perhaps it may be a case where the insufficient harvest was compensated by gathering wild fruits, but the uniqueness of the case does not allow us to draw general conclusions.

Crops selection

The shift to millet and spelt cultivation together with an increase in pulses towards the younger phases of the BA reflects a change in subsistence strategies. However, the low number of sites from the crucial period (mainly from the MBA) makes precise understanding of the process particularly difficult. Based on the changing composition of cultivated

plants, it is generally expected that the importance of spring-sown crops increased in the study area in the LBA (*Šálková et al. 2019*). Barley, as well as emmer and einkorn, can be grown either as spring-sown crops or as winter crops, while broomcorn millet and pulses are always sown in spring and spelt is often a winter cereal (*Hajnalová 2012*; *Šálková et al. 2019*). In order to specify the time of sowing, it would be possible to carry out a taphonomic and subsequently an ecological analysis of weed seeds at the studied locations (*Bogaard et al. 2001*), but this approach is beyond the scope of our study.

FBA appears to represent a final stage of agricultural transformation. While the RI of barley and broomcorn millet gradually increased from EBA towards FBA (from 32 to 50 and from 12 to 51), the RI of emmer decreased (from 80 to 55). As a result, the RIs of the three most important cereals were rather evenly distributed in the FBA (*Tab. 3*). The increased diversity of cultivated plants might have enabled deliberate selection of a suitable crop to achieve an optimum yield with respect to local conditions. The most important environmental factors which were previously proven to be governing crop choice were soil quality and length of growing season (*Dreslerová et al. 2017*). In the referred study, the hulled wheats correlated positively with chernozems and negatively with a mean annual precipitation, whereas barely positively correlated with altitude. Our data confirms this trend, mainly in the FBA. Broomcorn millet, on the contrary, dominated in our data from the MBA onwards in many sites regardless of elevation and the soil quality. This is somewhat inconsistent with previously published data (*Dreslerová et al. 2017*) which demonstrated dominance of broomcorn millet in the lowlands. It can be explained by the fact that we used a different dataset. We did not include some earlier analysed data, but we expanded the dataset with new data, especially from South Bohemia, which contained a high proportion of broomcorn millet, especially in LBA, in higher elevations.

Conclusions

We examined charred macroremains from 39 archaeological sites in the Czech Republic dated to the Bronze Age (BA) which provided data on proportional changes of cereals, pulses, oil plants and gathered plants. The most significant changes include the introduction of broomcorn millet in the Middle Bronze Age (MBA) and increased importance of pulses since the Late Bronze Age (LBA). Besides, we documented a shift in the importance from archaic diploid and tetraploid hulled types of wheat (einkorn and emmer) to hexaploid types (spelt) and perhaps even the free threshing wheats.

Emmer, initially the main crop in the EBA, lost its prominence in the MBA, however, it regained dominance in certain lowland sites again by the FBA. Barley, although present in all periods of the BA, was apparently more important in the south and south-west of the territory, especially in EBA and FBA. This trend could be related to possible preference for barley on poor soils and at higher elevations. Spelt showed an exceptional dominance in the southern part of the studied territory in the MBA; however, later it formed a common part of the assortment in different parts of the area, without any clear spatial pattern.

The study highlights a sudden introduction of broomcorn millet during the MBA. However, the limited number of sites, particularly from the MBA, complicates a precise understanding of all aspects of this transformative process. The dominance of broomcorn millet in the dataset from the MBA onwards, regardless of elevation and soil quality,

challenges some earlier findings and underscores the importance of using diverse datasets for a comprehensive understanding of agricultural practices in the Bronze Age.

The changes observed in crop cultivation patterns indicate evolving subsistence strategies. The increased diversity of cultivated plants and the increase in the importance of legumes may have allowed a better distribution of field work throughout the year, as well as a deliberate crop selection, resulting in optimised yields based on local conditions.

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TOPICAL REVIEW – TEMATICKÁ SYNTÉZA

Far from home: Stroke-Ornamented Ware and grog temper in the Polish Lowlands

Daleko od domova: Vypíchaná keramika a příměs drcené keramiky v Polské nížině

Danuta Żurkiewicz

After the disappearance of the Linear Pottery culture (LBK) in the area now known as the Polish Lowlands, we observe a heterogeneous cultural situation. The Late Band Pottery culture (LBPC) and the Stroke-Ornamented Ware culture (SBK) are distinguished here. Generally, none of these communities used grog (ground potsherds, 'chamotte') as the main type of clay temper. However, there are exceptions to these production rules. In this article, the presented pottery materials from sites in the Polish Lowlands allow us to conclude that grog temper was important for some of these communities. An attempt to interpret the addition of fragments of other vessels to the pottery clay does not point to the technical advantages of the chamotte itself, but rather to its symbolic meaning – the use of fragments of burned vessels to produce new forms. A great deal of ethnographic data justifies this approach, which is sometimes used in archaeological interpretations. The proposed hypothesis allows us to consider an alternative concept of the origin of some post-LBK communities in the Polish Lowlands.

Late Band Pottery culture – Stroke-Ornamented Ware culture – Stichbandkeramik – grog temper – pottery technology

Po zániku kultury s lineární keramikou (LBK) v oblasti dnes známé jako Polská nížina pozorujeme heterogenní kulturní situaci. Je zde rozlišována pozdní kultura s lineární keramikou (LBPC) a kultura s vypíchanou keramikou (SBK). Obecně platí, že žádná z těchto komunit nepoužívala drcenou keramiku („šamot") jako hlavní typ keramické příměsi. Existují však výjimky z těchto výrobních pravidel. Keramický materiál z lokalit v Polské nížině prezentovaný v tomto článku umožňuje vyvodit závěr, že příměs drcené keramiky byla pro některé z těchto komunit důležitá. Pokus o interpretaci přidávání zlomků jiných nádob do hrnčířské hlíny nepoukazuje na technické přednosti samotného šamotu, ale spíše na jeho symbolický význam – využití zlomků vypálených nádob k výrobě nových forem. Četná etnografická data ospravedlňují tento přístup, který je někdy využíván i v archeologických interpretacích. Navržená hypotéza umožňuje uvažovat o alternativním pojetí vzniku některých post-LBK komunit v Polské nížině.

pozdní kultura s lineární keramikou – kultura s vypíchanou keramikou – Stichbandkeramik – šamotová příměs – technologie keramiky

Introduction

Pottery decorated with stroke ornament is found among the materials of communities that developed in what is now known as the Polish Lowlands after the disappearance of the Linear Pottery culture (LBK) around 5100 BC (*Whittle et al. 2022*). In the lowlands between the Vistula and Odra rivers, the excavated archaeological remains have no analogues outside this area. This largely indicates the emergence of a new cultural unit known as the Late Band Pottery culture (LBPC) (*Fig. 1*; *Czerniak 1980*; *Czerniak – Pyzel 2019*). The term is associated with a broader concept allowing the LBPC community to be derived

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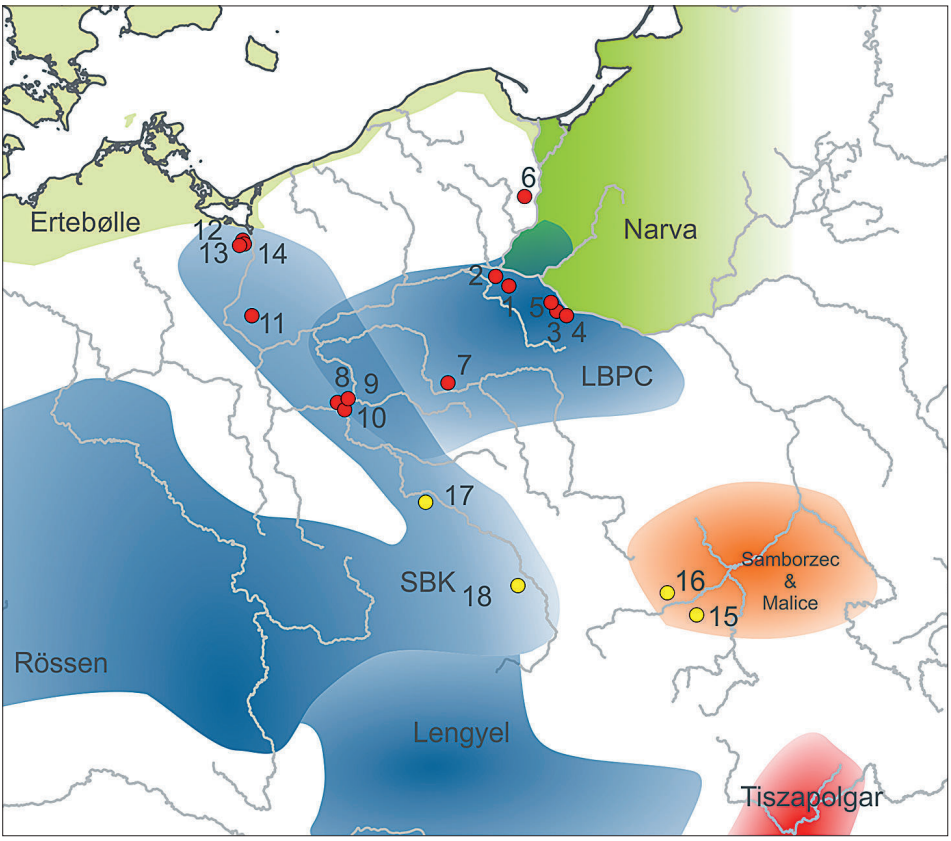

Fig. 1. North-central Europe around 4800–4500 BC. Sites mentioned in the text: Red points label SBK/LBPC sites: 1 – Węgierce 12; 2 – Gorzyce 38; 3 – Ludwinowo 7; 4 – Ludwinowo 6; 5 – Dubielewo 8; 6 – Barłożono 12; 7 – Kijewo 4; 8 – Święty Wojciech 7; 9 – Międzyrzecz 108; 10 – Międzyrzecz 11; 11 – Nowe Objezierze 22; 12 – Przylep 5; 13 – Szczecin-Gumieńce 17; 14 – Mierzyn 9. Yellow points label sites from outside the Polish Lowlands that have been radiocarbon dated: 15 – Targowisko 10–11; 16 – Kraków-Olszanica 2; 17 – Strachów 2; 18 – Racibórz Ocice 1 (based on *Czerniak 2012*; *Řídký et al. 2017*; *Czerniak – Pyzel 2019*).

from local LBK groups. The currently revealed chronological hiatus between the LBK and LBPC was likely caused by a crisis experienced by the first farmers communities that forced them to abandon permanent settlements and agriculture and instead base their existence on animal husbandry and temporary settlements. The result was the emergence of communities classified as the LBPC (*Czerniak – Pyzel 2019*, 62). The further stage of their development associated with the Brześć Kujawski culture (BKC) is characterised by renewed economic and settlement stabilisation appearing, among other ways, as multi-phase settlements featuring trapezoidal longhouses.

Not all researchers of the Polish Lowlands accept the development of the LBPC and some of the local materials have been classified directly as the Stroke-Ornamented Ware culture (*Stichbandkeramik*, SBK, e.g. *Kulczycka-Leciejewiczowa 2006*; *Grygiel 2008*), which poses additional problems for interpretation. Current representations of the SBK and LBPC 'range' (*Řídký et al. 2017*, 580, fig. 1; *Czerniak – Pyzel 2019*) indicate that in

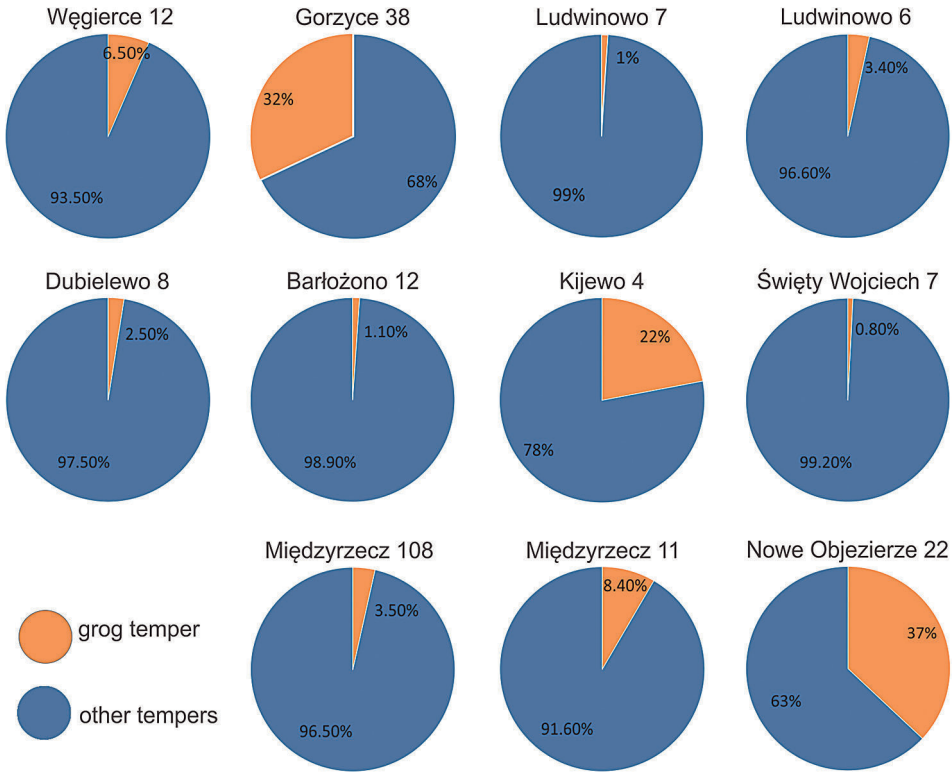

Fig. 2. LBPC/SBK sites featuring pottery with grog temper and its percentage share in pottery assemblages. For site locations see *Fig. 1*.

the Polish Lowlands, the paths of both communities, especially in the Odra Valley zone, actually ran very close and it is impossible to establish a clear border between them.

A much more distinct border during the Stroke-Ornamented Ware period can be drawn along the Vistula River. This demarcation is a reference to a broader hypothesis assuming that SBK communities in Central Europe were divided into specific zones differentiated by types of tempers used for pottery production (*Czerniak 1989*; *1994a*). The border of the proposed zones is thought to be located at the meridian course of the Danube River. The first zone, east of this section of the river, is characterised by the use of grog tempers (ground potsherds, 'chamotte'); the second zone, west of the Danube, is defined by the dominance of mineral tempers. Extending this border further north places it on the upper reaches of the Vistula, which, to the east of this section, was inhabited by communities that actually used grog temper. West of the Vistula up to its mouth, communities that added mineral tempers to the pottery clay were recorded. Therefore, according to this hypothesis, the area in which SBK and LBPC communities occurred belongs to the zone in which grog temper is of 'foreign' origin.

However, a recent analysis of materials from the LBPC site of Gorzyce located on the border of Kuyavia and Greater Poland revealed a significant share of pottery decorated with stroked ornament and made with grog temper (*Fig. 1*; *Fig. 2*; *Żurkiewicz et al. 2023*).

It also stimulated the search for further lowland analogies and aroused a discussion and interpretation of the procedure by which grog was added to vessels in the considered period of prehistory. This paper aims to review the LBPC/SBK sites from the Polish Lowlands where grog temper was identified as an addition to pottery decorated with stroke ornament and attempts to interpret this phenomenon.

Assemblages with grog temper in the Lowlands

The discussion on the presence of grog temper in pottery with stroked ornament in the Polish Lowlands began with discoveries from site 12 in Węgierce in the Kuyavia region of Poland (*Czerniak 1992*). A relatively small assemblage of pottery excavated from a clay pit was dated to the first phase of the LBPC. Of the 662 recorded pottery fragments (sherds), 43 (6.5% of the total) were classified into a new technological group: medium- and thick-walled pottery with a temper of fine sand and grog. Based on stylistic references (mainly 'stroked band' pottery), the author of the study argued that the materials were connected with the zone of Lower Silesia and the Czech Republic. The trace presence of 'chocolate' flint and grog in the ceramics from Węgierce is thought to be the result of contacts between the inhabitants of this settlement and Lesser Poland, perhaps with the Malice culture (MC) (*Czerniak 1992*, 46). In addition to the stylistic indications that the materials from Węgierce are from one of the earliest LBPC sites in the Lowlands area, a single radiocarbon date (Gd-2509 5860 ± 100 BP; *Czerniak 1994b*) is also available. Unfortunately, the date from an animal bone found in the clay pit described above is quite imprecise and marks the interval between 4988–4463 cal BC at 95.4% probability (*Tab. 1*).

Site no. 38 in Gorzyce is the newest on the list considered here and its recent excavation initiated the topic discussed in this article. In the complex of eight LBPC clay pits, 303 sherds from approximately 103 pottery vessels were documented (*Żurkiewicz et al. 2023*). The high frequency of decorated pottery (64%) is accompanied by the absolute dominance of the stroke technique performed on vessels with thin and medium-thick walls. The vast majority of vessels (up to 68%) were made with grog temper (*Fig. 3*).

Other sites in Kuyavia for which publications mention the presence of grog temper include Ludwinowo site 7, where pits, houses, and other LBPC household activity features were excavated (*Czerniak 2019*). Approximately 1% of LBPC pottery fragments from this site belong to technological groups containing grog. It is interesting that the custom of adding grog to ceramics is to a small extent visible also among the BKC – the successors of the LBPC at this site (*Czerniak 2019*, 162, tab. 3.3). A date obtained from a LBPC grave indicates the range of 4449–4330 cal BC (95.4%). An analysis of the stylistic attributes of this assemblage did not indicate any analogies outside Kuyavia.

In the same town, at Ludwinowo site 6 (*Czerniak 2017*, 213, tab. 2), the other LBPC settlement features were also excavated and included a pit house, a clay pit, and a 'special' feature (grave – cenotaph?). The assemblage excavated at the site includes 559 potsherds and eight flints. From this collection, approximately 19 sherds (3.4%) were made using sand with grog temper. The study did not identify any references to non-regional external styles of pottery decorated with stroked ornament.

In another Kuyavia settlement, at site 8 in Dubielewo, materials related to the LBPC and BKC were discovered. Graves (at least four features) and several household activity

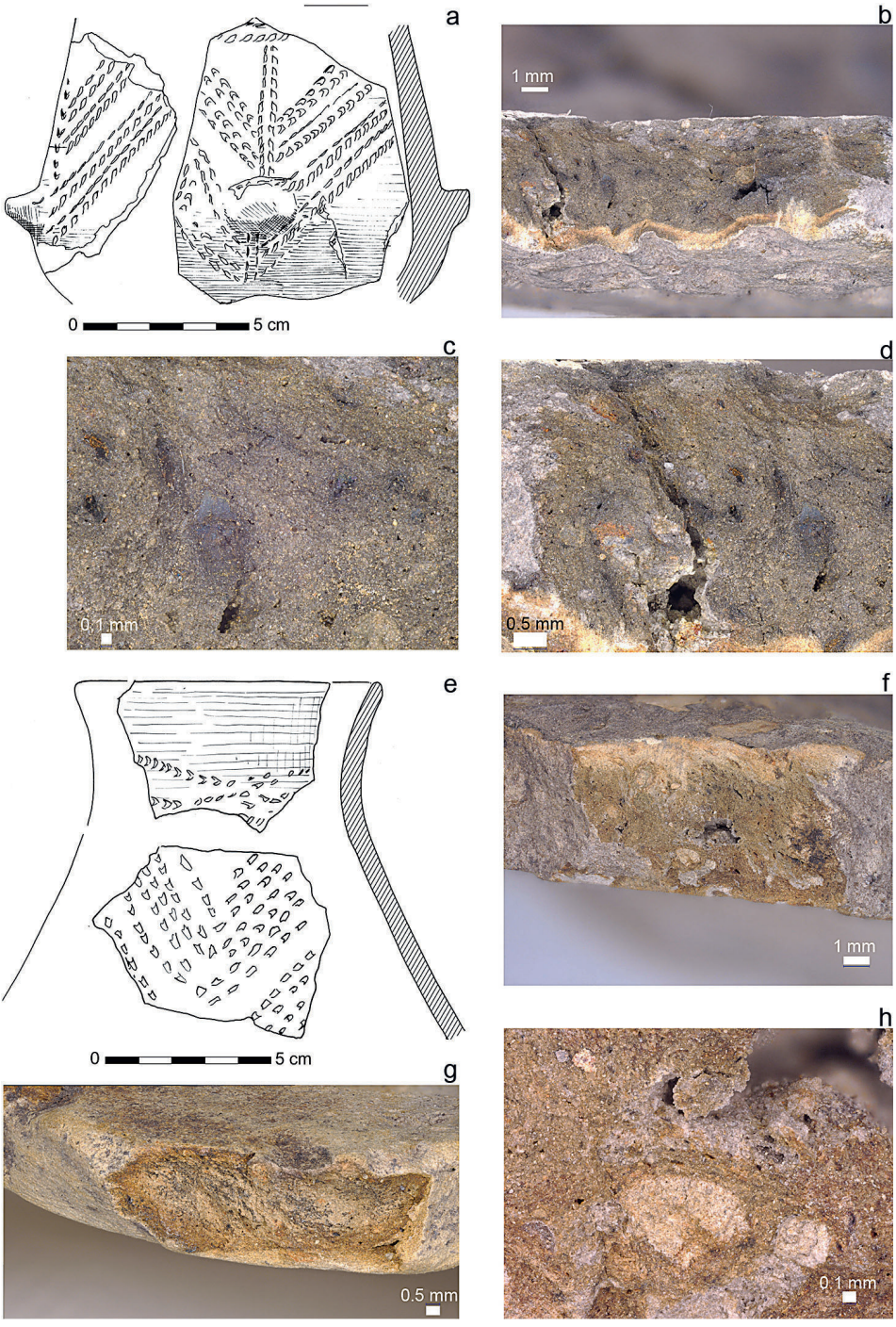

Fig. 3. LBPC pottery with grog temper. Gorzyce, site 38, Kuyavian-Pomeranian Voivodeship (drawn by E. Pawlak, photos by I. Sobkowiak-Tabaka).

#	Site	Lab. code	BP	Calibrated BC		Sample	References
				68.3% probability	95.4% probability		
1	Inowrocław Mątwy 5	Bln-1323	6000±120	5038 (61.8%) 4772 4762 (6.4%) 4726	5216 (95.4%) 4606	unidentified charcoal	*Czerniak – Kośko 1980*
2	Firlus 8	Gd-2429	6020±100	5045 (68.3%) 4790	5211 (95.4%) 4710	unidentified charcoal	*Kirkowski – Sosnowski 1994*
3	Nowe Objezierze 22	Poz-99611	5920±40	4837 (44.9%) 4774 4760 (23.4%) 4726	4928 (0.2%) 4925 4904 (95.2%) 4707	animal bone	*Czerniak et al. 2019; 2020*
4	Nowe Objezierze 22	Poz-99477	5890±40	4797 (68.3%) 4715	4889 (1.6%) 4870 4848 (93.3%) 4678 4630 (0.6%) 4622	animal bone	*Czerniak et al. 2019; 2020*
5	Nowe Objezierze 22	Poz-99478	5875±30	4785 (68.3%) 4716	4836 (4.5%) 4811 4805 (90.9%) 4681	animal bone	*Czerniak et al. 2019; 2020*
6	Białcz Stary 4	Gd-1753	5860±50	4795 (65.8%) 4678 4630 (2.5%) 4622	4843 (94.4%) 4591 4566 (1.0%) 4555	unidentified charcoal	*Czerniak et al. 2016*
7	Węgierce 12	Gd-2509	5860±100	4842 (66.8%) 4601 4563 (1.4%) 4556	4988 (1.2%) 4965 4956 (93.8%) 4493 4471 (0.5%) 4462	animal bone	*Czerniak et al. 2016*
8	Nowe Objezierze 22	Poz-99479	5850±40	4787 (68.3%) 4682	4834 (2.1%) 4814 4801 (92.7%) 4601 4564 (0.6%) 4556	animal bone	*Czerniak et al. 2019; 2020*
9	Nowe Objezierze 22	Poz-99612	5850±40	4787 (68.3%) 4682	4834 (2.1%) 4814 4801 (92.7%) 4601 4564 (0.6%) 4556	animal bone	*Czerniak et al. 2019; 2020*
10	Nowe Objezierze 22	Poz-99613	5840±40	4784 (20.9%) 4743 4733 (40.1%) 4674 4634 (7.3%) 4618	4796 (93.7%) 4587 4568 (1.7%) 4553	animal bone	*Czerniak et al. 2019; 2020*
11	Kraków Olszanica 2	Poz-77984	5830±40	4777 (8.1%) 4758 4727 (47.5%) 4654 4638 (12.7%) 4614	4792 (92.7%) 4585 4569 (2.7%) 4552	charcoal (*Quercus* sp.)	*Zastawny 2022*
12	Białcz Stary 4	Gd-2054	5820±80	4783 (11.3%) 4745 4731 (52.7%) 4586 4568 (4.3%) 4553	4881 (0.6%) 4871 4847 (94.0%) 4490 4474 (0.9%) 4460	unidentified charcoal	*Czerniak et al. 2016*
13	Targowisko 10–11	Poz-71637	5800±35	4711 (68.3%) 4611	4774 (1.3%) 4762 4726 (94.2%) 4544	charcoal (*Quercus* sp.)	*Zastawny 2022*
14	Nowe Objezierze 22	Poz-99476	5750±35	4672 (18.7%) 4635 4616 (49.6%) 4545	4698 (95.4%) 4500	animal bone	*Czerniak et al. 2019; 2020*
15	Strachów 2	Bln-3851	5730±80	4681 (66.5%) 4494 4469 (1.8%) 4463	4780 (2.0%) 4752 4729 (88.6%) 4441 4424 (4.8%) 4367	?	*Czarniak 2012*
16	Barłożno 12	Poz-17078	5720±40	4611 (68.3%) 4496	4681 (95.4%) 4457	?	*Felczak 2020*
17	Racibórz-Ocice 1	KN-1375	5690±55	4602 (14.4%) 4563 4556 (53.8%) 4453	4683 (89.9%) 4442 4422 (3.7%) 4395 4386 (1.8%) 4370	?	*Czarniak 2012*
18	Bodzia 1	Poz-43556	5580±40	4447 (9.2%) 4436 4429 (59.1%) 4363	4493 (6.0%) 4471 4461 (89.4%) 4345	animal bone	*Czerniak 2019*
19	Dubielewo 8	?	5580±60	4455 (68.3%) 4352	4541 (95.4%) 4335	human bone	*Siewiaryn-Mikulski 2015*
20	Janowice 2	Poz-83598	5560±40	4444 (24.4%) 4419 4402 (43.9%) 4355	4486 (1.3%) 4479 4456 (94.2%) 4340	animal bone	*Czerniak 2016*
21	Ludwinowo 7	Poz-31419	5525±35	4442 (20.9%) 4421 4396 (7.4%) 4385 4370 (39.9%) 4338	4449 (95.4%) 4330	human bone	*Czerniak 2019*

Tab. 1. Radiocarbon dates of LBPC and SBK sites from the Polish Lowlands compared with the earliest radiocarbon dates for assemblages with stroked ornament and grog temper from upland areas (red). Calibrated by the OxCal v.4.4 software (*Bronk Ramsey 2009*) using the IntCal20 calibration curve (*Reimer et al. 2020*).

features, including a clay pit, are connected with the LBPC stage. A detailed analysis of pottery technology carried out for the LBPC and the BKC (*Siewiaryn – Mikulski 2015*, 67, tab. 9) showed that out of 401 sherds, 10 were made using a temper of medium-grained grog and a very small amount of fine sand, mica and crushed stone. Single pottery fragments made using this technology also occur in other LBPC or BKC features. Within the stylistic analogies for the LBPC pottery, the authors emphasize clear attributes characteristic of the late horizon of the SBK (*Siewiaryn – Mikulski 2015*, 78). A radiocarbon date (5580 ± 60 BP) was obtained from the LBPC grave from this site (see *Fig. 4*; *Tab. 1*).

Further source assemblages come from the Starogard Lakeland slightly north of Kuyavia. At the Barłożno 12 site, a set of 12 sunken features and 1,973 potsherds were discovered (1,798 sherds from the sunken features). The description of the pottery analysis includes 988 fragments. The main type of temper in LBPC pottery at this site remains sand and crushed stone (*Felczak 2020*). Of the 202 isolated LBPC potsherds, 11 were identified as vessels made with a temper of sand and grog (*Felczak 2020*, 65–72, tab. 4). The presence of grog is also confirmed by mineralogical and petrographic analyses of the ceramic composition (*Rauba-Bukowska 2020*). Among the eight thin sections of LBPC pottery samples, grog temper was found in one – a fragment of the base of a thick-walled vessel (*Rauba-Bukowska 2020*, 216, tab. 2). In terms of stylistic features, O. Felczak clearly connects the Barłożno pottery with SBK assemblages from other regions of Poland. The influence of the Rössen culture is also mentioned for one of the vessels (*Felczak 2020*, 59).

Another site of interest can be found much further southwest of the previous settlement, in the Middle Warta River of central Greater Poland, where three LBPC sunken features were discovered at site 4 in Kijewo. Their attributes permit an interpretation as pits located along the walls of houses, even though there are no traces of the buildings themselves at this site (*Pawlak et al. 2008*, 191). A total of 466 potsherds were recorded, all within the features. From this collection, a relatively large number, 102 sherds (22%), were assigned to the technological group containing grog and fine sand (*Pawlak et al. 2008*, 245, tab. 5). According to the authors of that study, the materials from Kijewo are stylistically and technologically similar to the LBPC pottery from Kuyavia. The authors explain the exceptionally high frequency of pottery with stroked ornament by the intense connections of Greater Poland with the area of Lower Silesia and indirectly with the influence of SBK from phase IVb (according to *Zápotocká 1970*, 192). However, there is no interpretation of the fact that there was such a high frequency of ceramics with grog.

The remaining sites from the Polish Lowlands containing pottery with stroked ornament and grog temper come from the western border of the LBPC and SBK. They constitute a group of three points from the vicinity of Międzyrzecz (Lubuskie Voivodeship). The most complex remains related to the LBPC/SBK were discovered at the site of Święty Wojciech 7, but the available publication only presents an analysis of pottery (*Jankowska et al. 2014*). A total of 123 potsherds and 10 LBPC sunken features were discovered here. An organic temper and grog were noted only in one of the pottery fragments (the undecorated handle). The remains from this site were considered a manifestation of the short-term stay of the LBPC community along a route (north-south) concentrated in the Obra Basin. Based on the style of pottery ornament and vessel forms, as well as the occurrence of Rössen culture pottery in this area, the authors suggest chronological convergence with phase IV of the SBK in the Czech Republic (*Jankowska et al. 2014*, 67).

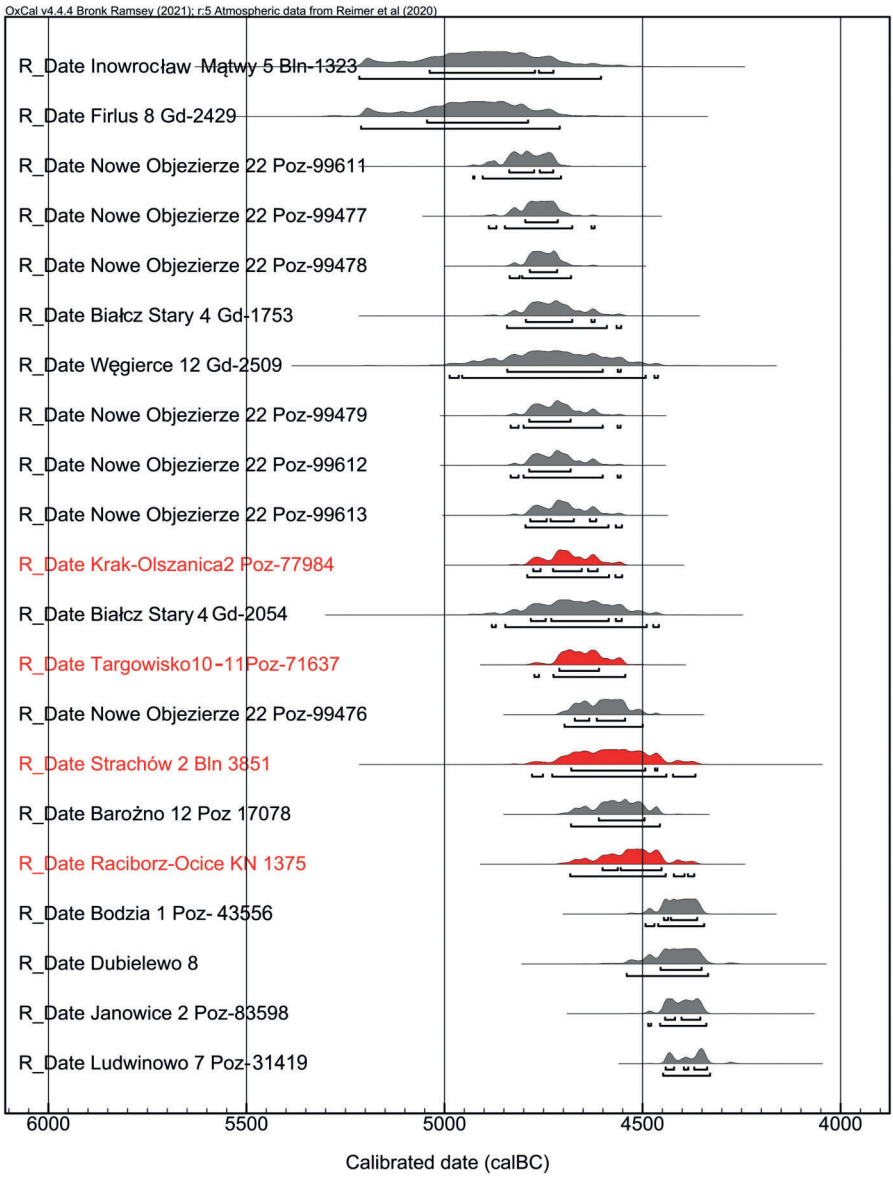

Fig. 4. Absolute dating of LBPC and SBK sites from the Polish Lowlands (grey) compared with the earliest radiocarbon dates for assemblages with stroked ornament and grog temper from upland areas (red). Calibrated by the OxCal v.4.4 software (*Bronk Ramsey 2009*) using the IntCal20 calibration curve (*Reimer et al. 2020*).

Of the 259 LBPC/SBK potsherds discovered at Międzyrzecz site 108, 37 were found in five sunken features (*Kaniewska – Sobucki 2006*, 138). The dominant type of temper added to LBPC/SBK ceramics was crushed stones. Grog was observed in only nine pottery fragments, constituting 3.5% of the collection (*Wierzbicki 2006*, 109). In the analysed

materials, the authors found numerous references to phase IV of the SBK from the Czech Republic, groups from the Elbe and Saale regions of this culture and to the Kuyavia LBPC groups (*Wierzbicki 2006*, 121).

At Międzyrzecz site 11, three sunken features were excavated: a pit house and two LBPC/SBK settlement pits (*Ciesielski – Gorczyca 2013*). A total of 391 pottery fragments were recovered, including 385 from the sunken features. The analysis of the pottery technology indicates that 33 sherds (8.2%) contain grog as the main temper. From the LBPC/SBK features, 309 fragments of daub containing grog were also recovered (*Ciesielski – Gorczyca 2013*, 20). The authors of the study suggest that these remains coincide with the late SBK phases (IV–IV/V) from the Czech Republic. They also indicate references to the areas of the Elbe and Saale, Lower Silesia and the Kuyavia LBPC and emphasise 'eastern influences' (LBPC) rather than western ones (Rössen culture) (*Ciesielski – Gorczyca 2013*, 20).

To summarise the cases presented above, it can be stated that the vast majority of stylistic attributes have references to SBK – usually in their classical versions (*Zápotocká 1970*). Sites near Międzyrzecz are *de facto* classified as SBK. It justifies an attempt to search the available studies of SBK assemblages from the Oder catchment area in terms of the presence of ceramics with grog.

The aforementioned sites from the vicinity of Międzyrzecz are a matter of the discussion regarding the occurrence of ceramics with grog temper and stroked decoration in the Odra Valley. Moving about 80 km in a straight line to the northwest, we stop in the immediate vicinity of the Odra Valley, at site 22 in Nowe Objezierze. The recent discovery of a unique form of a SBK rondel initiated intensive non-destructive research and excavations at this site. As indicated by the obtained series of radiocarbon dates, the rondel was established around 4850 BC and likely functioned for about 200 years (*Fig. 4*; *Czerniak et al. 2019*; *2020*). The significant fragmentation of ceramics obtained here mainly from the ditches of the rondel is emphasised, as are clear traces of damage on the shards related to erosion caused by their long exposure on the surface (rounded edges of fractures, poorly reconstructed forms of entire vessels). Of the 1331 fragments analysed, as many as 37% were classified into technological groups containing grog and grog with a mineral temper (*Czerniak et al. 2021*, 95).

At the mouth of the Oder River near Szczecin, approximately 60 km north of the site in Nowe Objezierze, we find further SBK sites where pottery with grog additions was identified (*Dziewanowski 2016*). In the opinion of the author of the study, stylistic attributes of the pottery refer to the late SBK influenced by the Rössen and Bischheim cultures.

A pit uncovered during the rescue excavation at the Przylep 5 site was probably a settlement pit. The excavated assemblage comprises a total of 183 potsherds as well as flint artefacts and animal teeth. Most of the vessels were beakers with stroked ornament with numerous analogies between the Elbe and the Vistula rivers (*Dziewanowski 2016*, 15). The ceramic technology is characterised by a significant amount of fine mineral dust and mica, with a trace amount of crushed stone. In one of the vessels decorated with a specific stroked ornament, chamotte was clearly visible.

An extensive settlement of post-LBK communities was identified at the Szczecin-Gumieńce 17 site (*Dziewanowski 2016*). Seven settlement features were examined here, from which 600 potsherds and 200 flints were recovered. In one of the features, which may have served as a pit house, 81 potsherds were identified, allowing for the reconstruction of the original vessels including stroke-decorated bowls, a decorated beaker and vessels

with Rössen culture decorative attributes. Their ceramic clays were based on a temper of fine grog and dusty crushed stone mineral, but vessels without the addition of grog were also recovered from this sunken feature. A few less characteristic vessel sherds with grog were also excavated in two other features at this site.

Finally, during rescue works carried out at site 9 in Mierzyn, three sunken features associated with post-LBK communities were discovered. In the settlement feature with a fireplace, at least 221 ceramic vessel sherds with fine grog additions were identified. In addition to vessels made using chamotte, there were also vessels with a temper of crushed stone and mica (*Dziewanowski 2016*, 23–28).

Summarising the sites and artefacts presented above, it can be stated that the mere discovery of grog temper is rarely accompanied by an attempt to interpret its presence. If performed, most analysts referred to the proposal of L. Czerniak, who considered this procedure as an inspiration coming from the MC (*Czerniak 1992*).

Assemblages with grog temper in the Uplands

In their home regions of the upper Oder Basin, the SBK community showed great attachment to the production of pottery using mineral tempers. This situation is indicated by classic studies on this culture (*Zápotocká 1970*, 4–9). Later analyses of SBK pottery focused mainly on the detailed classification of attributes describing stroked ornament (*Zápotocká 1978*). Also, recent studies of SBK materials more often address issues related to ornament rather than the technology of ceramic production (*Vondrovský et al. 2016*). Additionally, studies that describe ceramic technologies do not consider grog temper (*Novák et al. 2017*).

In Silesia, SBK assemblages are divided into two development phases. At the same time, the SBK and the early Lengyel-Polgar sphere also developed in the Silesian area (*Czarniak 2012*).

In K. Czarniak's monography on the communities of the later Danube sphere in Silesia, ceramic materials from 39 sites are considered in terms of the type of temper added. For phase I of the SBK, the author has information from 10 sites (*Czarniak 2012*, 48, tab. 1) and for phase II there is information from six sites (*Czarniak 2012*, 56, tab. 7). The author does not indicate even a trace amount of grog temper for any of these assemblages. However, researchers should be cautious when identifying grog with the unaided eye. Analyses of the petrographic composition of thin sections conducted using an electron microscope on SBK pottery from this region found two of the 13 samples from the Gniechowce 8 site to be tempered by grog (*Borowski et al. 2015*, 212).

Chamotte in this period in Silesia is visible in pottery associated with the Lengyel-Polgar sphere (phase Ia), as well as at sites originally identified as the MC, which was not separated by *Czarniak* (*2012*, 31). Grog can be considered the dominant temper in the earliest pottery associated with phase Ia of the Lengyel-Polgar sphere in Silesia since it was identified at three of four analysed sites (*Czarniak 2012*, 63, tab. 11) and it was considered a common or the dominant temper, present both in fine and coarse pottery. However, only two out of four analysed sites related to phase Ia show a small ('unique') presence of stroked ornament (*Czarniak 2012*, 64, tab. 13). The time horizon of this pottery in Silesia is determined by one radiocarbon date each from two sites (Strachów 2, pit 74, Bln-3851,

5730 ± 80 BP and Racibórz-Ocice, pit 9, KN-1375, 5690 ± 55 BP; see *Fig. 4*: probability distributions in red and *Tab. 1*). This is the period of approximately 4680–4450 BC, in which stroked ornament occasionally appeared on pottery with grog temper. The absolute chronology of phase Ia of the Lengyel-Polgar sphere in Silesia is assumed to be in the range of 4775–4650 cal BC (*Czarniak 2012*, 34, fig. 1), which does not coincide with the highest probability of dates from the aforementioned Silesian sites from this phase.

The situation changes slightly in the following Ib phase of the Lengyel-Polgar sphere (i.e. after c. 4450 BC). A much larger number of analysed sites are available (n=23), but grog as a temper in pottery was identified at only seven sites, and at two it occurred only in cooking pottery (*Czarniak 2012*, 72–73, tab. 21–23). It is also not the dominant temper anywhere in this phase. It often occurs only in one place, and in the remaining locations, its frequency has been described as sporadic or unique. At six of the seven sites where grog was recorded, pottery decorated with stroked ornament was also found. For phase Ib, we have evidence of this decoration on tableware for 40 sites (*Czarniak 2012*, 77–79, tab. 27–29). Stroked ornament was not observed at only three sites with very small pottery assemblages. Based on the concept of *Czerniak* (*1994a*, 6), the current interpretation is that the presence of grog in Silesian materials is a manifestation of contacts with the area of southeastern Poland, which is also evidenced by other attributes of this pottery (*Czarniak 2012*, 238).

Grog temper in the Malice culture

Returning to the initial hypothesis presented in the introduction, which assumes the division of Central Europe into two technological zones for the production of pottery, the closest 'initial' area for chamotte technologies used by lowland LBPC communities is Lesser Poland. The influence of SBK in the area of Lesser Poland is represented by the Samborzec-Opatów Group (*Kaczanowska – Kozłowski 2006*). Its range is limited to the Sandomierz Upland and the vicinity of Kraków. Researchers of the origin of this group have debated whether it was closer to or further from the SBK itself (*Zápotocká 1970*; *Pavúk 1996*). Pottery decorated with stroked ornament, however, is made of clay with almost no temper (*Kaczanowska – Kozłowski 2006*, 25). Undecorated ceramics usually contain sand and fine grog, and occasionally fragments of flint.

The local chronology assumes the contemporary existence of the Samborzec-Opatów group and the MC (*Kadrow – Zakościelna 2000*). The chronological framework of the MC, based mainly on relative sequence (*Kadrow – Zakościelna 2000*), has only recently been supplemented with a larger series of radiocarbon dates, mainly for the areas near Kraków (*Zastawny 2022*). Within the time period of interest, the assemblages of the MC from the initial sections of its phase I seem to be important.

Phase Ia, generally dated to 4822–4717 cal BC (*Kadrow 2023*, 57), is defined by artefacts from the following sites: Rzeszów 20, Ćmielów 2, Targowisko 10–11, Modlnica 5, and Kraków-Olszanica 2 (*Kadrow 1990*; *Michalak-Ścibor 1994*; *Grabowska – Zastawny 2011*; *2014*; *Zastawny 2022*). Absolute dating of sites from the vicinity of Kraków (Targowisko and Kraków-Olszanica) indicates that this phase may have begun in this region around 4850 BC (*Fig. 4*; *Tab. 1*; *Zastawny 2022*).

Although there are no absolute dates for the vicinity of Rzeszów, at the Rzeszów 20 site, characterised by phases Ia and Ib MC, thin-walled beakers decorated with stroked

ornament were produced using a technology applied on roughly 27% of the entire assemblage – pottery clay tempered by very small fragments of ochre, and less often sand, grog, or clasts of unmixed clay (*Kadrow 1990*, 96). A production technology based on temper from large fragments (grains) of grog characterises thick-walled vessels at this site.

All MC vessels at the Ćmielów 2 site were made using three technological formulas. Only one of the technological groups contains sand as the dominant temper (21.4%, 471 vessel fragments) and is characteristic of the older MC phase. The remaining vessels (78%, 1,731 fragments) were made using grog temper (*Michalak-Ścibor 1994*).

Among the technological formulas used by the MC community at the Targowisko 10–11 sites, grog is found in only one technological group (*Grabowska – Zastawny 2014*, 280). It includes pottery clays with an average content of sand, a small amount of crushed stones, and numerous fragments of grog, often of considerable size. This formula was mostly used to produce thick-walled vessels. Only about 7% of the beakers, which are the only type of vessels with stroked ornament at this site, were made using grog temper (*Grabowska – Zastawny 2014*, 278, tab. 8a).

Only a very small amount of grog was found at the Modlnica 5 site (*Grabowska – Zastawny 2011*), where it constitutes approximately 1% of all distinguished types of tempers. Moreover, it was present only in biconical vessels – pottery with medium wall thickness that was not decorated with stroked ornament. However, the composition of the pottery of all types of vessels at this site included clasts of unmixed clay – dry fragments of clay (*Grabowska – Zastawny 2011*, 53 fig. 30). Pear-shaped beakers, the only type of vessels at this site that were decorated with a stroked ornament, were made using technologies comprising sand (48% of these vessels), clasts of unmixed clay (20%), crushed flint, stone (16%), and from clay without temper (16%).

Phase Ib (the classic MC) dated to 4703–4474 cal BC, is associated with the expansion of these communities. From the vicinity of Rzeszów and Sandomierz it stretches northeast to Lesser Poland, Upper Silesia, and Kuyavia, as well as Slovakia and Transcarpathian Ukraine (*Kadrow 2023*, 57; *Kadrow – Zakościelna 2000*, 245).

Some of the pottery assemblages from the sites described above (Rzeszów 20, Ćmielów 2) also characterise the late part of phase I. The standard of publication of other sites does not allow conclusions about the technology used to make the ceramics (Kraków-Olszanica 2, Targowisko 14–15, Rozbórz 20). On the other hand, publications of pottery from the site in Malice and Kraków Nowa Huta – Mogiła 48 seem to be helpful in tracing the types of tempers. In a very detailed, descriptive characterisation of finds from the eponymous site in Malice, grog cannot be found on the list of mentioned pottery tempers (*Kamieńska 1959*). Approximately 30% of all MC pottery from the Kraków Nowa Huta – Mogiła 48 site contains grog and approximately 50% contains grog and sand, but there is no analysis of what types of vessels they are, i.e. thin- or thick-walled (*Kaczanowska 1996*, 18, fig. 7). Nevertheless, most of the beakers and thin-walled amphorae are decorated with stroked ornament.

In summary, it can be noted that the materials of the MC show a close relationship between stroked ornament and thin-walled vessels such as beakers. As the main type of temper added to vessels decorated with stroked ornament, grog is no longer so distinct. We can demonstrate such a relationship to a significant extent only for three of the six MC sites discussed above.

Discussion

Exit zone?

In the MC, the earliest pottery with grog temper appears in the Rzeszów region and occurs there only in thick-walled vessels (*Kadrow – Rauba-Bukowska 2017*, 276). The time of its appearance can be approximately estimated at 5000/4900 BC (*Kadrow 2015*, 300). Previously, this type of temper occurred sporadically in the Lesser Poland Voivodeship in the LBK, with which the genesis of the MC is associated (*Kadrow – Rauba-Bukowska 2017*, 278, fig. 7). It was proposed that the spread of the MC resulted in the dissemination of grog temper to not only thick-walled but also in thin-walled vessels. The commonness of this temper was confirmed by microscopic examination of pottery fractures at the few sites of the classic MC phase in western Lesser Poland dating to 4800–4400 BC (*Kadrow – Rauba-Bukowska 2016*).

The MC communities are assumed to be the main factor that influenced the lowland LBPC groups. These relations might be responsible for the technological attributes used for LBPC pottery (Węgierce) or just stylistic attributes without the characteristic grog technology, always with clear stylistic influences identified with SBK. However, it is difficult to assess the state of the discussion on the most distant northern influences of the MC in the zone of the northern borders of the SBK (sites near Szczecin).

A characteristic feature appearing in the descriptions of MC pottery from Lesser Poland, which brings it closer to observations from the Lowlands, is the destruction of the outer surfaces of the walls of vessels decorated with stroked ornament (*Kaczanowska 1996*, 8; *Grabowska – Zastawny 2011*, 51; *Grabowska – Zastawny 2014*, 266). This has also been noted in the assessment of LBPC materials from the Gorzyce 38 site (*Fig. 5*) mentioned above (*Żurkiewicz et al. 2023*).

The most plausible inspirations for the use of grog at the LBPC sites from the Kuyavia and Greater Poland regions may be the influences from the MC in Lesser Poland. However, these impacts cannot be considered sufficient when trying to interpret the occurrence of grog at the settlements of this culture at the western (Międzyrzecz, Św. Wojciech) or northern (Barłożno) borders. These hypotheses can be completely refuted when applied to the origin of this procedure at SBK sites from the northern enclave (Nowe Objezierze and the vicinity of Szczecin). Perhaps it is worth considering the presence of grog itself from the perspective of its technical advantages and treating it as an ‘invention’, a technological innovation introduced at several different points in space, in a similar time horizon.

Grog – technical advantages

Adding temper significantly changes the original properties of the clay and largely determines the chemical, mineralogical, and petrological composition of the finished vessels (*Santacreu 2014*, 73–74). It also makes it easier to form a vessel by reducing the plasticity of the pottery mass and supports the control of the firing process. Tempers can be divided into several types: mineral (that may contain quartz), organic (plant fragments, bones, shells), and tempers of anthropogenic origin – grog (chamotte). Grog, unlike the previously mentioned tempers, which may be elements of a natural clay deposit or its accidental contamination, can almost always be considered an intentional admixture (*Ots 2008*). In this case,

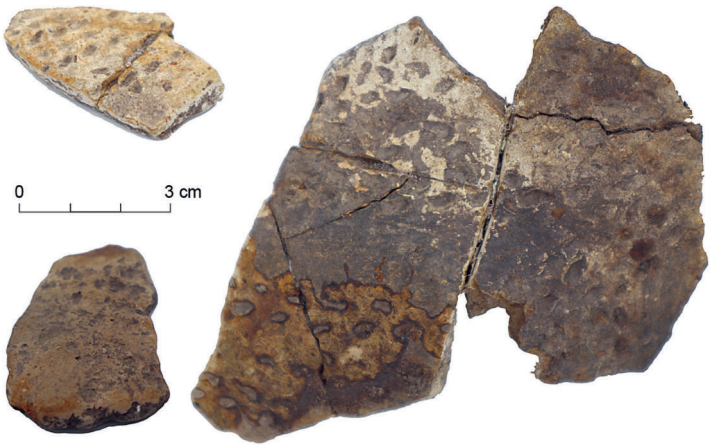

Fig. 5. Damage to the surface of the external walls of LBPC pottery with stroked ornament and with grog temper. Gorzyce, site 38, Kuyavian-Pomeranian Voivodeship (photo by D. Żurkiewicz).

it is important to distinguish fragments of ceramic vessels (grog) from clasts of unmixed clay, which could also be a kind of temper (*Cuomo di Caprio – Vaughn 1993*; *Whitbread 1986*, examples describing the MC above).

The use of grog, compared to the use of, for example, sand, requires several additional activities related to the preparation of such a temper. However, unlike rocks that require intensive grinding, grog requires less force for this activity. It is also more accessible within the manufacturer's immediate environment – it does not require knowledge of the local environment in terms of outcrops of suitable sand and rocks.

From a technical perspective, chamotte used as a temper seems to be a particularly advantageous solution due to its thermal expansion coefficient similar to clay. It prevents cracking of vessels during their firing and use, which involves gradual, continuous heating and cooling. However, this type of temper does not protect the vessels against sudden changes in temperature (thermal shock) unlike, for example, quartz, which allows for thermal expansion, or crushed stone, which significantly increases the durability of cooking vessels (*Santacreu 2014*, 154–155).

The functionalist approach assumes that the change in technological features is initiated by functional requirements or the discovery of a more optimal way to make a vessel (e.g. *Feathers 2003*; *Tite et al. 2001*). The addition of grog does not seem to be optimal from a functional point of view; it does not allow the creation of a vessel that would be most effective in use. In many of the aforementioned cases, chamotte was used as a temper for decorated vessels with thin walls, which are not connected with the functions of cooking vessels, so the advantages of the thermal properties of this temper would have little chance of being effective here. Instead, another cultural reason for including grog in pottery temper should be explored.

Grog – symbolic meaning

Many researchers emphasise the symbolic role of chamotte temper, referring to its universal meaning (*Chapman 2000*; *2022*) and highlighting the symbolic connotations of the cycles of life and death of people and artefacts (*Santacrue 2014*, 241). Artefacts can act as reminders of a previous home and family members left behind. Personal objects are also

associated with an individual's personality or 'soul' and may enhance the owner's sense of identity (*Sterner 1989*, 454). Another potentially important factor in pottery recycling is the creation of bonds with former family members and ancestors, which may have been particularly significant in the event of community or individual relocation. Pottery can be symbolically linked to an ancestral network (*Smith 1989*, 65), and vessels are recycled as grog to bring '*the spirit of the old pot in the new*' (*Pikirayi – Lindahl 2013*, 466).

These hypotheses are largely supported by ethnoarchaeological data looking for analogies for prehistoric counterparts in modern cultures, also in relation to the production of ceramic vessels (*Hegmon 2000*). These studies indicate the existence of a cross-cultural tradition related to the production of new objects from older ones. There are many ethnographic sources that record the use of grog as a temper in this context. In Ghana, for example, the Gurensi break the vessels (mainly bowls) of a dead woman and use their fragments as tempers for new products. In this way, they emphasise the relationship of the deceased with her family (*Smith 1989*, 61). Among the Sirak Bulahay and Kapiski tribes in Cameroon, fragments of a ceremonial vessel that was accidentally broken were brought to a blacksmith, who ground them up and gave them to his wife, a potter, for use in making a new container (*Sterner 1989*, 458). In some societies, recycling personal vessels maintains the connection with the deceased. For example, when someone dies, a piece from their personal pot is cut off, prepared as grog, and then used to make new pots. In this way, a bond is created between the deceased person and his or her family (*Smith 1989*, 61; *Sterner 1989*, 458). *Sterner* (*1989*, 454) stated that for Sirak potters in northern Cameroon, ceramic vessels communicate and attract ancestors to share family meals. This type of symbolism may be of greater value to people who have emigrated from their native community or territory.

The interpretation of chamotte temper described above was also used in an attempt to understand the local records of this ingredient in the ceramics of the Corded Ware culture (CWC) along its northern borders (Battle Axe culture – BAC). The earliest pottery of the BAC discovered in Sweden is made with grog temper. Over time, this temper becomes less common (*Larsson 2009*, 240). Moreover, early vessels were made according to more rigorous technological formulas than their later counterparts (*Larsson 2009*, 242). The author connects these treatments with the specific preferences of new arrivals who wanted to maintain contact with the traditions of their home areas and their ancestors by adding fragments of old used vessels. This procedure especially concerned vessels of particular importance – beakers. It could have been implemented based on the three explanations proposed here: 1) the tradition of '*This is how we make pottery*'; 2) a potentially functional solution – although adding even a very small amount of grog may not have actually had any empirical significance, the potters themselves may have been convinced of such importance; and 3) symbolic meaning as adding parts of old vessels, and thus their history of use makes a connection with the potters who created them (*Larsson 2009*, 353).

Beckerman's (*2015*) studies on the Corded Ware coastal community from the Netherlands indicate the possibility of distinguishing two groups of ceramic vessels – those containing crushed stone and those containing grog as the dominant tempers. The former type of temper and other morphological and ornamentation determinants characterise older ceramics, while the latter type comprises the later ones. The author rejects other ways of explaining these differences, i.e. those based on functional differences in vessels or social issues (*Beckerman 2015*, 173). This is related to the author's concept of the spread of CWC patterns in the northern Netherlands based mainly on diffusion among local Funnel

Beaker culture communities that used a temper of crushed stone (*Beckerman 2015*, 211). Only the stabilisation of the local CWC patterns led, in the later phase, to the adoption not only of the forms of vessels and decorations but also of a change in the technology of their production (i.e., grog admixture).

Analyses of 163 CWC potsherds from 24 archaeological sites in Finland, Sweden, and Estonia were aimed at detecting clusters related to its production and patterns corresponding to recycling, i.e. processing fragments of old vessels into grog temper (*Holmqvist 2021*). Microscopic and chemical analyses of the chamotte temper itself revealed that most of it was made from locally produced vessels, while a foreign origin of the chamotte temper in vessels produced in local centres was observed only for the earliest products related to the emergence of CWC in the analysed regions (*Holmqvist 2021*, 18). Based on these analyses, the route of the spread of the earliest CWC ceramics from Finland to Estonia and from Estonia to Sweden was reconstructed. According to the author, the sociocultural significance of this discovery proves the movement (migration) of pottery producers (probably women) to new areas. After identifying local clay deposits, the newcomers started local pottery production using the broken fragments of old vessels they had brought with them.

The procedure of adding fragments of old vessels to a new prepared ceramic clay may refer to memory practices observed as far back as Neolithic communities from the Polish Lowlands (*Pyzel 2018*; *2019*). *Pyzel* (*2018*) refers this custom to the remains of settlements and, based on this, concludes that there was an attitude towards the past visible from the perspective of subsequent prehistoric communities. Typically, such practices are better understood within archaeological comparisons between cultures. In the case proposed here, we would be dealing with memory practices carried out within the same social group. Therefore, we obtain a much narrower time frame that was previously more difficult to capture based on, for example, stratigraphic or typological observations (*Pyzel 2018*, 144).

Earlier studies of the memory of the past had a long tradition, especially in English-speaking archaeology (e.g. *Bradley – Williams 1998*; *Bradley 2002*). They also concern the Neolithic period, but here they focus mainly on monumental structures (*Edmonds 1999*; more recently e.g. *Whittle et al. 2011*). Incorporating aspects related to ceramic vessels and their production in this trend could create a completely new field for researching this phenomenon.

The theory of memory practices among the Neolithic communities of Kuyavia can also be supported by stratigraphic and spatial relations of features, particularly at sites described above with the presence of stroke-ornamented and grog-tempered pottery. For example, at site 8 in Dubielewo, the densely placed BKC houses do not violate the ground plans of earlier LBK houses (*Pyzel 2018*, 165–168). At Ludwinowo site 6, the LBPC clay pit is a clear reference, as it is a continuation of an LBK clay pit (*Pyzel 2018*, 188). Furthermore, at Ludwinowo site 7, an LBPC grave was located in an existing feature that was probably an LBK well (*Pyzel 2018*, 191–193). In general, *Pyzel* (*2018*, 148) states that at almost all BKC sites in Kuyavia excavated to a large extent, there is enigmatic pottery of the earlier LBPC phase with more or less visible ‘stroked ornament’.

Chronological arguments

In light of current knowledge, it is difficult to consider the area of the Silesian SBK as the source from which the use of grog by the lowland SBK and LBPC communities orig-

inated. Currently, we have 17 radiocarbon dates from nine lowland LBPC and SBK archaeological sites (*Tab. 1*; *Żurkiewicz et al. 2023*). The modelled dates indicate that 'stroked band' pottery appeared in the lowland zone between 4876–4781 cal BC (68.3% probability) and disappeared around 4412–4331 cal BC (68.3% probability) (see *Żurkiewicz et al. 2023*, fig. 16). The proposed model indicates that the earliest dates from Silesia and Lesser Poland (Strachów, Racibórz-Ocice, Targowisko 10–11 and Kraków-Olszanica 2) are later than the beginnings of the appearance of pottery with stroked ornament in the Polish Lowlands (*Fig. 4*).

The time period in which the earliest MC pottery with stroked ornament appeared in the vicinity of Rzeszów is somewhat speculative, currently based only on relative chronology. It is also difficult to accept such a distant northern (e.g. around Szczecin) manifestation of MC influence recognised only through the type of pottery temper.

Conclusion

This paper presents a coherent and comprehensive explanation for the presence of grog tempers in ceramic vessel fragments from LBPC and SBK archaeological sites in the Polish Lowlands. The inclusion of older vessels as grog temper in the manufacture of subsequent vessels is interpreted as a means by which these communities maintained the memory of their past.

The custom of using chamotte as a temper with symbolic meaning and in symbolic quantities may have concerned more traditional or isolated LBPC communities. To a small extent, this custom could be continued in the next stage of stabilisation of those communities identified with the BKC. This is indicated by very preliminary findings of grog temper in potsherds from BKC sites (Broniewice 1, feature 2; Ludwinowo 7; Stawc 44; Brześć Kujawski 4; Boguszewo 43b, features 11 and 23; Rakowiec 22; *Bednarczyk et al. 1979*, 26–27, table 7a; *Grygiel 1986*, 288; *Kirkowski – Kukawka 1990*; *Dzierżanowska 2011*; *Czerniak 2019*, 162, table 3.2; *Kurzyk et al. 2019*) and suggests the continuity of such a procedure to an equally small extent (it was not common) in the next stage of the development of post-LBK communities in the Polish Lowlands.

Grog as an analytically important type of temper appears on the list of technological groups in the first attempt to describe them for the LBPC (*Bednarczyk et al. 1979*). It creates a technological group including crushed stone (white, grey, pink), grog, and mica. Indeed, *Bednarczyk et al.* (*1979*) point out the difficulties in identifying grog. In the next description of technological groups for the LBPC/BKC (*Czerniak 1980*), grog is no longer on the list of tempers but it reappeared after the analysis of the materials from Węgierce 12 (*Czerniak 1992*). However, this addition has not been disseminated as in the monographic publication (*Czerniak 1980*) and perhaps contributed to the reduced vigilance of later analysts of LBPC/BKC ceramics or the conscious elimination of this component as irrelevant for chronological considerations (e.g. *Kirkowski – Sosnowski 1994*, 119).

Currently, four sites are considered as the determinants of the earliest LBPC stage in the Polish Lowlands. The first is Węgierce 12 (*Czerniak 1992*), where grog was identified. According to *Czerniak* (*1992*, 66), this ceramic temper clearly represents the influence of SBK phase III/IVa (see also *Zápotocká 1970*), and the grog-tempering tradition originated from Lesser Poland. The next early context, feature 15 from Jankowo 4, represents the

influence of the Samborzec-Opatów group, although grog was not identified here (*Bednarczyk et al. 1979*). Next, materials from Inowrocław Mątwy 5 are thought to represent a significant share of Lengyel elements visible against the background of the forged style derived from the Rössen culture (*Czerniak – Kośko 1980*). Despite a detailed technological analysis, no grog was identified. Finally, the list ends with Konary site 20, which is associated with the influence of the MC, elements of SBK from phase IVb, and the Rössen culture. Here, a clear lack of grog temper can be observed (*Czerniak 1978*; *1980*), possibly indicating that only some of the earliest LBPC groups felt the need to maintain ties with the past by extending the 'life' of ceramic vessels through the addition of grog temper.

Perhaps this allows us to interpret at least some of these communities as groups of new migrants who arrived in foreign areas. Until recently, the origin of the LBPC was associated with the LBK communities that absorbed new waves of migrants and influences from other cultural centres (*Czerniak 1994b*, 60; *Czerniak 2012*, 155–156). Therefore, it was assumed that there would be continuous development of LBK communities that would gradually transform into the LBPC in the Polish Lowlands. Currently, new data indicating the relatively short duration of LBK communities in the Polish Lowlands and their disappearance around 5100 BC (*Whittle et al. 2022*) along with the possibility of the earliest dating of the origins of the LBPC to around 4800 BC (*Czerniak et al. 2016*) promote an alternative concept of the genesis of these latter communities. Thus, the hypothesis by *Grygiel* (*2004*, 631) is gaining credibility, as it assumes that the emigration of LBK communities from the Polish Lowlands to the Saale Basin was the result of unfavourable climate changes and the re-population of this zone of Europe by migrants from Lower Silesia representing the SBK.

In the technical aspect of the considerations presented here, the vigilance of researchers conducting a preliminary analysis of prehistoric ceramics seems to be particularly important. Many studies mention difficulties in identifying chamotte as a type of temper that may occur in various degrees of fragmentation. Additionally, this type of temper is easily confused with clasts of unmixed clay, which are also used as a type of temper. In the perspective of future research related to the identification of grog temper and the possibilities of its further analysis, the role of microscopic examination of selected batches of ceramic fragments seems to be important. It should also be mentioned that a certain pool of data could not be used in this study because the available publications did not contain a descriptive/analytical part regarding the production technology of vessels.

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BOOK REVIEW – RECENZE

Tomasz Gralak: Archaeology of Body and Thought: From the Neolithic to the Beginning of the Middle Ages. Archaeopress Archaeology, *Oxford 2024*. ISBN 978-1-80324-721-9. 198 pages with 56 figures.

The relationship between the human body and culture is a significant topic in a multitude of academic disciplines, including anthropology, ethnography, ethnoarchaeology, archaeology, history, and numerous others. However, it is not only the disciplines that focus on our past; the human body is perhaps an even more significant topic of our time. This is not only in terms of medicine, healthy lifestyles, or fashion; it is increasingly a socio-cultural topic, as the twin terms of sex and gender are used perhaps more than ever before. As long as the body and physicality retain their biological significance for us as a species, they will continue to be an integral part of our cultural and social tradition. The physical form of the body and its cultural reflection will continue to be inextricably intertwined and to influence each other. It is therefore unsurprising that this topic has been the subject of considerable interest among scholars for many years (notable examples include the ethnographic works of *Mauss 2006/1935* and *Leroi-Gourhan 1943*). Its popularity has continued to grow in recent years, as evidenced by the large number of recently published works, including this book.

Before embarking on a detailed examination of the book itself, it seems appropriate to allow myself a brief personal input. It should be mentioned at the outset that for me, as a reader and a biological anthropologist not only by education but also by thinking (whereby the whole review is greatly influenced), reading the author's opening sentence, '*A human body is an artefact and an archaeological source*', start ringing the bell. I would posit that my state of mind is analogous to that of a significant proportion of the archaeological community when they initially encountered the assertion '*Archaeology is anthropology or it is nothing...*' published in 1958 by Willey and Phillips (*Willey – Phillips 1958*, 2). Although I cannot inherently identify with book opening statement, and the extent to which it is and is not possible to view human remains as artifacts could be the subject of a long debate, it did prompt me to read the text more closely. The deliberately provocative opening sentence was well chosen, if the author's aim was to provoke potential readers.

The book examines the various ways in which people in the past treated their bodies, the functions they ascribed to them, the modifications they made, and the ways in which our ancestors understood the body. It also considers how we can gain insight into these understandings through the interpretation of the past. However, this is not primarily a biological perspective; rather, it is a socio-cultural and historiographical one. It is therefore not reasonable to expect that this publication will address questions such as the biological response of the organism to environmental stress and its possible interpretation of the statutory hierarchy of the society under study. Instead, it will address the ways in which human remains are reintegrated into a living culture and reflected in the social status of their bearer, or the projection of corporeality in a figurative style into the artefactual equipment of a given culture and its meaning. The author addresses individual research questions in fourteen chronologically arranged chapters, preceded by an introduction and summarized by a conclusion. The chapters present a selection of intriguing facts from our prehistory and history concerning the potential projection of corporeality into material culture and vice versa. The author endeavours to address these individual questions in a solitary manner, relying on an evaluation of grave finds, anthropomorphic depictions, and written records. Overlaps between chapters are minimal.

The book's temporal and geographical scope is extensive. It covers the period from the Neolithic to the early Middle Ages in central Europe, Greece, Scandinavia, the Eurasian steppes, and also contains a number of analogies from all over the world, including Asia and Africa. The author partially builds on his previous book, *Architecture, Style and Structure in the Early Iron Age in Central*

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Europe (*Gralak 2017*), in which he addressed the influence of ideology on the understanding and shaping of space and material culture, as opposed to the perception and shaping of the physical aspect of people in culture. Due to the extensive temporal and geographical scope, the author selects topics that are both popular in the scientific community and among the general public. He does not hesitate to emphasise these topics, which he sometimes does by using somewhat provocative titles such as 'Bone Collectors', 'Head Hunters', or by revisiting the previously very popular topic of vampirism. While this approach may attract more attention to the book, it does not detract from its overall value. On the other hand, the author employs these contentious topics, it would appear, with a certain lack of critical engagement, particularly when they pertain to archaeological or biological anthropological subjects. This is particularly evident when the author does not present alternative interpretations that may be perceived as less engaging from a popular standpoint.

It is regrettable that this review is unable to examine each chapter in turn and address all of the topics discussed by the author. Given the author's selection of popular topics, it is challenging to select only a few representative examples to convey the thematic scope of this publication to potential readers. Chapter XI, entitled 'People on the Steppes', is worthy of particular mention. In it, the author focuses on nomadic groups in the Eurasian steppes of the Iron Age. In this context, the author highlights the well-documented findings of animal-style tattooed human remains from sites such as Pazyryk and Verkh Kardrzhin II. These tattoos were believed to have served as status symbols among nomadic communities because they were characterised by a lack of material possessions. On the other hand, there were also large and rich mounds, which could have served, among other things, as landmarks in the often-monotonous steppes, but certainly also had a statutory significance. In addition, the author also manages to address in the chapter the nature of early Iron Age nomadic society, its potential brutality, and the issue of rituals (based on written sources) that today could be considered rituals that desecrate human remains.

In certain instances, it would be beneficial to enhance the book with additional support literature for the author's claims or to conduct experimental verification of these claims. An illustrative example is Chapter IV, 'The Únětice Culture Bone Collectors', wherein the author discusses the typical Únětice daggers and halberds and their most effective use in combat. As a biological anthropologist, I would be particularly interested in a reference to skeletal material or directly to soft tissue from an experimental setting. In Chapter XV, 'The Slavs and the Myth of Vampire', the author proposes that part of the world-understanding of the populations of the Migration Period and the early Middle Ages was the belief that the body and soul were tightly bound together. This led to the conclusion that decapitations or other forms of disintegration had to be conducted in order for the soul to complete its exit from the world of the living. However, the author does not provide references to other works, historical or linguistic sources, nor does he offer other possible explanations. Consequently, the author makes statements of a general deductive nature that may be misleading in certain respects. To illustrate, consider the following sentence: '*We may thus conclude that in both cases this phenomenon accompanies the change in funerary rites from cremation to skeleton burials as its consequence.*' In this sentence, the author refers to the change in burial rite during the period of the Migration period and the early Middle Ages and relates it to 'anti-vampiric' measures. Without further substantiation in the existing literature and a more detailed examination of the text itself, the impression may be given to the reader that the fear of the supernatural was the driving force behind the general change in the manner of burial of the populations of the time. It is unclear from the text whether the author is referring to the transition from skeletal to cremation burials in the transition from the Migration period to the early Middle Ages or the gradual transition from cremation ritual to flat skeletal burials in the early Middle Ages. It is evident from the historical record that the people of the past were able to cope with the bodies of revenants. In addition to cremation, they treated them with various stabbing and chopping instruments, as well as soaking them in water and letting the remains go downstream (*Barber 1988*). They also tied them up, turned them face down,

and weighted them down with stones (e.g., *Betsinger – Scott 2014*; *Gregoricka et al. 2014*; *2017*) have all proposed various methods for dealing with the remains of the deceased, including the use of lime as a sarcophagus (*Králíková 2007*; *Schotsmans et al. 2015*). It is not my intention to engage in a detailed debate on this topic. My objective is merely to utilize this enumeration to illustrate the numerous, more straightforward methods of dealing with the remains that have the potential to evoke superstitious fear in the broader community. Furthermore, I aim to highlight the limitations of generalizing such statements.

The book presents a synthesis of a number of chronological, cultural, and contextual themes. The author includes these themes in one volume under the thematic umbrella of corporeality and different views of the human body, which is always determined by a particular social group. The aforementioned themes are discussed in isolation, with no overlap into the other chapters. The book does not aim to produce broad chronological interpretations of human behaviour; rather, it presents a synthesis of knowledge based on written records, artefacts, and, in some cases, finds of bodily remains specific to the period and population under study. As a result of its nature, this work is not only intended for scholars engaged in any of the topics covered, but can also serve as an introduction for researchers who are just beginning to work on similar topics, or can provide a direction for further research. It would be of great interest to connect the author's chosen research model with more in-depth biological and anthropological or bioarchaeological research. For example, the integration of kinship and mobility assessment with the author's methodology for analysing past populations would significantly enhance our understanding of the past. Such an endeavour would undoubtedly yield a plethora of insights, while also prompting a multitude of further inquiries, as is often the case in our field.

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BOOK REVIEW – RECENZE

Tomáš Klír: Zánik a pustnutí venkovských sídlišť v pozdním středověku. Chebsko a Slavkovský les. Univerzita Karlova – Nakladatelství Karolinum, *Praha 2023*. ISBN 978-80-246-5103-03. 334 str.

Tomáš Klír je v Čechách už dvacet let hlavním hybatelem výzkumu pozdně středověkých agrárních dějin. Heuristicky suverénně se pohybuje na poli archeologie i historie, umně zapojuje přístupy historické sociologie, intenzivně využívá poznatky přírodních věd a v neposlední řadě budí velký respekt sečtělostí v relevantní zahraniční literatuře. Mimořádné badatelské schopnosti osvědčil opakovaně, nejnověji v knize o příčinných okolnostech pustnutí vesnic v nejzápadnějším cípu dnešních Čech. Výsledky svého zájmu o osídlení pohraničního regionu předtím předložil v několika obsáhlých časopiseckých studiích (např. *Klír 2016*; *2017*) a zčásti sumarizoval v knize *Rolnictvo na pozdně středověkém Chebsku* (*Klír 2020*).

Tato monografie přináší v prvé řadě analýzu rejstříků chebské zemské berně, což je pramen, který skýtá jedinečnou výpověď o sociální a geografické mobilitě venkovského obyvatelstva ve 14. a 15. století. Ponor do ohromného a prozatím jen minimálně badatelsky využitého chebského archivu si vyžádal odklad komplexní publikace terénního výzkumu zaniklých vesnic, realizovaného především v letech 2006–2008 (tehdy jako společný projekt pražské a bamberské univerzity). Prodleva se však bohatě vyplatila, protože teprve při mravenčí heuristické práci s písemnými prameny postupně vyvstaly neotřelé otázky, které představují výkladovou osu recenzované knihy. A co je hlavní, autor k nim dokáže dodávat i přesvědčivé odpovědi, které v mnoha ohledech podrývají dosavadní apriorní vzorce archeologického uvažování.

Originalita autorova přístupu tkví ve způsobu objasňování zásadního problému, a sice v jakém vzájemném poměru byla dynamika pozdně středověkého pustnutí determinována přírodními a sociálními faktory. Jestliže dosavadní české archeologické bádání přímočaře hledalo příčiny zániku určitých vsí v křehkém ekologickém rázu jejich zázemí a v katastrofách typu válečných událostí, Tomáš Klír spíše klade důraz na obecnější dobové demografické a sociální změny, které se projevovaly v hustotě osídlení větších teritorií. Nevylévá však vaničku i s dítětem. Důsledně bere na zřetel přírodní podmínky jednotlivých extravilánů, nikoli ale v úzkém kontextu konkrétních lokalit (jak bylo dosud zvykem mezi archeology), nýbrž v širší regionální perspektivě. Všiml si, že ve sledované oblasti se pustnutí dotklo hlavně obvodových pásů horských oblastí. V knize opakovaně předestírá otázku, proč v těchto místech vesnice zanikaly v relativně větším počtu, když blízké lokality s obdobnými podmínkami zemědělské výroby, položené ale hlouběji v rámci stejných ekozón, naopak přetrvaly do současnosti, respektive do 20. století. Jejich obyvatelé hospodařili *de facto* na stejně (málo) úrodné půdě, využívali srovnatelné pastviny a lesy, přičemž i vodní zdroje měli k dispozici podobné.

Jako laboratoř pro řešení nastíněného problému slouží zaniklá středověká ves Schwarzenbach. Umístěním na okraji Slavkovského lesa představuje typický příklad trvale opuštěné lokality v horských oblastech obklopujících úrodnou Chebskou pánev. Autor nejprve rekonstruuje osídlovací postup daného území, přičemž založení vsi klade *per analogiam* k přelomu 12. a 13. století. Paralelně sleduje vývoj vrchnostenské držby. Důkladně se zaobírá i ekonomickými a sociálními vazbami daného mikroregionu, formovanými napojením na tržní okruh Chebu. Sleduje i úlohu tržních center druhého až třetího řádu. Byly to právě sociální vazby, jež autor považuje za rozhodující faktor trvalého opuštění vsi na konci 14. století.

K samotnému Schwarzenbachu je k dispozici jen minimum písemných pramenů; všechny pocházejí z 2. poloviny 14. století. Zdejší usedlosti byly evidovány v leuchtenberských lenních knihách, z jejichž zápisů vyplývá, že se ves v této době postupně vylidňovala. Na základě kusých zmínek

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však nelze zodpovídat ambiciózní otázky po příčinných okolnostech jejího definitivního zániku. Argumentaci proto autor vystavěl na řetězci hypotéz, jimiž úzce navazuje na zmíněnou knihu o rolnictvu na pozdně středověkém Chebsku (*Klír 2020*). V ní obšírně pojednal mj. problematiku migrace držitelů poddanských usedlostí, která byla překvapivě vysoká. Relativně časté střídání hospodářů představovalo jeden z doprovodných jevů tehdejší populační krize. Dynamika přesídlování byla totiž ovlivňována uvolňováním lukrativních nemovitostí. Autor daný jev popisuje jako dominový efekt. Začátek řetězce představovalo přesídlování nejbohatších a podnikavých sedláků do Chebu. Noví obyvatelé města většinou pocházeli z jeho blízkého zázemí. Jimi uvolněné lukrativní venkovské usedlosti obsazovali rolníci z vesnic relativně vzdálenějších od města. Tento řetězec měl několik článků, přičemž se zastavil v obvodovém pásu horských oblastí, kde ležel i Schwarzenbach. Proč skončil právě zde, autor vysvětluje logickou úvahou. Usedlosti Schwarzenbachu, jehož obyvatelé přesídlili většinou do blízkých vesnic ležících ve znatelně úrodnější oblasti při úpatí Slavkovského lesa, nebyly ničím atraktivní. Skýtaly totiž stejné podmínky pro zemědělskou výrobu jako sousední, hlouběji ve Slavkovském lese položené vsi. Tyto lokality tudíž přetrvaly; jejich obyvatelé by si přesídlením do Schwarzenbachu (a dalších podobně situovaných a postupně opouštěných vsí na okraji horského území) nijak nepolepšili.

Autor své interpretace staví na všestranné srovnávací analýze přírodních podmínek někdejšího hospodářského zázemí Schwarzenbachu. Zohledňuje bonitu půdy, sluneční expozici obhospodařovaných pozemků, vydatnost vodních zdrojů atd. Strukturu a rozsah extravilánu zaniklé vsi rekonstruuje dosti bezpečně, protože díky vysoce kvalitním datům leteckého laserového skenování zemského povrchu (zpracoval Ondřej Malina) lze sledovat relikty plužiny v podobě dobře dochované soustavy mezních hřbetů. Prostor někdejšího intravilánu, lokalizovaný ve svahu nad drobným potokem, je naproti tomu málo „čitelný“. Relikty usedlostí a další antropogenní (zčásti pozdější) útvary byly dokumentovány na samém začátku badatelského projektu při tradičním geodeticko-topografickém průzkumu. Zaniklé stavby se na dnešním povrchu terénu prakticky neprojevují. Místa, kde se rozkládaly jednotlivé usedlosti, lze identifikovat pouze podle terénních úprav, které jsou však dnes dosti erodované. Jedná se o snadno přehlédnutelné svahové odřezy. Počáteční hypotézu, že na těchto plošinách, zčásti zapuštěných do svahu a dílem nasypaných, stály obytné a hospodářské stavby, potvrdily geochemické analýzy půdy. Nejvýraznějším reliktem vsi je malé tvrziště s okrouhlým příkopem. Popis, klasifikace a interpretace terénních reliktů Schwarzenbachu zabírají několik desítek tiskových stran. Tato část knihy nabývá formy metodiky, což je pochopitelné vzhledem k tomu, že v českém kontextu dosud nebyla publikována zaniklá ves, která by se projevovala obdobnými terénními relikty – prakticky pouze svahovými odřezy. Autor proto uvádí analogie z Britských ostrovů, kde je průzkum těchto objektů dosti rozvinut (např. *Christie – Stamper 2012*).

Publikace výsledků terénního výzkumu Schwarzenbachu a jejich následná interpretace jistě představovaly hlavní motiv k sepsání knihy, její cíle jsou však mnohem ambicióznější. Okolnosti pustnutí zkoumané pod drobnohledem ve Slavkovském lese autor porovnává s dynamikou vývoje sídelní struktury v dalších oblastech (ekozónách) širšího Chebska. Jako ostrý kontrast slouží úrodná Chebská pánev. Zde se během 14. století změnila sídelní struktura jen minimálně, přičemž příčinné okolnosti jejího nepatrného prořídnutí byly úplně jiné než v (pod)horských oblastech. V úzkém zásobovacím okruhu Chebu zaniklo jen několik málo vsí, bez výjimky drobných sídlišť. Ta se vylidnila v důsledku jevu, který autor nazývá komercionalizací zemědělské produkce a hladem po půdě. Zásadní byla skutečnost, že obhospodařování polností drobných sídlišť nebylo svázáno přísnými komunitními pravidly jako v případě většiny okolních (větších) vsí s traťovými plužinami. Úzké pole tvořící součást široké trati bylo nezbytně nutné obdělávat ve stejném cyklu jako okolní pozemky, ať z důvodu společné pastvy na úhorech nebo kvůli omezené dostupnosti z polních cest. Polnosti usedlostí drobných sídlišť bylo naopak možné využívat podle vlastního uvážení. Proto se na tyto pozemky soustředila pozornost chebských měšťanů a bohatých sedláků, a to z více důvodů. Získávali půdu, již mohli dlouhodobě využívat k zemědělské produkci orientované primárně pro trh, a nikoli k subsistenci.

Potažmo držbou (dobře prodejné) půdy zhodnocovali finanční prostředky a rozšiřovali majetek pro případné dělení mezi potomky. Vlastní dvory vázané na tyto pozemky (obhospodařované z jiných usedlostí) nebyly osazovány, a proto zanikaly.

Další oblastí, k níž autor upírá pozornost, jsou pahorkatiny a vrchoviny západně a severozápadně od Chebu, konkrétně Smrčiny, severní část Hornofalckého lesa a západní cíp Krušných hor. Z hlediska výpovědních schopností písemných pramenů jsou příhodné zvláště Smrčiny. Autor zjistil, že zde na přelomu 14. a 15. století zpustly téměř tři čtvrtiny všech sídlišť. Z nich třetina zanikla trvale. K opětovnému osazovaní většinou došlo po 10–20 letech, což bylo někdy provázeno i zmenšením počtu usedlostí a současně zvětšením jejich hospodářského potenciálu (kontrakcí zemědělsky využívané půdy). Neobnoveny zůstaly vsi v hraničních přírodních podmínkách. Značný demografický propad byl způsoben lokálními ozbrojenými konflikty. I na příkladu těchto oblastí autor uvažuje o migraci do ekonomicky výhodnějších lokalit jako o rozhodujícím faktoru trvalého prořídnutí sídelní sítě. Na začátku tohoto řetězce stál opět Cheb, což lze sledovat díky berním rejstříkům.

Když autor ve středoevropském kontextu porovnává procesy pustnutí na širším Chebsku, resp. na území chebského městského státu, není překvapivým zjištěním, že po chronologické stránce obdobné vývojové trajektorie shledává v říšských oblastech, a nikoli v zemích Koruny české. Opírá se o výsledky poměrně rozvinutého německého bádání, které v knize přehledově nastiňuje. Z řady regionálních sond vyplynulo, že v říšských oblastech proběhla vlna výrazného pustnutí v posledních desetiletích 14. století, což – jak historici poměrně podrobně zmapovali – úzce souviselo s hlubokou mortalitní krizí, jejíž počátky se překrývají s šířením morové nákazy v Záalpí. Autor však upozorňuje i na jeden podstatný aspekt, který regionální sondy opakovaně odhalily, a sice že výrazné vylidňování venkova nastalo až s určitou časovou prodlevou vůči nástupu pandemie.

Co mě na recenzované knize udivuje nejvíce, je její komplexnost. Autor ve dvojjediné roli archeologa-historika předložil sondu do sociálních a hospodářských dějin pozdně středověkého venkova, v níž obyvatelé zaniklých vsí nevystupují jako pasivní oběti dobových katastrof či vrtkavé přírody, nýbrž lidé schopní adaptace. Klírovy vývody stran migrace jako jednoho z klíčových faktorů vylidňování určitých regionů působí naprosto logicky a jednoduše, o to je překvapivější, jak moc archeologové doposud věřili na osudové změny v (mikro)ekosystému jednotlivých lokalit. Autor nastavuje úplně jinou perspektivu, když ukazuje město a venkov jako dvě spojité nádoby.

Jan Kypta

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