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Editor-in-chief – Vedoucí redaktor
Václav Vondrovský
vondrovsky@arup.cas.cz; tel.: +420 257 014 357

Technical editor – Technický redaktor
Filip Laval
laval@arup.cas.cz; tel.: +420 257 014 321

Orders/Objednávky: František Ochrana, ochrana@arup.cas.cz, tel. +420 257 014 415
Yellow Point Publications, ul. Nowowiejska 110/2, 50-340 Wrocław, Poland, www.ypp.com.pl
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CONTENT – OBSAH

EDITORIAL

Attentive readers might have noticed that this release of *Archeologické rozhledy* comes as a double issue, an unusual step we took to restore our journal's publishing pace and timing. Over the past years, the delay has accumulated for a variety of reasons and new issues were released several months after the traditional scheduled dates – March, June, September, and December. This double issue is, therefore, another measure the editorial team has taken to ensure fluent and timely dissemination of new archaeological research, which, I am sure, both authors and readers will appreciate.

Starting with this (double) issue, *Archeologické rozhledy* has also adopted a new heritage protection policy. While you can read the full version on our website and at the end of this issue, the policy stands on a few elementary principles that can be easily summarised here. Firstly, our journal will not publish papers that deal with archaeological finds from private collections. Although private collecting of archaeological artefacts is permitted in some countries, it carries a high risk of misconduct in numerous aspects. For instance, many early medieval swords held by private collectors were proved to be forgeries or were retrieved under dubious conditions that did not comply with professional standards. All finds presented in *Archeologické rozhledy* must come from an institution officially authorised in archaeological heritage protection. The acquisition of such finds must have complied with the legislation of the country of origin.

This issue starts with three research articles that employ scientific methods in their archaeological inquiries. Ondřej Chvojka and his colleagues present a new Late Bronze Age hoard excavated near Krtely in South Bohemia. While Bronze Age hoards are a long-term research topic of Chvojka, the assemblage from Krtely is unique in that it included two fragments of a miner's picks used in the famous salt mines in Hallstatt. The objects described in the paper are thus the northernmost occurrence of Hallstatt picks. Employing X-ray, tomography, and use-wear analysis, the authors reached interesting conclusions about the histories of the metal objects, which ended their 'life' assembled in a ceramic vessel and deposited on the top of a burial mound.

The article by Michaela Látková resides in archaeobotany and seeks the origin and development of grape cultivation and viticulture in the territory of the Czech Republic and Slovakia, studying the morphometry of cultivated forms of grapevine and its wild counterparts. The analytical assemblage comprises 1087 archaeobotanical finds from 28 sites spanning from prehistory to the Early Modern period and accompanied by recent reference finds. Thanks to its wide chronological scope, I am sure that the study will attract the attention of archaeologists as well as historians dealing with development of viticulture or agricultural production in general.

Filip Facincani and Jaroslav Pavelka addressed the conundrum of so-called acoustic vessels, which appear hitherto installed in the walls and vaults of medieval churches. To reveal if new, custom-made vessels were acquired or just mundane house pottery was reused, the authors searched for food residues that might be preserved on acoustic vessels from two churches in South Bohemia. As the enzyme-linked immunosorbent analysis indicated the presence of milk and grain, the latter hypothesis seems more plausible. In addition,

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the paper gives a comprehensive overview of the research topic and can serve as a suitable starting point for further exploration of acoustic vessels.

With the last two articles, we return to the ground of more traditional archaeological approaches, though widely supported by absolute dating. In the first, the collective led by Petra Schindlerová examines the issue of Linear Pottery culture longhouses with adjacent fenced areas. Such settings are rather rare at Early Neolithic settlements and their purpose remains unclear, though various hypotheses have been proposed. Choosing Hostivice-Sadová as a case study site, this article follows up much of the research tradition established by the campaign at the famous site of Bylany, where the longhouses with fenced areas were excavated and discussed already by Bohumil Soudský. Schindlerová and colleagues performed a detailed analysis of pottery supported by radiocarbon dating to explore chronological relationships between houses, fenced areas, and various pits flanking the houses as well as dotting the grounds surrounded by fences.

The research article by Ivana Boháčová and Nikola Koštová presents the results of excavations in Stará Boleslav, more specifically cemeteries surrounding local churches. Stará Boleslav is undoubtedly one of the key sites for understanding the formation of early Czech statehood. Beyond that, the article draws attention for the application of radiocarbon dating in early medieval contexts. Such approaches are rather scarce. I am convinced that there is still some kind of disbelief in this method among specialists in early medieval archaeology, who consider radiocarbon data too imprecise for their purposes. However, as Boháčová and Koštová demonstrate, radiocarbon dating can produce relevant results if sampling follows rigorous standards and results are considered within more elaborate mathematical frameworks.

Václav Vondrovský

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Hoard with a miner's pick from Krtely in South Bohemia: On the question of the relations of hoards, imports and burial mounds of the Urnfield period

Depot s hornickým špičákem z Krtel v jižních Čechách: K otázce vztahů depotů, importů a mohylových pohřbů v období popelnicových polí

Ondřej Chvojka – Luboš Jiráň – Jan John – Matěj Kmošek – Richard Thér – Tomáš Zachar

This article presents a hoard of 27 metal artefacts and fragments of one ceramic vessel from the South Bohemian site of Krtely, dated to the earlier phase of the Late Bronze Age (Br D – Ha A1). Two exceptional phenomena are associated with the hoard. The first is its placement in a burial mound, and the second is the presence of two fragments of a broken miner's pick, analogous to those found in the salt mines of Hallstatt. In addition to typological-chronological analyses, the article also includes elemental composition and use-wear analyses of the pick. Unique to this find is the reutilization of the pick as a chisel. The hoard also contained a fragment of a cast sword hilt with embedded fragments of other artefacts, examined by X-ray and tomographic analyses. The hoard from Krtely significantly contributes to the ongoing discussion on the role of Bronze Age metal hoards and their potential connections to ritualized behaviour and the spiritual world of that era.

South Bohemia – Late Bronze Age – hoard – pick – burial mound – XRF analyses – use-wear analyses

V článku je publikován depot 27 kovových artefaktů a zlomků jedné keramické nádoby z jihočeské lokality Krtely, který lze datovat do starší fáze mladší doby bronzové (Br D – Ha A1). S depotem jsou spojeny dva výjimečné fenomény, na něž je tento článek zaměřen. Prvním je uložení depotu do mohyly, druhým pak přítomnost do dvou fragmentů rozlomeného hornického špičáku s analogiemi v solných dolech v Hallstattu. Vedle typologicko-chronologické analýzy je v článku tento artefakt podroben i analýze prvkového složení a traseologické analýze. Zatím bez analogií je jeho reutilizace na dláto. Depot obsahoval i zlomek lité rukojeti meče, do níž jsou vloženy zlomky dalších artefaktů, které byly zkoumány pomocí rentgenové a tomografické analýzy. Depot z Krtel významně přispívá do bohaté diskuse o roli kovových depotů doby bronzové a o jejich možných souvislostech s ritualizovaným chováním a duchovním světem tehdejších lidí.

jižní Čechy – mladší doba bronzová – depot – špičák – mohyla – XRF analýzy – traseologická analýza

Introduction

In archaeological terminology, graves and hoards are typically distinguished as separate entities (*Neustupný 2010*, 154–156). A straightforward definition of a hoard implies that it is a collection of at least two artefacts intentionally and simultaneously deposited outside grave goods (e.g., *Salaš 2005*, 12, with earlier literature). This usually leads to the spatial exclusion of hoards and graves. However, there are exceptions, as evidenced by the recently discovered hoard from Krtely in South Bohemia, which was embedded at the top of a burial

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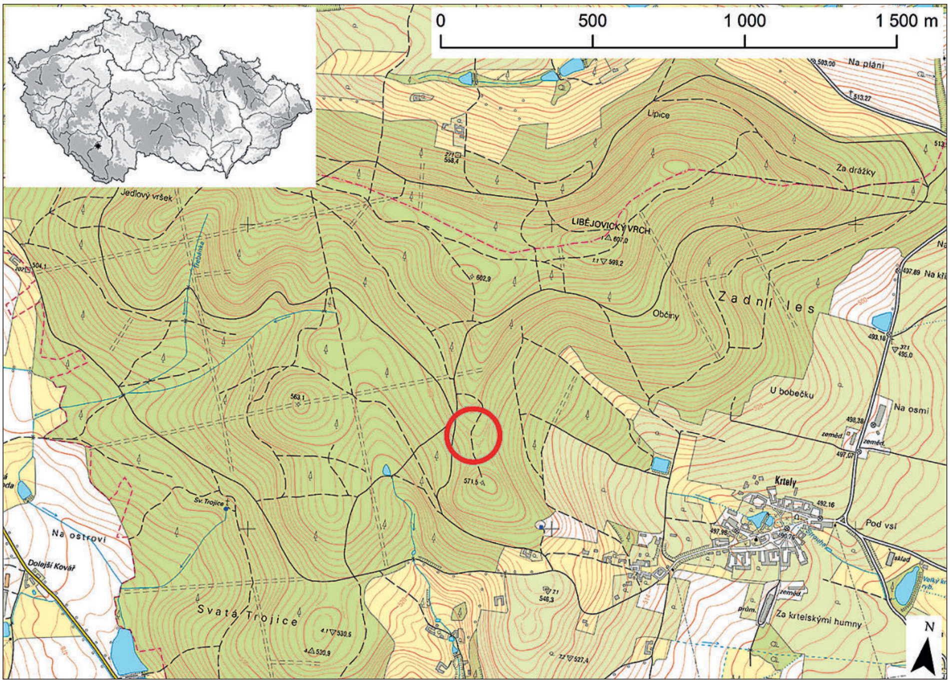


Fig. 1. Krtely. Location of the site on the map of the Czech Republic and topographic position on the 1:10,000 ground map (modified by J. John).

mound. In the following text, we will discuss not only the archaeological analyses of the hoard itself, distinguished by a unique miner's pick, but also the phenomenon of placing metal hoards in or near graves during the Bronze Age.

Find circumstances and natural conditions of the hoard from Krtely

In November 2017, Aleš Hutter found a set of metal artefacts, which he removed from the ground and then handed over to the archaeological collection of the South Bohemian Museum in České Budějovice. On 29 August 2018, O. Chvojka, J. John, J. Fröhlich, and J. Michálek conducted site documentation and a survey of the find and surrounding burial mounds.

The hoard was found in the 'Na Překážce' forest on the southern spur of the Libějovický Hill, 1000 m WNW from the chapel in the village. The altitude of the find is 567 m and WGS-84 coordinates 49.0861128N, 14.1549303E (*Fig. 1*). This is the northeastern edge of the burial mound cemetery, dated to the Hallstatt period and the early Middle Ages (*Michálek 2017*, 180; *Lutovský et al. 2023*, 269–270). At least 35 burial mounds in two groups were identified during the surface survey (*Fig. 2*). Based on their formal and spatial characteristics, some mounds can be dated to the early Middle Ages (arrangement in rows, rectangular shape, shallow ditches around the mounds), while others (probably older prehistoric mounds) are manifested only by surface accumulations of stones.

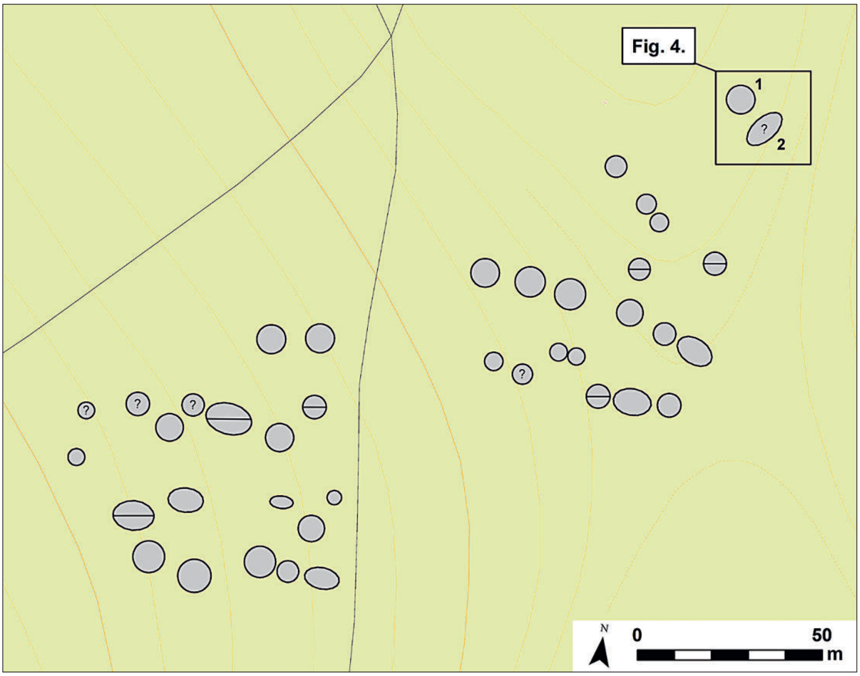


Fig. 2. Krtely. Plan of the barrow cemetery with the location of the hoard (box) (made by J. John).

The massif of the Libějovický Hill (607 m above sea level) forms part of the Bavorovská Highlands, which is the largest of the Šumava foothills, separating the middle course of the Blanice River from the Českobudějovická Basin (*Chábera et al. 1985*, 15–16). In the wider vicinity of the site, there are gold deposits that were mined in the Middle Ages and modern era; the remains of historical shafts are preserved on Libějovický Hill (*Fröhlich 2006*, 77; *Mašlová 2017*, 44–45). A mining trench was located close to the hoard, but it is uncertain whether it is related to the exploitation of gold or quartz (*Mašlová 2017*, 38–39). However, there is no way to prove a possible connection between the hoard analysed here and the burial mound cemetery with the mentioned gold deposits.

According to the finder, the metal artefacts were found clustered in a pit approximately 20 × 30 cm and up to 45 cm deep. The objects were located in a cavity between quarry stones up to several tens of centimetres in size, evidently part of the mound embankment construction. One large ingot was reportedly placed shallow below the surface, with other objects found without any arrangement beneath it. Unfortunately, the finder did not take any photographic or other documentation, nor was detailed information about the position of individual artefacts recorded. The pit also contained several dozen ceramic fragments from one vessel (see no. 28 in the *Online Supplementary Material 1*), which were also collected by the finder. No further findings were made in the excavated pit during the subsequent expert survey. Excavation outside the pit was not carried out, as it was determined that the hoard was deposited in a yet unrecognized burial mound (marked as Mound No. 1), the detailed examination of which could not be conducted. Mound No. 1 is covered by a mature spruce forest, and the pit with the hoard was located directly at the foot of one spruce (*Fig. 3*).

Fig. 3. Krtely. Mound 1, the place of the hoard discovery (photo by O. Chvojka).

Description of the archaeological situation and artefacts from the hoard

Mound No. 1, into the top of which the hoard was placed, appears as a relatively inconspicuous elevation today (*Fig. 4*). Nearby is a second, probably prehistoric burial mound. Although both of elevations have not yet been archaeologically investigated, we assume that they are burial mounds. In addition to the mounds themselves, which clearly stand out from the surrounding terrain (*Fig. 4*), this interpretation is also supported by the finding of a bronze three-edged arrowhead from the Hallstatt period which was found at the Mound No. 2 (see *Michálek et al. 2022*, 116, Fig. 4: 4).

The recovered assemblage from Mound No. 1 contained 27 metal artefacts (one in 2 fragments) with a total weight of 7257.2 g, as well as fragments from one ceramic vessel that likely served as a container for some of the metal artefacts. All finds are now stored in the archaeological collection of the South Bohemian Museum in České Budějovice under inventory numbers A 36.419–36.446.

For a description of both mounds and artefacts (*Fig. 5–9*), see *Online Supplementary Material 1*.

Analyses

Archaeological analysis and chronological classification of the hoard

Miner's pick

The most interesting artefact in the hoard is a miner's pick with butt wings and a hexagonal cross-section body, which was later ground into a chisel and then deliberately broken

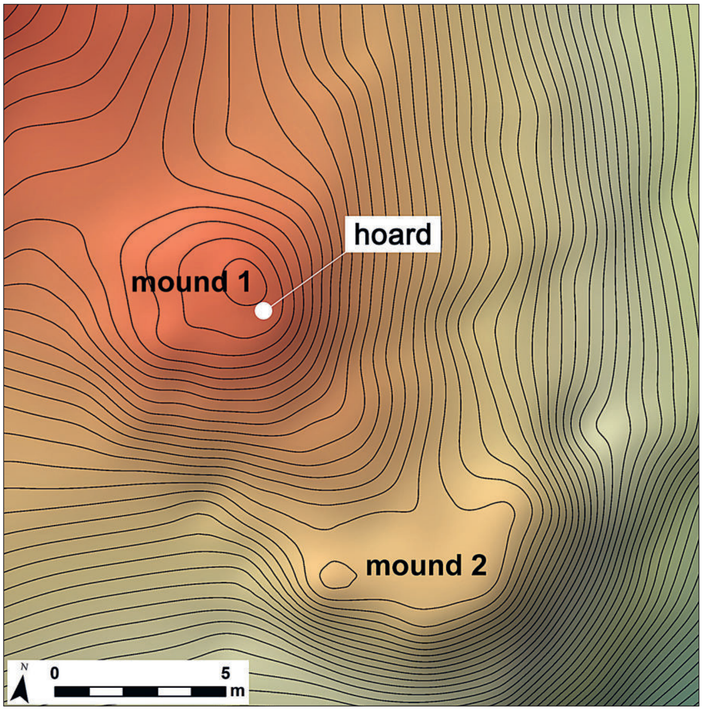


Fig. 4. Krtely. Contour plan of mound 1 (made by J. John).

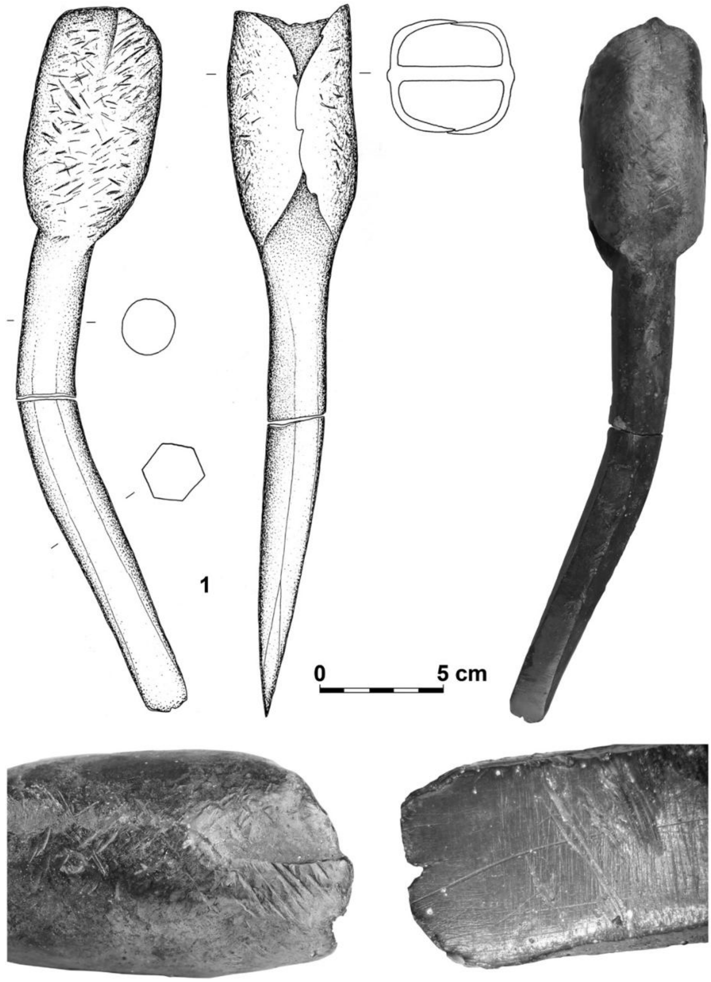
(*Fig. 5*). It is only the third such find in the Czech Republic (*Fig. 10*), with all three picks coming from hoards of fragments dating to the early phases of the Late Bronze Age (*Tab. 1*). While the specimens from Holašovice in South Bohemia (*Kytlicová 2007*, Taf. 21: 22) and from the South Moravian hoard from Réna u Ivančic (*Salaš 2018*, 50–52, Tab. 3: 75) are small fragments of hexagonal bodies with tips, the pick from Krtely is preserved whole. The closest analogy can be found in the Upper Austrian hoard from Sipbachzell, which contains six picks with wings in various states of preservation, as well as two socketed picks associated with the copper exploitation centre at Mitterberg (*Höglinger 1996*, 40–45). Notably, one almost completely preserved pick with wings from Sipbachzell was already broken in prehistoric times in the same manner as the specimen from Krtely (*Höglinger 1996*, Taf. 20: 349).

A significant number of bronze picks with butt wings and bodies of hexagonal cross-section, along with their fragments, have been found in the Hallstatt salt mines and the nearby burial site (both in several graves and as solitary scattered finds within the burial site). In the mid-1970s, 34 specimens were documented (*Mayer 1977*, 228–233), but many more have been added since then (*Barth 1993–1994*, 29, 31). However, no comprehensive list has been published since Mayer's work. The chronological classification of these picks is more complicated, ranging from the Urnfield period to the later phases of the Hallstatt period (*Mayer 1977*, 230). Nevertheless, some years ago, it was established that Bronze Age miner's picks differ from those of the Hallstatt period in both shape and size; Bronze Age picks are more robust, while Hallstatt period specimens are more delicate (*Barth 1993–1994*, 31; *Kowarik et al. 2019*, 65–67). This reflects the development of salt extraction techniques,

	Country	Site	Context	Dating	Number of pieces	Preservation condition	Length (mm)	Weight (g)	References
1	CR	Holašovice	hoard	Br D – Ha A1	1	Fragment	57	78	*Kytlicová 2007*, Taf. 21: 22
2	CR	Krtely	hoard	Br D – Ha A1	1	Broken	308	1643	current paper
3	CR	Ivančice	hoard	Br D – Ha A1	1	Fragment	21	9	*Salaš 2018*, 50–52
4	A	Hallstatt	mines, burial site	Br D – Ha D	34	Complete – 3 Fragments – 31	a/ 382 b/ 283 c/ 255*	a/ 1750, b/ undeterm. c/ 1300*	*Mayer 1977*, 228–233
5	A	Koppental	sacrificial site	Br D	2	Fragments	a/ 18 b/ ?	a/ 4,4 b/ ?	*Modl 2008*, 188–189
6	A	Obertraun	hoard?	Urnfield?	1	Broken	348	1730	*Windholz-Konrad 2018*, 181, 183
7	A	Sipbachzell	hoard	Br D – Ha A1	6	Complete – 2 Fragments – 4	a/ 338 b/ 324*	a/ 1742, b/ 1485	*Höglinger 1996*, 129
8	A	Straßen	isolated find	Urnfield?	1	Complete	289	549	*Windholz-Konrad 2003*, 41–42
9	RO	Guşteriţa	hoard	Ha A1	2	Complete – 1 Undetermined – 1	?	?	*Vulpe 1975*, Taf. 46: 464
10	RO	Uioara de Sus	hoard	Br D – Ha A1	7	Nearly complete – 3 Fragments – 4	?	?	*Vulpe 1975*, Taf. 45: 457–459, 46: 460–463
Total					**56**	**Complete/nearly complete – 12 pcs, fragments – 43 pcs, undetermined – 1 pc**			

Tab. 1. Overview of European finds of miner's picks with a hexagonal cross-section body and butt wings. Asterisk (*) indicates cases where only complete or nearly complete pieces are listed. For the Hallstatt site, the minimum number is according to the latest inventory (*Mayer 1977*); later finds that have not yet been comprehensively published are not reflected.

Fig. 5. Krtely. Bronze pick from the hoard (drawing by T. Kolegar, photo by L. Töröková).



as seen in the varying lengths of preserved wooden handles, of which over 1400 have been found in Hallstatt (*Kowarik et al. 2019*, 50, Abb. 23). Radiocarbon dating of these handles has significantly refined the chronology of the picks, dating them from approximately 1400 to 1000 cal BC (*Barth 1993–1994*, 29–31, Tab. 1; *Thomas 2014*, 183).

Two recently found picks analogous to those mentioned above have been recorded near Hallstatt. The first is a whole specimen from the 'middle Koppental' valley near the village of Straßen, about 8 km east of the prehistoric salt mines (*Windholz-Konrad 2003*, 41–42, Taf. 25: 352). This is, however, an isolated find without further context. The second find, discovered in 2007 near the village of Obertraun at the southern edge of Hallstatt Lake, has no clear finding context, although a fragment of a cake-shaped ingot was found about 10 m away. Notably, the tip of this artefact was broken off and subsequently pushed between the butt wings (*Windholz-Konrad 2018*, 181, 183, Abb. 96). Two further fragments of pick tips come from the Koppental sacrificial site near Bad Aussee, dated by ^{14}C between 1420 and 1260 cal BC (*Modl 2008*, 86–88, 188–189).

Other finds of bronze hexagonal picks come from the eastern part of the Carpathian Basin. Two large hoards from the beginning of the Late Bronze Age were found in Transylvania, containing analogous picks to the Czech and Austrian specimens mentioned. The Guşteriţa II hoard included one complete pick and one undescribed fragment (*Vulpe 1975*, 80, Taf. 46: 464; *Petrescu-Dîmboviţa 1977*, 95, Pl. 155: 1),[1] while the Uioara de Sus hoard contained three large and four smaller fragments (*Vulpe 1975*, 80, Taf. 45: 457–459, 46: 460–463; *Petrescu-Dîmboviţa 1977*, 115, Pl. 220: 17–19, 221: 1, 5). Unfortunately, none of these Transylvanian specimens have been described in detail in the literature.

An artefact from an unknown site (Velikaya Began, Zmeevka, or Orosievo near Berehovo) in Transcarpathian Ukraine (*Kobaľ 2000*, 98, Taf. 94B: 5), sometimes referred to as a miner's pick (e.g., *Salaš 2018*, 50), has been excluded from the analysis after a revision by the authors. It is an artefact of a different type and likely served a different function.

From the point of view of the primary function of these picks, there is no doubt that they served as tools (diggers) for salt extraction, while no evidence for their possible use for copper extraction has yet been provided. Most recently, this question has been addressed in the case of the Romanian specimens by P. Thomas, who opines that the aforementioned finds from both hoards cannot be linked to mining in Romanian copper or salt deposits, as no similar picks have been found in any of the Bronze Age mining areas, despite relatively intensive modern archaeological excavations (*Thomas 2014*, 181).

The origin of these picks is often sought in the Alpine region, as recent research suggests the oldest Austrian specimens predate the Transylvanian ones (*Thomas 2014*, 183, 185). However, their place of production has not yet been identified (*Kowarik et al. 2019*, 67). Some picks, including some pieces from Transylvania, have carved marks on the bodies at the junction of the wings (*Mayer 1977*, 232–233, Abb. 2; *Höglinger 1996*, Taf. 20: 349–351; *Thomas 2014*, 184), but no mark is visible on the specimen from Krtely.

The specimen from Krtely is unique in its reutilization from a pick to a chisel, with no other documented pick showing this secondary modification. Speculatively, we may consider the reworking of this originally mining tool after its transfer to South Bohemia, where it could then have been used, for example, as a woodworking tool.

Other artefacts

Sword

A fragment of a sword with a cast hilt (*Fig. 6*: 2) is exceptional in South Bohemia, representing only the third specimen of this type of weapon from the Urnfield period in this region. No sword with a cast hilt from this epoch was known here until recently (*Chvojka 2009*, 102). Two swords have been recovered since then: one complete specimen of the Liptov type, found in 2010 at Písecká Smoleč (*Jiřík – Pták 2013*, 163), and another fragmented with a heavily damaged hilt (typologically indeterminate) from Předčice (*Chvojka et al. 2021a*, 60–61, Fig. 15: 4).

[1] M. Petrescu-Dîmboviţa mentions two additional pick tips from this hoard, which were lost at the beginning of the 20th century (*Petrescu-Dîmboviţa 1977*, 95); since it is impossible to verify these findings, they are not further considered and are not included in *Table 1*.

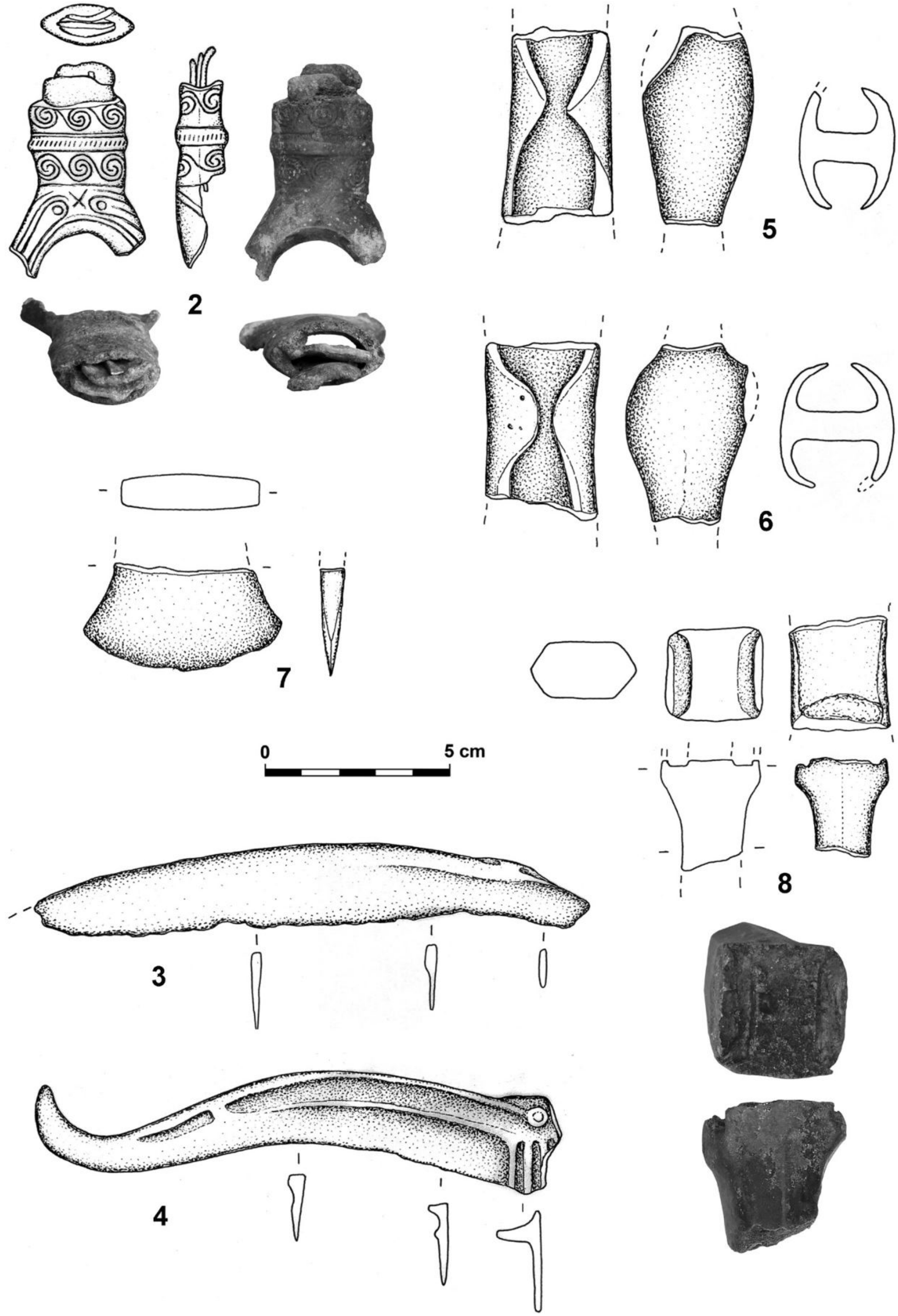


Fig. 6. Krtely. Bronze artefacts from the hoard. The numbers of artefacts correspond to their list in the *Online Supplementary Material 1* (drawing by T. Kolegar, photo by L. Töröková).

The typological determination of the sword from Krtely does not present any serious difficulties. It can be classified into the group of Liptov type swords (see *Hrala 1954*). The full-hilt of oval cross-section, with continuous spiral decoration in the tang areas formed by a single line, places the fragment among the swords of the Erding type, sometimes referred to as Erlach type. These swords are widespread throughout Europe (*Stockhammer 2004*, 177–178, Karte 21). It is the overall composition of the tang in which the Krtely specimen shows an only significant discrepancy from the existing classification. Unlike other swords of this type found so far, which have a tang fitted with three embossed horizontal ribs (Dreiwulstschwerter), the lowest of which separates the tang from the guard, the guard on our fragment is separated from the sword by only one groove, with the usual horizontal rib missing.

If we exclude the specimens from watercourses, the fragment from Krtely is the first evidence of the deposition of a Liptov type sword in Czech hoards of fragments, not considering the solitary deposited sword with a full hilt of the Aldrans type from Jezeří in northern Bohemia (*Jiráň et al. 2023*).

The fragment of the sword from Krtely is only the second find of an Erding-type sword in Bohemia. The only earlier find of the same type is a sword drawn from the Vltava River below Prague's Vyšehrad in 1900. The decoration of the hilt and guard differs somewhat between the two swords. While the Vyšehrad sword has clearly recognizable two bird protomes on the guard and the ribs on the hilt are diagonally incised on both sides from the outside, the Krtely specimen has the incisions applied to the body of the rib, and the guard features a more abstract motif of two kidney-shaped loops set in the largest extension with small circles.

These decorative elements are also found on other Erding type swords. The decoration on the tang of the Krtely sword closely resembles that of South Bavarian swords from the eponymous Erding and especially from Erlach, where the decorative scheme coincides with the unusual motif of an oblique cross in the centre of the sword's guard (*Quillfeldt 1995*, Taf. 45: 135–136).

The Krtely sword fragment is also notable for containing three other fragments of bronze objects inserted into the hilt's inner space. To further typologically identify these artefacts, the hilt was subjected to X-ray and tomographic imaging (see chapter X-ray and tomographic analysis of a sword fragment). The images reveal one rod-shaped chisel or burin, and two fragments of rounded, undecorated, heavily burnt metal sheets of indeterminate typological classification.

Knife

Among the several complete or nearly complete artefacts in the Krtely hoard is a knife (*Fig. 6*: 3), an older form with a plate-like hilt of the Riegsee type. The knife from Krtely fulfils its basic morphological signs, especially the straight, not arched, edge of the blade. However, the shape of the knife in the transition between the blade and hilt is unusual. Typically, the contour of the butt straightens at the hilt's point, while the contour of the hilts's lower part rises in relation to the blade's contour (e.g., *Jiráň 2002*, 21–23). In the case of the Krtely knife, both the upper and lower contours of the hilt symmetrically curve downwards in relation to the contours of the butt and blade. The only similarly profiled knife is a specimen found in 1870 at Schöngeisinger Forst (*Hohlbein 2016*, Taf. 25: 269).

Sickle

The typological analysis of the sickle from Krtely (*Fig. 6*: 4) focuses on its overall construction and applied technological elements. The distinctly S-shaped blade with an upward-pointing tip is less common among Upper Danube Urnfields finds, where arched blades predominate even in lateral thorn sickles. Sickles are mostly found as fragments in hoards, so the overall shape of the blade cannot be reconstructed in most cases. However, the occurrence of S-shaped sickles in such assemblages in the oldest time horizon is demonstrated by a fragment from the Plzeň-Jíkalka hoard and a sickle from the St. Matěj cemetery in Prague-Šárka (*Kytlicová 2007*, Taf. 10: 17, 40: D3). Similar S-shaped sickles appear in younger hoards from Lažany, Prague-Vinoř, Rýdeč, Radětice, and potentially Kamýk nad Vltavou (*Kytlicová 2007*, Taf. 25: 31, 27: 68, 49: 104, 50: 105, 107, 110, 69: 88, 91, 76: 260, 262, 267, 78: 40, 92: 220, 225, 226).

The additional parallel reinforcing rib on the side of the blade's upper part, accompanying the butt rib, lacks chronological sensitivity and is common in sickles with a lateral thorn dated to the Plzeň-Jíkalka horizon and slightly later ones. Small perpendicular ribs at the heel of the sickle under the knob are minimally represented in Knovíz culture sickles. In Bohemia, this element appears on sickles from hoards in thirteen cases only, with varying forms. All sickles with similar ribs on the heel are found in hoards from the Lažany and Suchdol horizons from the early period of the Knovíz culture (Kamýk nad Vltavou, Lhotka, Pětipsy, Vinoř, and Rýdeč: *Kytlicová 2007*, 146; Rataje u Bechyně: *Chvojka et al. 2018*, Fig. 16: 18). However, the technological execution of these ribs mostly differs, whether it is just their schematic indication or the resulting ornamentation. Closer analogies to the form and execution of the perpendicular ribs on the sickle from Krtely are shown only by the ribs on the sickle from Kamýk nad Vltavou and one sickle from Rýdeč (*Kytlicová 2007*, Taf. 25: 28, 93: 228). In the case of the above-mentioned two hoards, it should be noted that both contain artefacts that demonstrate their connection with territories outside the Bohemian Basin (*Hrala 1966*; *Kytlicová 2007*, 9, 22, 224, 232, 239, and others).

Based on the comparison of the morphological elements used, which characterize the specimen from Krtely, with other sickles with a lateral thorn found in hoards of the Knovíz culture, it can be stated that the sickle from the hoard in Krtely is a distinct solitaire on Czech territory. However, we reach a similar conclusion if we search for similarly shaped sickles in the neighbouring European area. Several closer or more distant analogies can be found in the eastern regions, particularly in Moravia, quite frequently in Slovakia, and even in Vojvodina (*Říhovský 1989*, Taf. 4: 39, 44, 52; *Vasić 1994*, Taf. 2: 32, 34–36; *Furmánek – Novotná 2006*, Taf. 8: 133–149, 9: 150–156). West of the Bohemian Basin, one can mention the German specimens in the Niedernberg hoard or the river find from the Rhine near Mainz (*Müller-Karpe 1959*, Taf. 161: A11, 12; *Primas 1986*, 70, Taf. 16: 254, 256, 257). If we focus solely on the exceptional profile of the blade with two longitudinal ribs and a markedly extended tip, it is noteworthy that the closest to the sickle from Krtely is the sickle from Bavarian Affalterthal, which was part of a hoard dated to stage Br D, where it cannot be ruled out that it was also deposited in the context of a burial mound (*Müller-Karpe 1959*, Taf. 152: A11; *Primas 1986*, 63, Taf. 7: 122).

Axes

Three artefacts can undoubtedly be identified as fragments of axes – in two cases with medial wings (*Fig. 6*: 5–6) and in one case as a fragment of the blade of an indetermined type of axe (*Fig. 6*: 7). Axes with medial wings are typical artefacts of the Late Bronze Age, which are abundantly represented especially in hoards from this epoch (*Kytlicová 2007*, 122–130; *Chvojka et al. 2017b*, 174), including in South Bohemia.

The classification of the fragment of the central part of the tool (*Fig. 6*: 8) is problematic, which we tentatively classify with reservations as a fragment of the central part of an axe with a stepped ridge. This type of axe is relatively rare in Bohemia, found from the end of the middle to the later phases of the Late Bronze Age (*Kytlicová 1959*). However, the above-mentioned classification is complicated by the fact that the groove separating the edge ridges from the body of the tool comes to the surface. Therefore, the precise original shape of this artefact is unknown. It is also possible that this fragment could be classified as some type of hammer with a central hole (see *Nessel 2019*, 67, Abb. 67).

Chisel

The flat rod-shaped chisel, which is damaged by burning (*Fig. 7*: 15), represents a chronologically insensitive shape, appearing throughout the entire Bronze Age (*Mayer 1977*, 218–219, Taf. 87: 1279–1280; *Říhovský 1992*, 274–276, Taf. 76: 1219–1226). In South Bohemia, there are many rod-shaped chisels from the Bronze Age, though most are more delicate. In shape, the chisel from Krtely is closest to the broader chisel from Lišov (*Chvojka et al. 2017a*, Fig. 16: 25).

Twisted rod

The fragment of a twisted rod with one preserved straight end (*Fig. 7*: 10) could be interpreted as a working tool – a burin or punch? This hypothesis is suggested by similar artefacts from other Central European sites, which are often interpreted as rod-shaped chisels secondarily remade from objects originally of a different function, including twisted rods (see *Nessel 2019*, 99–100, Abb. 112e; for Bohemian examples see *Kytlicová 1961*). The closest analogy in South Bohemia is a rod-shaped twisted object from the Paseky 3 hoard, which was labelled as a chisel or punch (*Chvojka et al. 2017b*, 174, Tab. 128: 19). Similar shaped chisels can also be found in other Czech hoards, such as those from Kundratice and Velké Žernoseky (*Kytlicová 2007*, Taf. 116: 67, 118: A10). To confirm the interpretation of the mentioned artefacts as working tools, it would be advisable to carry out use-wear analyses in the future.

Neckring

The hoard from Krtely contained several complete and fragmented examples of circular jewellery. These include a fragment of a massive twisted neckring with engraved decoration at the seal-like end (*Fig. 7*: 9), which belongs to typical forms of the Late Bronze Age (*Kytlicová 2007*, 56–62). Similar twisted rings were found in several hoards of the Br D/Ha A1 stages in South Bohemia (e.g., Staré Sedlo: *Kytlicová 2007*, Taf. 23: 11–16; Olešná 2: *Chvojka et al. 2017b*, Tab. 117:10; Paseky 1: *Chvojka 2009*, Tab. 20: 9–14) and Ha A2/B1 (Albrechtice nad Vltavou: *Kytlicová 2007*, Taf. 131A).

Bracelets

Three artefacts belong to bracelets or general arm ornaments, each belonging to a different type. From the end of the Middle and especially in the following Late Bronze Age, massive cast bracelets with fine engraved decoration are common (in South Bohemia, e.g.,

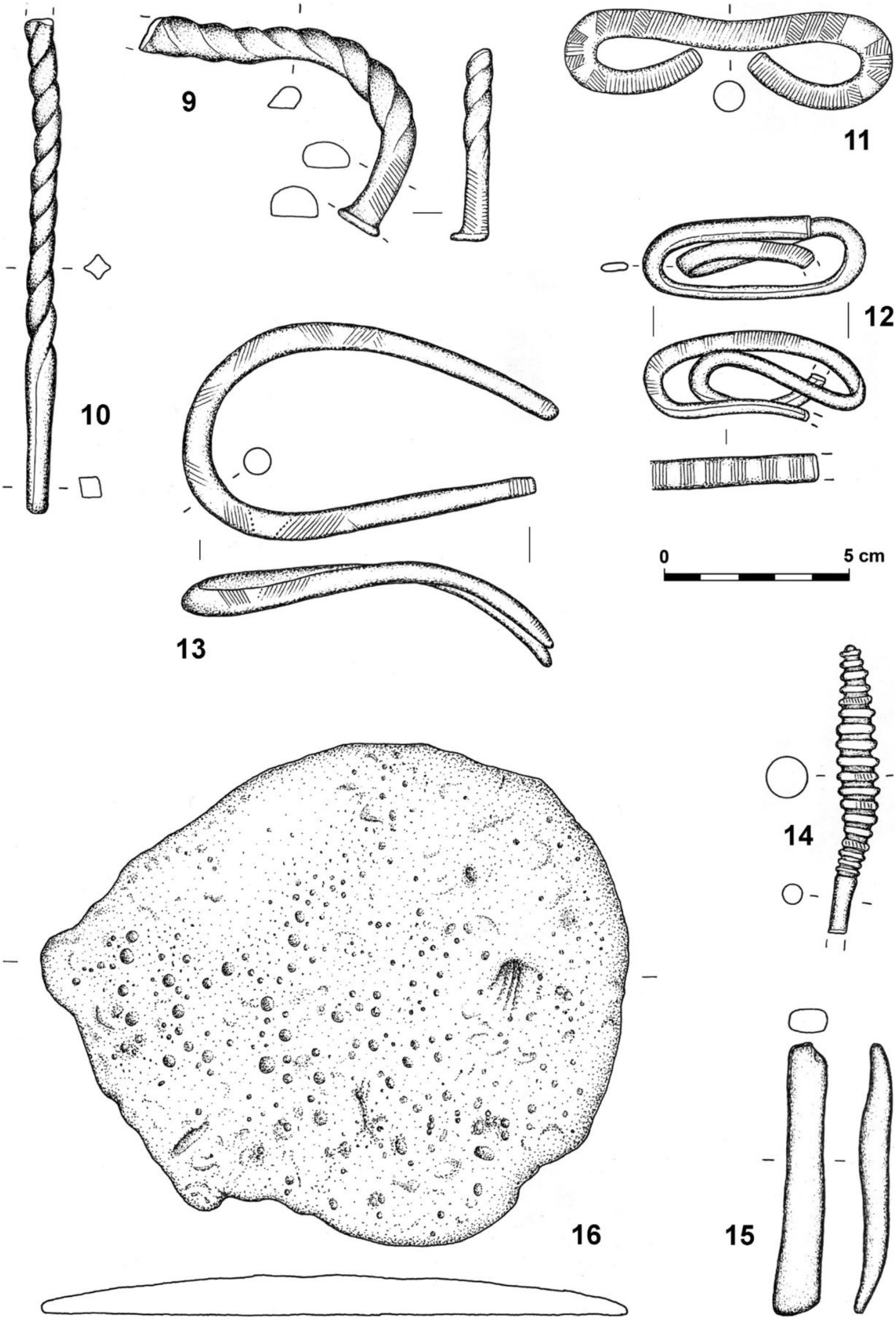


Fig. 7. Krtely. Bronze artefacts from the hoard. The numbers of artefacts correspond to their list in the *Online Supplementary Material 1* (drawing by T. Kolegar).

Beneš – Kytlicová 1991; *Chvojka et al. 2017b*, 170–171), one example of which is represented in the hoard discussed here (*Fig. 7*: 11). This massive object, however, was deformed into the shape of a figure eight before being deposited in the hoard, with the closest geographic and chronological analogy found in the hoard from Staré Sedlo (*Kytlicová 2007*, Taf. 23: 10).

The second fragment from Krtely is more delicate, made from a flat band, and is also significantly deformed (*Fig. 7*: 12). Given its decoration and band profile, we interpret it as a fragment of a spiral armring, with close analogies found, for example, in the South Bohemian hoard from Olešná 1 (*Chvojka et al. 2017b*, Tab. 110: 1–2). Similar examples can also be found in other regions (e.g., *Salaš 2005*, Tab. 242: 62).

The fully preserved bracelet was probably slightly saddle-shaped secondarily (*Fig. 7*: 13). Bracelets with similar shapes and decorations can be found in several other South Bohemian hoards (e.g., *Kytlicová 2007*, Taf. 23: 7–8; *Chvojka et al. 2017b*, Tab. 117: 7), though none are curved in the same way as the bracelet from Krtely. Similarly shaped, undecorated rods are found in the Moravian hoard from Přestavlky, but these cannot be classified as circular jewellery (*Salaš 2005*, 386, Tab. 265: 158).

Pin

The only representative of pins in the Krtely collection is a fragment probably with a long-knobbed head (*Fig. 7*: 14). Although it cannot be entirely ruled out that the top of the head is broken off and the pin originally had a differently shaped head (e.g., *Kytlicová 2007*, Taf. 60: D3, 66: B5), we assume this is not the case and that it is a pin with a long and distinctly knobbed head, as known from many hoards from the Br D – Ha A1 stages (*Kytlicová 2007*, Taf. 60: A3, 66: B1). Similar pins are documented in South Bohemia from the horizon of the Plzeň-Jíkalka hoards (*Kytlicová 2007*, Taf. 5: A1, 6: B4, 6: C4), but they are also common in hoards and graves from the following early phases of the Urnfield period (*Chvojka 2009*, 87; *Chvojka et al. 2017b*, Tab. 110: 16).

Cake-shaped ingots

Although raw material ingots are very common in hoards of metal artefacts from the Late Bronze Age, they are mostly present as larger or smaller fragments of original cake-shaped ingots (cf. most recently *Kmošek et al. 2020*). Whole examples are scarcely documented in Czech hoards from the area of Upper Danubian Urnfield culture. The report of a large ingot found in 1876 at Plešivec, along with other artefacts in a burnt pit containing ash, is problematic (*Richly 1893*, 125; *Jelínek 1896*, 216). The mentioned artefact has not been preserved, and its identification as a cake-shaped ingot is certainly questionable.

The oldest and largest documented whole cake-shaped ingot is from the hoard from Malé Nepodřice (*Kytlicová 2007*, 283, Taf. 11: B), which was deposited together with an axe and a pin, dating the set to the very beginning of the Urnfield period in the Plzeň-Jíkalka hoard horizon.

In terms of size and time frame, the ingot from Krtely is closest to the whole cake-shaped ingot from the Velvary hoard (*Kytlicová 2007*, Taf. 56: A82). This set belongs to the Lažany horizon and contains, among other things, a metal sheet fragment with typical decoration, linking it to the Upper Bavarian area of the Riegsee horizon (*Kytlicová 2007*, 175, 208). Similarly, the whole cake-shaped ingot from the Prague-Butovice hoard and a smaller ingot from the hoard from Zahájí are dated to the Lažany horizon (*Kytlicová 2007*,

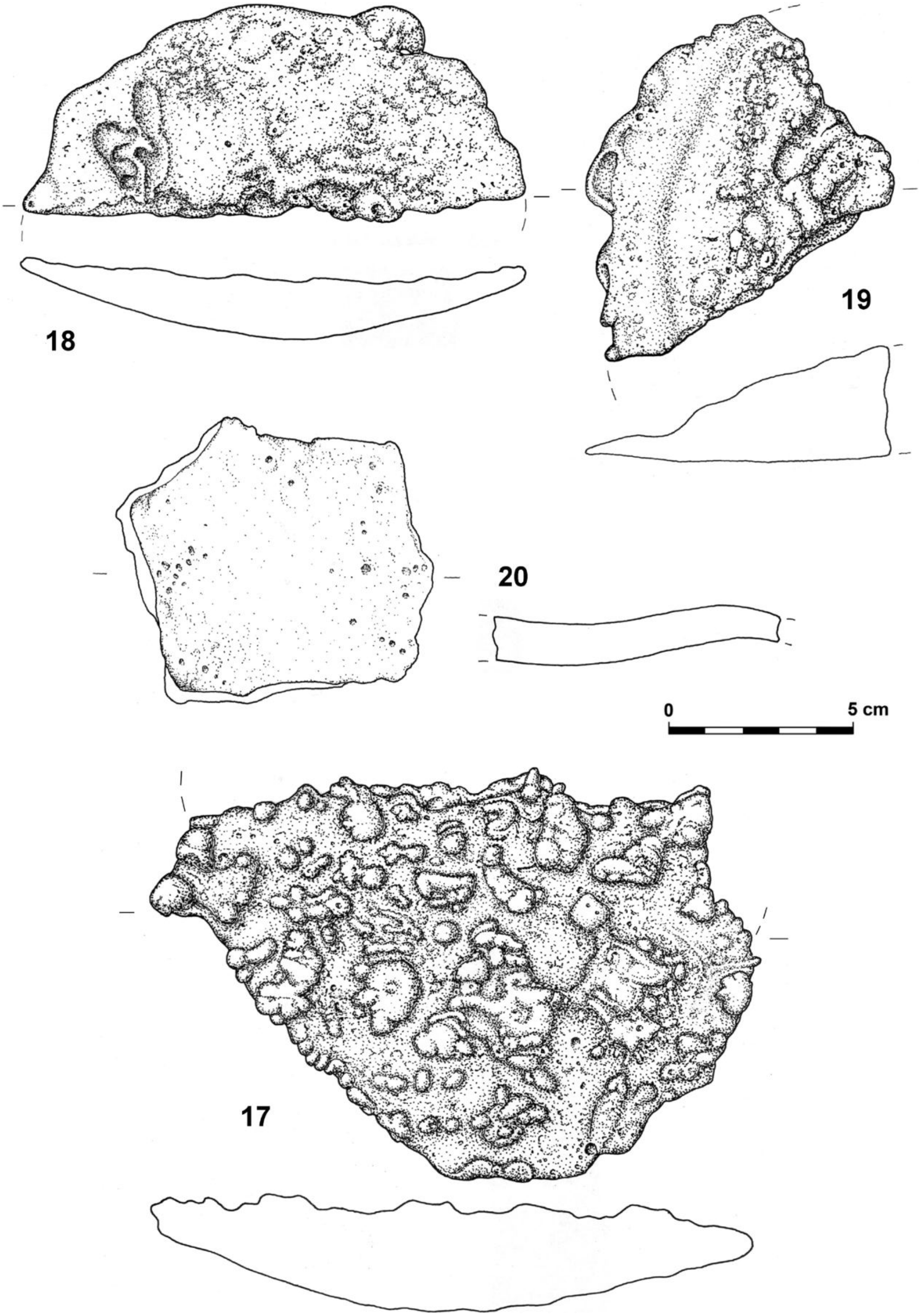


Fig. 8. Krtely. Copper artefacts from the hoard. The numbers of artefacts correspond to their list in the *Online Supplementary Material 1* (drawing by T. Kolegar).

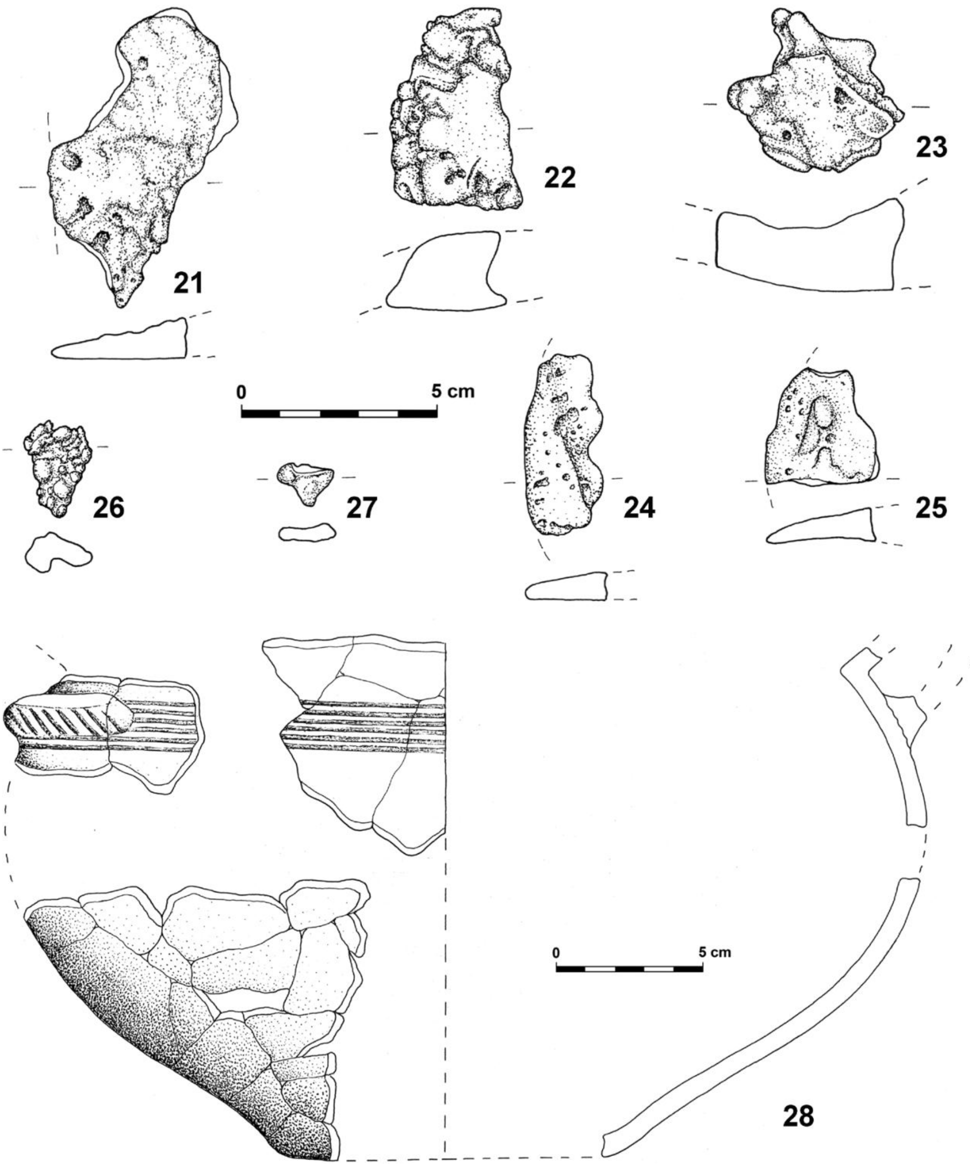


Fig. 9. Krtely. Copper artefacts and the torso of a ceramic vessel from the hoard. The numbers of the artefacts correspond to their list in the *Online Supplementary Material 1* (drawing by T. Kolegar).

295, Taf. 22: B8, 45: 54 – as Prague-Jinonice). A more recent find from the same period is a smaller cake-shaped ingot found with a larger number of incomplete ingots in the Olešná 2 hoard (*Chvojka et al. 2017b*, 117, Tab. 121: 34).

The cake-shaped ingot from Krtely (*Fig. 7*: 16) is thus the sixth verifiable complete example found in hoards from the Upper Danubian Urnfield culture in Bohemia. All previous cases can be associated solely with the early phases of the development of this cultural complex. The remaining 11 ingots from the hoard in Krtely are variously sized fragments and pieces (*Fig. 8–9*), which cannot be typologically evaluated in detail.

The presence of cake-shaped ingots and their fragments is also a significant argument for classifying the assemblage as a hoard, since they do not appear in graves with a few exceptions (e.g., *Hennig 1993*, Taf. 45: 20–21).

Ceramic vessel

Similar to several other South Bohemian hoards from the Late Bronze Age, the assemblage of metal artefacts found near Krtely was accompanied by a ceramic vessel, unfortunately without a clear relationship. The vessel was preserved only fragmentarily, with its upper part completely missing (*Fig. 9*: 28). Therefore, its typological classification is problematic; however, we consider the classification of the vessel as an amphora or jug to be the most likely. Numerous analogies for both types of vessels with decorations in the form of a bundle of narrow grooves on the neck can be found directly in South Bohemia. Similarly decorated large jugs formed the container for the hoard from Holašovice (*Kytlicová 2007*, Taf. 22: A37), and other examples of jugs with grooved decorations come from settlement areas and grave complexes (e.g., *Chvojka 2009*, Tab. 33: 2, 44:6, 54: 19; *Hlásek et al. 2016*, 151, Fig. 8: 1). However, similar grooved decorations on the neck are also documented on some South Bohemian amphorae from the earlier phase of the Late Bronze Age (*Chvojka 2009*, Tab. 61: 5).

Chronological classification of the hoard from Krtely

The typological analysis of the artefacts clearly indicates the chronological classification of the hoard from Krtely. All datable metal products and the torso of the ceramic vessel belong to the earlier phases of the Late Bronze Age, i.e., to the Reinecke stages Br D – Ha A1, although some have a broader chronological range. Due to the absence of organic materials, this date was not supported by radiocarbon dating, but the typological analysis of most artefacts provides a clear classification into the stated period. This is also confirmed by the chronological classification of the most interesting metal product from the hoard – the pick, which is based on analogies mainly from the salt mine environment in Hallstatt. Although bronze picks with butt wings were used throughout the Urnfield period and into the Early Iron Age, as already mentioned, there was a certain evolution in shape and size of the picks during these epochs, reflecting a functional shift in salt mining techniques (*Barth 1993–1994*). The specimen from Krtely in its shape, dimensions, and weight corresponds to the picks from the Late Bronze Age, as shown by similar complete picks from the hoards in Sipbachzell (*Höglinger 1996*), Guşteriţa II, and Uioara de Sus (*Vulpe 1975*, 79–80, Taf. 45: 457–459, 46: 460–464). Based on these analogies, the pick from Krtely can be clearly dated to the Late Bronze Age. The above typological classification of the sword, knife, sickle, circular jewellery, and pin safely confirms the dating of the entire hoard to the period Br D – Ha A1.

Analysis of the elemental composition of metal artefacts from the hoard

Small samples of metal shavings were taken by drilling from all artefacts from the Krtely hoard and then subjected to pXRF elemental analysis using a handheld Niton XL2 GOLDD

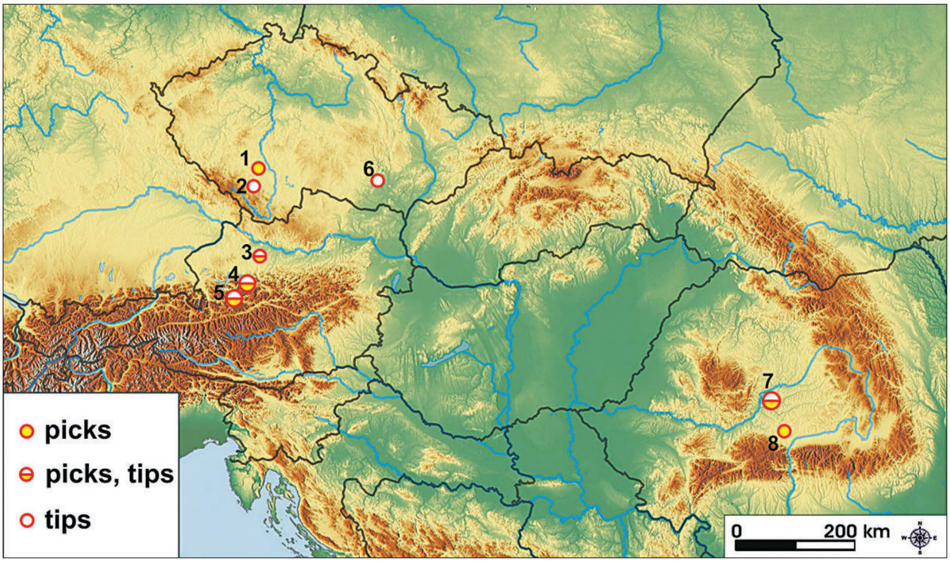


Fig. 10. Map of the distribution of Hallstatt-type picks in Central Europe. 1 – Krtely, 2 – Holašovice, 3 – Sipbachzell, 4 – region of Bad Aussee, 5 – Hallstatt, 6 – Ivančice, 7 – Ocna Mureş-Uioara de Sus, 8 – Sibiu-Guşteriţa (background www.stepmap.com, modified by T. Zachar).

spectrometer and a low-power X-ray lamp (45 kV/2W). The measured values clearly indicate that tools, weapons, and ornaments were made of tin bronze, while the ingot fragments are copper (*Tab. 2*). Unlike the copper ingots, the fragments of products often also contain small amounts of lead. Among the bronze artefacts, the highest tin content was found in the miner's pick (9.48%), but it should be noted that the sampling and measurement procedure typically leads to a slight underestimation of the tin content in the alloy (see *Malý et al. 2019*), and the actual content of this element is probably slightly higher (see ED-XRF analysis results below).

The Hallstatt-type winged pick from the find assemblage from Krtely (*Fig. 5*), as well as a fragment of an identical type of pick in the hoard from Holašovice (*Kytlicová 2007*, Taf. 21: 22), were subjected to elemental analysis using the ED-XRF method (*Nørgaard et al. 2019*, 3–4). After removing the surface layer of patina, we drilled out a small amount of metal (30 mg). The analyses were performed by the CEZA Mannheim laboratory (using the EDRFA Spectro Xepos HE instrument). Given the function of the picks as mining tools (*Reschreiter et al. 2018*), the aim of the analyses was to obtain more detailed information on the tin content in the bronze alloy. The pick from Krtely contained 12% tin, the specimen from Holašovice 10.6% tin (*Tab. 3*: ID1, ID3). The analysis of the artefact from Krtely using the XRF method indicated a value of 9.48% tin (see above), while in the case of the pick from Holašovice, the NAA method measured a value of 12.96% tin (*Tab. 3*: ID2, ID4; *Salaš 2018*, 51, Fig. 20). The differences found in the measurements, in the case of the Krtely specimen up to 2.52%, represent a common deviation resulting from the use of different methods (e.g., *Salaš 2014*, 73, Fig. 21; *Zachar – Salaš 2019*, 619, Tab. 1). The content of other elements in the bronze alloy of the monitored miner's picks (<0.33%, ED-XRF method) represents natural contamination of the primary copper raw material.

ARTEFACT	Cu	Sn	Fe	Co	Ni	As	Sb	Pb
1	89.93	9.48	0.05	< LOD	0.27	0.03	< LOD	< LOD
2	89.89	8.10	0.04	< LOD	0.77	0.48	0.14	0.25
3	94.82	2.96	< LOD	0.04	0.30	0.98	0.19	0.36
4	94.32	4.82	< LOD	0.05	0.11	0.17	< LOD	0.18
5	92.22	6.80	< LOD	< LOD	0.26	0.12	< LOD	0.14
6	93.34	5.93	0.04	< LOD	0.27	0.12	0.03	0.08
7	92.93	6.16	< LOD	< LOD	0.32	0.13	0.04	0.12
8	94.92	4.26	0.06	< LOD	0.35	0.11	0.02	< LOD
9	91.38	7.93	< LOD	< LOD	0.15	0.09	< LOD	< LOD
10	92.93	6.16	< LOD	< LOD	0.29	0.13	0.04	0.09
11	93.89	4.85	0.25	0.04	0.31	0.20	0.04	0.09
12	92.64	6.43	< LOD	0.03	0.29	0.14	0.03	0.07
13	93.42	5.41	0.06	< LOD	0.24	0.25	0.04	0.13
14	91.30	8.12	0.23	< LOD	0.04	< LOD	< LOD	< LOD
15	92.20	7.25	< LOD	< LOD	0.17	0.13	< LOD	0.04
16	98.94	< LOD	0.59	0.07	1.21	0.04	< LOD	< LOD
17	99.80	< LOD	0.26	< LOD	0.61	0.09	< LOD	< LOD
18	97.35	0.15	0.81	< LOD	0.06	1.24	0.30	< LOD
19	99.57	< LOD	0.05	< LOD	0.28	0.05	< LOD	< LOD
20	98.04	< LOD	2.12	0.05	0.30	0.31	< LOD	< LOD
21	78.78	< LOD	19.85	< LOD	0.85	0.35	0.05	< LOD
22	97.91	< LOD	1.92	< LOD	0.08	0.03	< LOD	< LOD
23	98.53	< LOD	0.66	0.14	0.50	0.19	< LOD	< LOD
24	98.66	< LOD	0.79	0.13	0.15	0.06	< LOD	0.16
25	97.04	< LOD	1.91	0.15	1.23	0.49	< LOD	< LOD

Tab. 2. Results of elemental analysis (pXRF) of all metal artefacts from the Krtely hoard. LOD – below detection limit (prepared by J. John).

ID	Locality	Analysis	Fe	Co	Ni	Cu	Zn	As	Ag	Sn	Sb	Pb	Bi	Au	Se	References
1	Krtely	ED-XRF	<0.05	0.02	0.26	88	<0.05	0.02	0.009	12	<0.005	<0.005	<0.01	n	n	MA-223762
2	Krtely	XRF	0.05	n	0.27	89.93	n	0.03	n	9.48	n	n	n	n	n	in this article
3	Holašovice	ED-XRF	<0.05	0.01	0.27	89	<0.05	0.05	0.018	10.6	0.008	0.064	<0.01	n	n	MA-223761
4	Holašovice	NAA	0.185	0.012	0.329	86.43	n	0.052	0.017	12.96	0.008	n	n	0	n	*Salaš 2018*
5	Ivančice 4	NAA	0	0.047	0.611	87.39	n	0.323	0.038	11.34	0.219	n	n	0.001	0.001	*Salaš 2018*
6	Sipbachzell Nr. 349	XRF	0.19	n	0.11	84.24	n	n	n	15.42	0.04	n	n	n	n	*Frána – Jiráň 1996*
7	Sipbachzell Nr. 353	XRF	0.11	n	0.36	87.28	n	0.37	n	11.52	0.25	0.11	n	n	n	*Frána – Jiráň 1996*
8	Sipbachzell. unknown	NAA	0.139	0.013	0.122	82.644	0.0058	0.0465	0.0091	13.44	0.045	0	n	0.00033	0.0026	*Frána – Jiráň 1996*
9	Hallstatt	OES	n	n	0.36	90.6	n	0.34	0.56	6	1.45	0.69	n	n	n	*Junghans – Sangmeister – Schröder 1974*

Tab. 3. Results (%) of elemental analysis (ED-XRF, NAA, XRF, OES) of Hallstatt-type picks. n – not analysed (according to *Junghans et al. 1974*; *Frána – Jiráň 1996*; *Salaš 2018*; CEZA Mannheim MA-223761-62; prepared by T. Zachar).

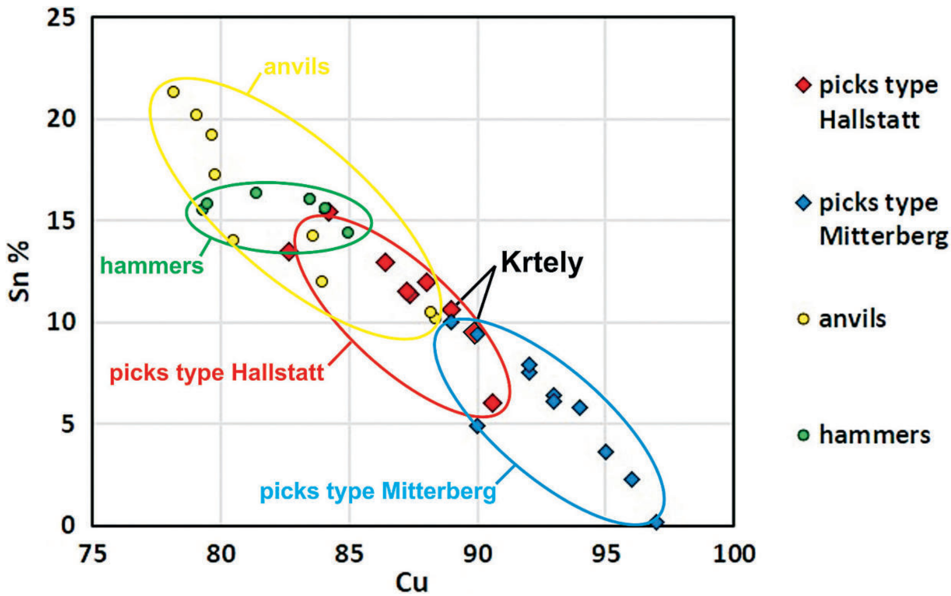


Fig. 11. Graph comparing Sn contents (ED-XRF, NAA, XRF, OES) of Hallstatt and Mitterberg type picks with anvils and hammers from the Late Bronze Age (according to *Junghans et al. 1974*; *Frána – Jiráň 1996*; *Stöllner – Schwab 2009*; *Salaš 2014*; *2018*; *Chvojka et al. 2022*; prepared by T. Zachar).

We compared the amount of tin in the bronze alloy of two Hallstatt-type winged picks from South Bohemia with available elemental analyses (methods NAA, XRF, OES) of other miner's picks from Central Europe. The tin values in the bronze alloy of the Hallstatt-type picks, or their fragments from the hoards in Sipbachzell (*Frána – Jiráň 1996*, 107, Tab. D: 349, 353; *Höglinger 1996*, 129, Taf. 20: 349, 353) and Ivančice (*Salaš 2018*, 51, Fig. 20, Tab. 3: 75), range between 11.34 and 15.42% (*Tab. 3*: ID5–8). An exception is the specimen from the eponymous site Hallstatt (*Mayer 1977*, 228, 229, Taf. 1370–1375), where spectral analysis indicated a tin content of only 6% (*Tab. 3*: ID9; *Junghans et al. 1974*, 306, Nr. 20103). The measured amount of Sn (OES method) corresponds more to the tin content of Mitterberg-type socketed picks, whose values range mostly from unalloyed copper to 10% (*Fig. 11*; *Frána – Jiráň 1996*, 107, Tab. D; *Stöllner – Schwab 2009*, 162, Tab. 6). So far, in no case have we found significantly increased tin contents between 12 and 21.3% (lowest value 10.13% Sn), as we observe in the majority of anvils and small hammers (*Fig. 11*; *Salaš 2014*, 74, Fig. 23; *Chvojka et al. 2022*, 86, Tab. 1). The tin contents found in the Hallstatt-type miner's picks suggest slightly increased tin contents compared to other bronze artefacts (e.g., *Frána et al. 1997*, 152–160), which form the ideal hard tin bronze (for more details, e.g., *Salaš 2014*, 73).

The amount of tin in the alloy of the picks probably did not need to match the hardness of the hammers and anvils, as mining rock salt did not require the hardness of metallurgical tools used for working metal. At the same time, this minimized the brittleness of the bronze picks, which was a problem and led to the breaking off of tips (*Reschreiter – Kowarik 2019*, 115), because rock salt can be very hard. In this context, the significantly lower tin content in the Mitterberg-type picks, intended for mining copper ore, is surprising. However, hardness was increased here by forging and annealing (*Stöllner – Schwab 2009*, 163–165). Comparing the amount of tin in two different types of picks (Hallstatt and Mitterberg) with metallurgical tools confirms that the amount of tin in the bronze alloy in the Late Bronze Age was not accidental but closely related to the function of the artefact (*Reschreiter et al. 2018*).

Use-wear analysis of the pick

The spectacular find of the pick from Krtely was subjected to thorough analysis aimed at identifying and interpreting the manufacturing and use-wear traces on the artefact. It underwent detailed microscopic examination, photographic documentation using RTI, visual inspection, and elemental composition analysis via pXRF. The artefact exhibited a progressive sequence of evidence of its life, from the identification of the material used, through the manufacturing process, usage, reutilization, deposition, and post-depositional processes (*Fig. 12*).

Manufacturing of the artefact

The pick was manufactured by casting molten tin bronze into a stable two-part mould. Subsequently, the sprue channel was cut off at the butt, and the surface was ground down. Post-casting marks are visible on the sides of the artefact's butt in the form of incompletely ground seams at the parting line of the mould. To achieve a perfect grind would have required removing a presumably excessive amount of material, hence this was abandoned. The entire butt of the artefact bears irregular break marks likely resulting from the rough removal of the sprue channel. The flanges were originally cast perpendicular to the body of the pick and then hammered and bent at their ends, creating a closed space for attaching a handle on each side through partial overlap. Consequently, the material of the wings is thicker at the body than at the ends. Additionally, the edges of the wings are irregular, likely due to their imperfect casting. A similar method of wing creation was used in winged axes, as evidenced by comparing the wings of preserved casting moulds with the finished products. The body beneath the wings transitions from a slightly irregular circular cross-section to a regular hexagon, originally extending to the tip of the artefact.

Usage of the pick

The outer surface of the upper part of the artefact shows a considerable number of linear depressions (*Fig. 13*: A). These are primarily located on the sides of the item and to a lesser extent at the point where the wings meet. The depressions cluster into bundles of roughly parallel grooves, which in the butt area intersect at angles of 90° ± 3°. Given the function of analogous finds, these marks can be linked to the intensive use of the artefact in mining activities, specifically mechanical disruption of rock. Based on their character and placement, the linear depressions likely resulted from abrasion against the mine walls or the present rock. Numerous impact marks on the sides of the pick may also indicate its use as an anvil, as similarly documented on the sides of some axes and other artefacts from Moravian hoards (*Malach et al. 2016*, Fig. 17, 54, 67: A, 93–94, 105) or on the hammer from Zlatna in Romania with similar marks, which suggest the interpretation of the secondary use of this object as an anvil (*Nessel 2019*, 69, Abb. 69).

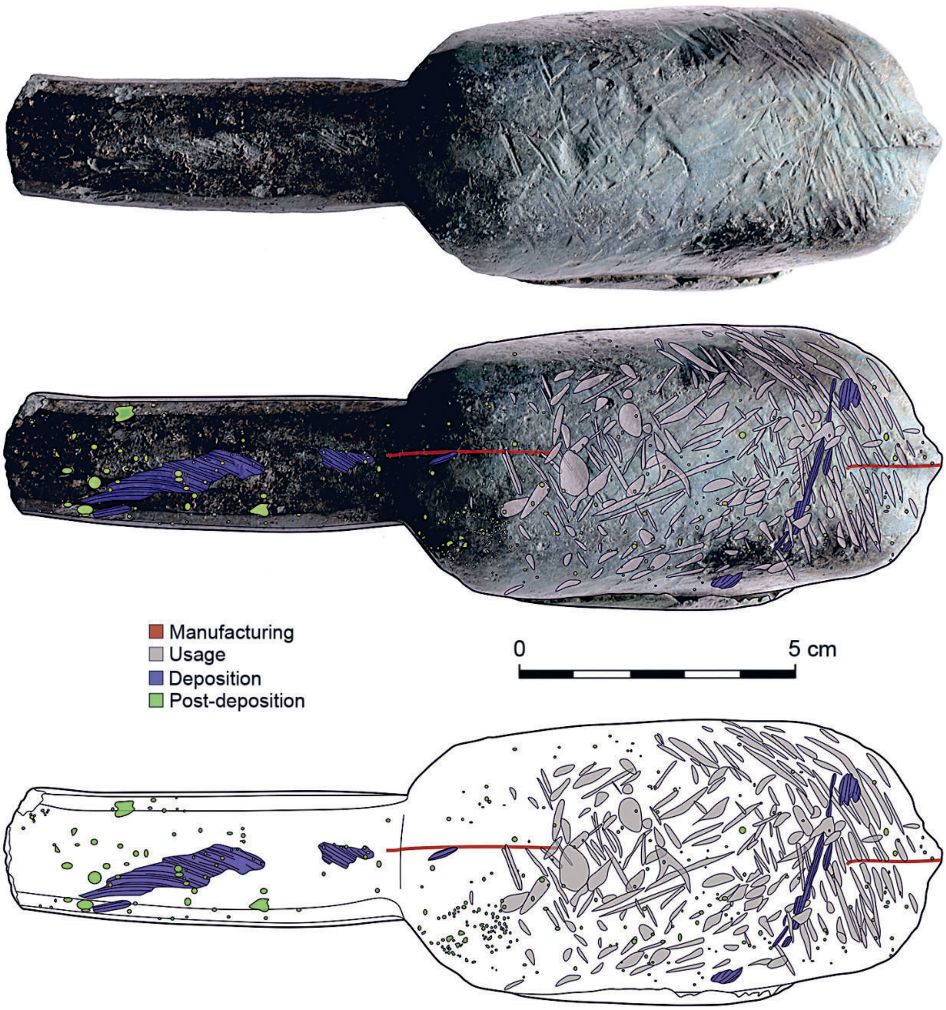


Fig. 12. Krtely, pick. RTI documentation and interpretation of surface traces (photo and drawing by M. Kmošek).

The placement of use-wear marks mainly on the sides of the pick raises questions about its fixation to the handle. Comparing it with analogous finds from Hallstatt (*Kowarik et al. 2019*), where wooden handles were preserved, the placement of work marks on the sides rather than at the point where the wings meet does not correspond. According to the wear marks, the pick from Krtely would have been fixed to a handle perpendicular to all analogous finds of handles.

Reutilization of the artefact

The functional end of the artefact was modified in relation to a change in its use. The original conical/pyramidal tip was reshaped into a chisel-like form. The modification affected the terminal 15 cm of the artefact (*Fig. 5*). Two parallel planes were further flattened,

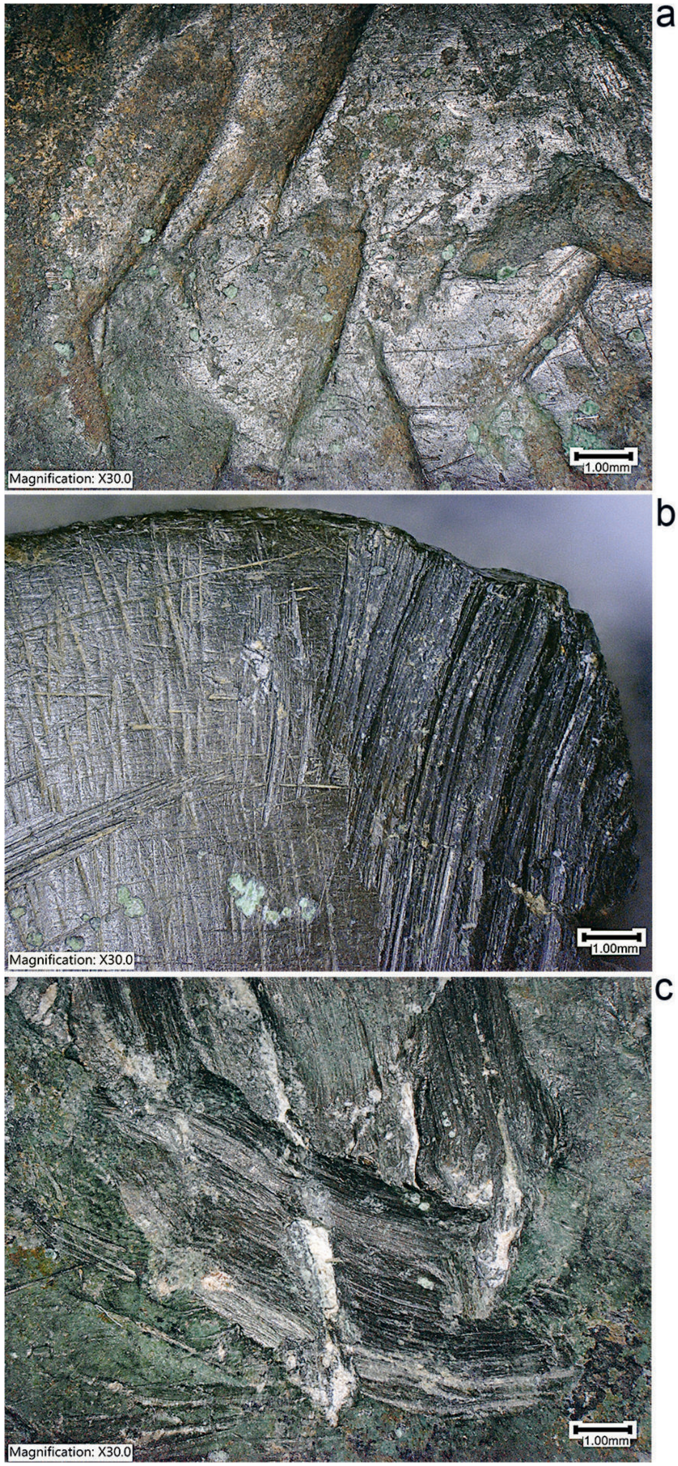


Fig. 13. Krtely, pick. A – microscopic photo of traces of use on the upper part of the artefact. B – microscopic photo of the traces of grinding (left) and damage on the blade. C – microscopic photo of damage marks on the body of the artefact (photo by M. Kmošek).

forming a chisel edge. This adjustment is marked by a noticeable break in the artefact's structure, surface texture, and different and compact coloration of the corrosion products compared to the rest of the surface. The side edges were also slightly flattened to narrow the width of the artefact's end. Such a modified functional end would have hardly served for mining anymore, suggesting the modification was due to a change in the artefact's use. The created edge could have functioned as a chisel, with lesser probability as an axe, adze, weapon, or another tool. A possible function related to cutting cake-like ingots into pieces, also found in the hoard, is feasible but remains a somewhat constructed interpretive solution. The reutilized function again raises the question of how the artefact was fixed to a handle, which is challenging to resolve without assigning a specific interpretation from those mentioned. Reutilization and modification of the functional end might also have occurred in the context of the tip breaking off, as there are a considerable number of broken tips compared to other parts of picks (*Mayer 1977*; *Kowarik et al. 2019*, 65, Abb. 42). Instead of re-forging the pick into its original shape, it may have been modified to its current form. The edge shows grinding marks parallel to the cutting edge, contrasting with all other parts of the artefact (*Fig. 13*: B).

Deposition

The artefact was found in a hoard with numerous other copper alloy items. Its lower part was broken off from the rest of the body by the application of significant mechanical force, causing bending leading to the artefact's breakage. Whether the cause was an accident during use or intentional action to remove the artefact's primary function cannot be determined, leaving both possibilities, or other unknown ones, relevant. The surface of the artefact bears irregular deep abrasion marks randomly distributed (*Fig. 13*: B–C). These damage marks overlay both usage and reutilization marks. The cause of these marks remains undetermined but may be connected to one of the above-mentioned deposition methods. Unfortunately, there is no way to determine how long before its deposition the artefact broke and got abraded, and thus how long it might have circulated in society after these events.

Post-deposition

After the hoard was deposited in the ground, post-depositional processes began, primarily evidenced by soil corrosion forming a compact layer of corrosion products on the artefact's surface, ranging from light green to dark brown. Likely after being removed from the ground and disturbing the stable burial conditions, localized corrosion damage in the form of pitting corrosion occurred, creating small depressions in the previously formed corrosion products.

X-ray and tomographic analysis of a sword fragment

The aim of the CT reconstruction and its visual analysis was to determine the shape and composition of the metal fragments embedded in the sword's hilt. Acquisition images for CT reconstruction were taken with the Explorer X test 200 – 120/400 from Testima. The device is equipped with two X-ray sources. The first source, with a maximum voltage of 200 kV, is more suitable for imaging more massive metal samples, but due to the longer

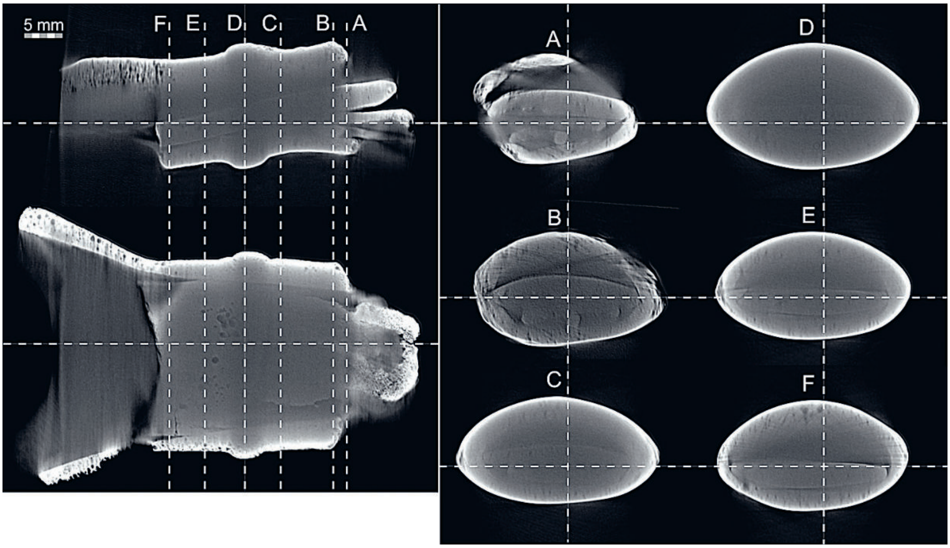


Fig. 14. CT reconstruction of the sword hilt: selected hilt cuts (photo by R. Thér).

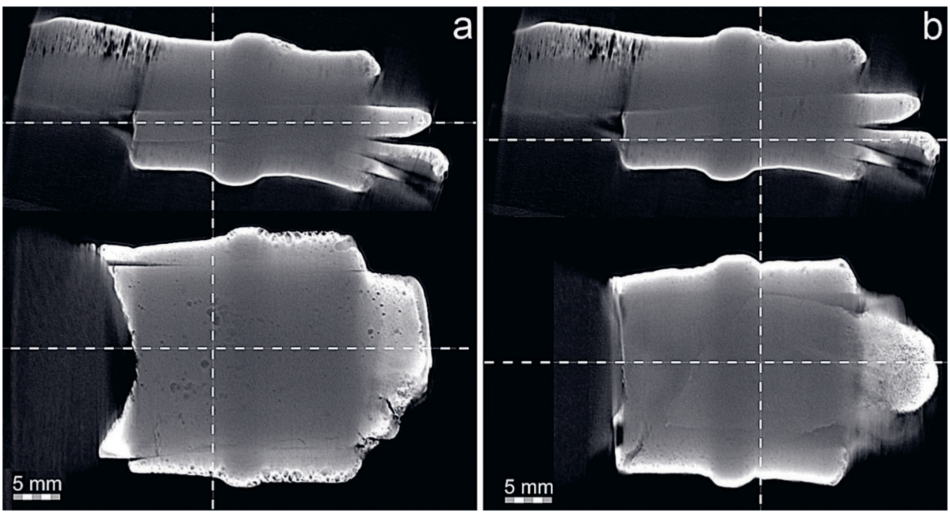


Fig. 15. CT reconstruction of the hilt of the sword. a – captured shape of the thicker upper plate inserted into the hilt, b – captured shape of the weaker lower plate inserted into the hilt (photo by R. Thér).

focal length (0.8 mm), it is not suitable for imaging smaller objects in higher resolution. The second source, with a maximum voltage of 120 kV, is suitable for detailed imaging (focal length 0.05 mm) but has limited power, insufficient for penetrating larger objects with high radiodensities. Thus, the setup used did not provide optimal imaging parameters for the task. Better results were obtained with the second source, but it is evident from the reconstruction that its power was insufficient for optimal penetration of the hilt, and

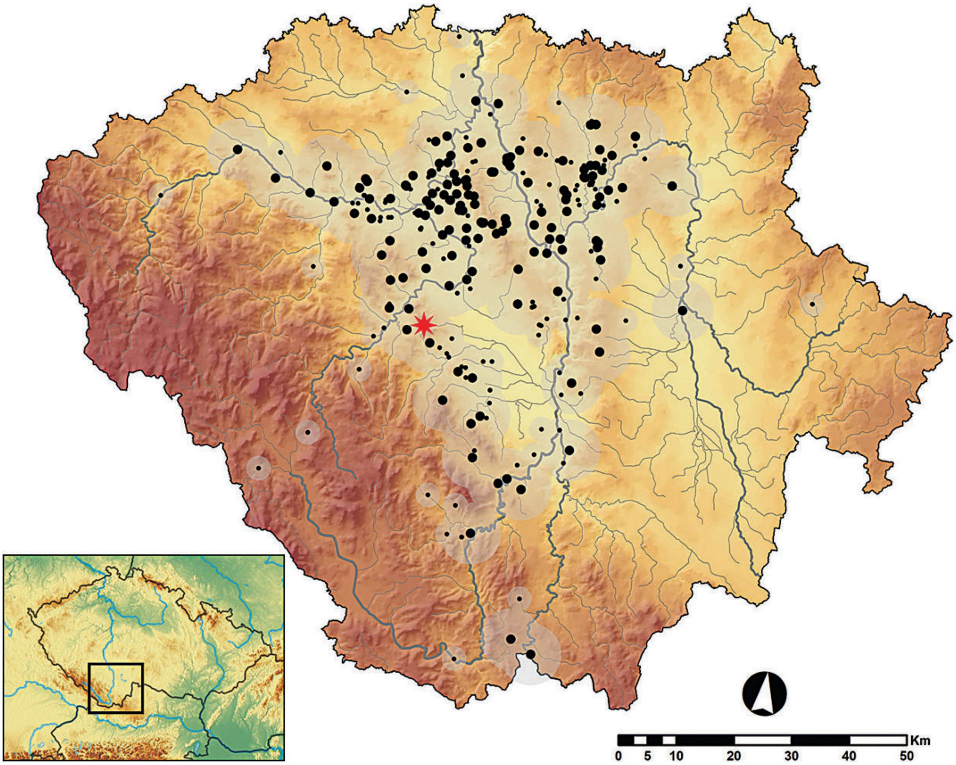


Fig. 16. South Bohemia in the earlier phases of the Late Bronze Age (Br D – Ha A1; according to *Chvojka et al. 2021b*, Fig. 6.21). Red star – location of the hoard from Krtely; larger points – certain dating; smaller points – probable dating.

in places with the greatest thickness of the metal fragment assembly (at the rib reinforcement of the hilt; *Fig. 14*: D) the X-ray photons were completely absorbed.

For the CT reconstruction, 400 acquisition images were taken at 120 kV and 260 μA. The reconstruction was performed using LometomArk software developed for Testima X-ray imaging systems. Despite the mentioned limitations, the primary goal of the analysis was met. The shape of the embedded fragments (two plates and one rod-like object; *Fig. 15*) can be observed in the defined sections, allowing documentation of the entire composite. It was also possible to verify that no decoration or other morphological features remained on the surface of the inserted fragments, which would have allowed identification of the artefacts from which these fragments originated. We can see the deformation of the inner profile of the hilt by the thicker plate, indicating its forcible insertion into the hilt (*Fig. 14*: B).

Settlement-topographical analysis of the hoard

The hoard from Krtely was deposited in a landscape that was inhabited during the Late Bronze Age, though it was not part of the core areas of the South Bohemian region (*Fig. 16*; *Chvojka et al. 2021b*, 127–130, Fig. 6.21). Sporadic settlement from the Late

Bronze Age is known directly from the Krtely cadaster (*Chvojka 2009*, 253). In the Krtelský forest, located in the Netolice cadaster south of Krtely, are several prehistoric burial mounds, at least two of which can be dated to the beginning of the Late Bronze Age (*Chvojka 2009*, 255 and new, as yet unpublished finds). The nearest proved settlement from the Late Bronze Age is located at the Rábín court in the Malovice cadaster, 3.7 km from the hoard (unpublished research by the Prachatice Museum in 2014).

The hoard's deposition site itself represents a relatively prominent location elevated about 60 m from the surrounding terrain, which, if deforested, would provide a view south and east into the western part of the Českobudějovická Basin and the Netolická Highlands. Depositing hoards in similarly conspicuous locations is also documented elsewhere in the Late Bronze Age in South Bohemia, such as in the Písek Mountains, where several hoards from the Br D to Ha A stages were found at peaks or on ridges (*Fröhlich et al. 2015*).

Discussion

Bronze Age hoards in the context of burial mounds

The deposition of hoards of bronze artefacts within the context of burial mounds is a completely unique phenomenon in the Czech territory. No similar cases have been convincingly proved for the Urnfield Culture period (see *Šteffl 2014*, 28). In the past, some sets of bronze artefacts were considered to be hoards deposited within the context of burial mounds (e.g., finds from Albrechtice nad Vltavou or Vrcovice in South Bohemia: *Fröhlich 1997*, 6–8, 218–219; *Kytlicová 2007*, 254, 315), but this has not been proved for any of them. In the case of Albrechtice, the only indication of a connection between the set of five twisted anklets and the funerary component is the fact that they were part of a large collection of bronze artefacts gathered at Ohrada Castle, most of which came from the local burial mound site, which was destroyed by the end of the 19th century. There are no specific details available regarding the discovery circumstances of these anklets from the Ha B1 stage. There is no evidence to suggest that this is a hoard deposited within the context of a burial mound. In Vrcovice, according to initial information, two shield fibulae were found along with 'two boxes resembling shells' (phalerae?) and many bronze rings among the stones while removing a mound at the edge of a meadow. No skeletal remains or containers or ashes were found. Therefore, the existence of a burial mound is highly uncertain (see the latest discussion: *Chvojka et al. 2023*, 194).

From the perspective of the investigated issue, it is also not relevant to consider finds deposited near burial mound sites but outside their areas – for example, a sword from Písecká Smoleč, found about 50 meters from the edge of an undated burial mound site (*Jiřík – Pták 2013*).

Even within the broader Central European Urnfield Culture settlement area, the deposition of hoards within the context of burial mounds can be considered extremely rare (*Tab. 4*). Specifically, such a context cannot be ruled out for eight other hoards in Germany (*Wahle 1925*; *Falkenstein 2011*, 89–90). However, these hoards display many different characteristics from one another.

The closest site to Krtely, where the deposition of a hoard in the context of a burial mound can be considered, is Affalterthal in Upper Franconia, located 220 km away. Here,

Site	Position	Tools	Ornaments	Raw Material	Dating	Problem
Zeublitz	at the foot of the mound	x	0	0	Br C	hoard?
Wekheim	near the edge of the mound	x	0	0	Br C	moulds: hoard?
Krtely	to the top of the mound	x	x	x	Br D/Ha A1	–
Affalterthal	western part of the stone pile	x	x	0	Br D	hoard near mound?
Ederheim	in the grave chamber	x	0	x	Br D/Ha A1	hoard in grave chamber?
Jüchsen	outer edge of the stone circle	x	0	x	Br D/Ha A1	–
Marburg-Lahnberge	outside the stone circle	0	x	0	Br D/Ha A1	only one pin
Bad Friedrichshall-Jagstfeld 1	in the mound	0	x	0	Ha A2	unclear information
Bad Friedrichshall-Jagstfeld 2	inner side of the ditch around the mound	0	x	0	Ha A2	–

Tab. 4. Overview of Bronze Age metal hoards from burial mound areas. Selected examples from Central Europe. The hoards from the same period as the Krtely hoard are highlighted in grey.

a collection of bronze artefacts consisting of three sickles, eight pins, and an armband was found in the late 19th century. The hoard was found in the western part of a stone pile, which was interpreted as a mound, although no traces were found to confirm its funerary use. P. Reinecke interpreted the elevation rather as a heap of prominent stones after subsequent inspection (*Reinecke 1937*). On the other hand, *K. Schwarz* (*1955*) again connected the deposition of the hoard with a mound. Later, some authors avoided the connection with a mound, referring to it only as a hoard (*Müller-Karpe 1959*, 286; *Stein 1979*, 122–123), however, others accepted the association of the ensemble with the mound (*Hennig 1970*, 67; *Hansen 1994*, 443; *Falkenstein 2011*, 89).

The nearest undisputed mound site, from which the hoard in a burial mound is also mentioned, lies at the western border of Bavaria, 270 km from Krtely in Ederheim (*Ludwig-Lukanow 1983*, 24–26). Here, 20 mounds were heavily damaged during deforestation in the 1920s. During the excavation of mound No. 8, a collection of two complete sickles and two fragments of sickles, along with a small piece of an ingot, was found at the right knee of the buried skeleton. The collection was designated as a hoard based on the functional nature of the artefacts. For the same reason, the tweezers found together were assigned to the grave goods of the buried.

A small hoard deposited within the context of a burial mound comes from Jüchsen in Thuringia, where 10 mounds were investigated. The hoard was discovered during a proper excavation in 1959. It was deposited under two stone slabs at the outer edge of the stone circle of a large burial mound No. 1 from the Middle Bronze Age. It contained two axes and two small ingots (*Feustel 1993*, 62–66, Taf. 31: 14–16).

Regarding the hoard from the Lahnberge-Lichter Kuppel position in Marburg, there is a question. During the research in 1897, Mound No. 2 was investigated. On its western side, outside the stone circle, a peculiar semicircular structure made of small stones was uncovered, at the centre of which a broken pin was found (*Dobiat 1994*, 260, Taf. 70: 1–2). It is likely impossible to determine whether this is a solitary hoard or a symbolic burial.

The collection of two sickles and an axe, supposedly found in 1929 at the foot of a mound near the village of Zeublitz in Upper Franconia (*Stein 1979*, 172), has been preserved only in drawing form (*Radunz 1969*, Taf. 9: 5–7). The discovery circumstances are not known, nor can the completeness of the original find be confirmed. The find can most likely be classified as a hoard, although there are doubts (*Radunz 1969*, 129; *Hennig 1970*, 88).

Another one or possibly two hoards originate from the site of Bad Friedrichshall-Jagstfeld in Baden-Württemberg (*Biel 1977*). Around the year 1862, one mound was excavated, in which, besides burials, two stone axes were said to have been found in the central part and at the edge of the mound. Additionally, a hoard of 19 bronze rings and many small rings was reportedly placed higher up in the mound. The situation in this case is unclear as the artefacts have not been preserved. However, it is possible that some of the circular ornaments published by *R. Dehn* (*1972*, 84, Taf. 7: A) originate from this find. If this is the case, it offers a parallel with the hoard of nine bracelets that was later found at this site. During a rescue excavation in 1974, another significantly damaged mound was examined, and this hoard was placed north of the central burial, by the inner side of the ditch surrounding the mound.

A somewhat different deposit is the find of two casting moulds found near the southwest edge of one of the four burial mounds in the cadastral area of Wenkheim in Baden-Württemberg (*Wahle 1925*). Since these artefacts were deposited outside the central funerary space, this find can likely be interpreted as a hoard. The products from these moulds belong among the representative artefacts of the later phase of the Middle Bronze Age, with no direct analogies yet found for the knife cast from the second mould (*Hohlbein 2016*, 33).

The mentioned possible cases of hoards deposited in the context of burial mounds represent a time span from the Middle to the Late Bronze Age. The find from Zeublitz and the moulds from Wenkheim should be classified into the Middle Bronze Age, where it is relevant to consider the different symbolic meanings of depositing actual bronze artefacts versus depositing the means of their production.

Most of the possible identified analogies fall within the chronological interval Br D – Ha A1. These assemblages regularly contain tools and raw materials, some also include ornaments. More detailed conclusions based on a comparison of the find circumstances are practically impossible with such a small sample. Besides Krtely, we record only four other sites from this period, although in the case of Affalterthal it is not entirely certain that the structure to which the hoard was deposited is a burial mound, and in Ederheim, doubt arises from the fact that the assemblage was deposited directly by the body of the buried. Another question is whether a single fragment of a pin deposited by the mound in Lahnberge can be viewed as a hoard. Thus, only the assemblage of artefacts from Jüchsen, whose find circumstances are documented by proper research, can be unequivocally considered a hoard deposited in the context of a burial mound. Unlike the situation in Krtely, however, it was deposited outside the actual mound body. At this point, we must admit that even in the case of the Krtely hoard, it is not possible, due to the absence of professional research on the actual mound structure, to unequivocally consider this structure a burial mound.

In the subsequent chronological interval Ha A2, we record the last traces of the observed behaviour in the case of finds from Bad Friedrichshall. Here, one or perhaps two hoards deposited in the context of burial mounds consist exclusively of circular ornaments.

As can be seen, the deposition of hoards of bronze products in the context of burial mounds is a very rare phenomenon. Such deposits do occur over a very wide area, but only sporadically. One notable observation is that, similar to the case in Krtely, other studied assemblages also contain atypical artefacts. This is true for one sickle from Affalterthal, which is very close to the unusual example from Krtely, or in the case of the negative of a unique type of knife from Wenkheim.

The conducted analysis clearly shows that the deposition of hoards in the context of funerary components can be considered a special, unconventional form of ritual behaviour. The situation identified in Krtely is therefore unique, and the origin or initiator of such a ritual must be sought outside the Czech basin.

Notes on the fragmentation and secondary modifications of deposited artefacts

In recent years, especially in connection with Bronze Age hoards, the deliberate damage and fragmentation of deposited artefacts has been a widely discussed issue (e.g., *Nebelsick 1997*; *Rezi 2011*; *Brück 2016*; *Bradley 2017*, 124–141; *Knight 2020*). A fundamental question is the intentionality of this phenomenon, which can be determined or at least suggested by use-wear analysis. This, in turn, has a decisive influence on the interpretation of the entire hoard: while unintentionally damaged artefacts may have been collected for the purpose of remelting and reutilization, deliberately devalued artefacts suggest interpretations such as size and weight standardization in connection with potential (pre)monetary use of the artefacts, or as a means of removing the artefact from active use, thus interpreting the hoard as a permanent deposit (*Rezi 2011*, 303–305).

In the case of the Krtely hoard, we can distinguish five groups of metal artefacts based on their state of preservation:

1. Completely or almost completely (more than 80% of the item) preserved undeformed artefact: knife (No. 3), sickle (No. 4), ingot (No. 16).
2. Completely preserved artefact, broken: pick (No. 1).
3. Completely preserved artefact, deformed: bracelets (No. 11, 13), chisel (No. 15).
4. Large fragment of an artefact (50–80% of the item): twisted rod (No. 10), pin (No. 14), ingot (No. 17).
5. Fragment of an artefact (up to 50% of the item): sword (No. 2), axes (No. 5–8), neckring (No. 9), armring (No. 12), ingots (No. 18–27).

From this overview, it is evident that out of a total of 27 metal artefacts in the Krtely hoard, only three were preserved in a complete or almost complete and undeformed state (*Fig. 6*: 3–4; *Fig. 7*: 16). The pick is also preserved in its entirety (*Fig. 5*), but it was (intentionally?) broken into two parts. Therefore, it cannot be ruled out that in this case, deliberate removal from active use occurred. It is interesting to note that a similar pick from the Sipbachzell hoard was broken in the same way (*Höglinger 1996*, Taf. 20: 349), while another was deposited whole. For other fragments of products from the Krtely hoard, the intentionality of their fragmentation cannot be proved, nor can it be excluded. In the case of fragments of cake-shaped ingots, the incomplete parts could have been removed for the practical use of copper raw material for smelting.

Two bracelets were deposited whole but secondarily deformed. While we do not know precise analogies for the saddle-shaped rod bracelet (*Fig. 7*: 13) in Czech hoards, deformation of cast massive bracelets is relatively common in hoards from the Urnfield Culture period (e.g., *Salaš 2005*, Tab. 131: 417; *Lauermann – Rammer 2013*, Taf. 32: 2–3), as shown by several South Bohemian examples (*Chvojka 2009*, Tab. 77: 2; *Chvojka et al. 2017b*, Tab. 110: 15, 117: 12). A similar 'figure eight' crushing of a bracelet, as documented in Krtely (*Fig. 7*: 11), is also documented in the hoard from Staré Sedlo (*Kytlicová 2007*, Taf. 23: 10). Similar to the aforementioned intentional breaking of the pointed tool, the deformation of the cast bracelet can be seen as clear evidence of the item's devaluation and deliberate removal from active use.

Four fragments show signs of fire. While this could have led to the warping of the chisel (*Fig. 7*: 15), it did not lead to visible deformation of the pin (*Fig. 7*: 14), twisted rod (*Fig. 7*: 10), or sword (*Fig. 6*: 2). Unfortunately, it is not possible to determine whether the burning was intentional.

In the case of the mentioned sword hilt fragment, it is necessary to point out an interesting phenomenon: the use of the cavity in the cast hilt fragment as an opening for inserting three other artefact fragments (*Fig. 14–15*). The combination of several objects into one by inserting them into each other is occasionally documented during the Urnfield period. A good example is the Blučina 6 hoard, consisting of an axe, with a dagger placed between its medial wings on one side and a spearhead on the other, all tied together with three bracelets (*Salaš 2005*, 292, Tab. 65, 482: 1–2). Similarly, in the Blučina 17 hoard, an axe blade fragment was placed between the wings on one side and a sickle fragment on the other (*Salaš 2005*, 306, Tab. 89: A). A very interesting analogy is offered by hoard no. 3 from the Kladky site, where an axe was found with an axe blade and a fragment of a circular ornament inserted into its socket (*Vích 2012*, 260, Fig. 28). However, the insertion of other artefacts or their fragments into the cavity of a sword hilt has not yet been documented in Czech hoards. Therefore, the meaning of this phenomenon in the case of the sword fragment from Krtely eludes us.

We can thus conclude that at least the pick and two bracelets in the Krtely hoard might have been intentionally damaged, i.e., taken out of everyday use. Therefore, it is probably not a collection of material intended for remelting, but rather a reflection of the deeper spiritual beliefs of the people who gathered and placed this collection at the top of an already existing mound.

Conclusion: Interpretation and significance of the Krtely hoard

Given its composition and the circumstances of its discovery, the Krtely hoard can be considered an example of a votive deposit (*Hansen 1994*, 381–384), containing several artefacts that are exceptional in South Bohemia, some of which may have been intentionally damaged. Considering the placement of the collection at the top of the mound, we can consider the following possibilities for its interpretation: 1) the hoard as a memorial/offering to deceased ancestors, 2) a so-called 'burial of bronzes', or 3) the hoard as a remnant of the deceased (cf. *Hansen 1994*, 388–390; *Šteffl 2014*, 94–96, 106–112). The exact explanation of the original meaning of the Krtely hoard is not possible, but its relationship to the mound is evident. However, we must also consider the possibility that the people who placed the hoard on the mound's surface may not have been aware that it was a burial monument. This naturally takes us into the realm of speculation; however, given the aforementioned examples from other regions in our text, we hypothesize that it was a conscious placement of the hoard into a burial monument.

The relationship between hoards of fragments with intentionally damaged artefacts and contemporary cremation burials with also damaged (by fire) human remains and grave goods has already been noted in the past (*Nebelsick 1997*, 40). In the case of the discussed hoard with a predominance of fragments from Krtely, which has a clear spatial connection to a burial monument, this connection to burial can undoubtedly be assumed. Indeed, some of the metal artefacts in Krtely were damaged by fire, and it can be assumed that the bronzes were placed in a ceramic vessel, similarly to how cremated human remains with their grave goods were commonly deposited during this era.

The Krtely hoard thus significantly contributes to the rich discussion on the role of metal hoards in the Bronze Age and their possible connections to ritualized behaviour and the spiritual world of the people of that time. It also serves as evidence of long-distance contacts of the inhabitants of South Bohemia during the Late Bronze Age. Notably, the miner's pick unequivocally indicates a connection to the salt mines in Hallstatt, which, together with a previously found fragment of another pick from Holašovice (*Kytlicová 2007*, Taf. 21: 22), suggests a possible distribution of salt to South Bohemia. Along with many other pieces of evidence (e.g., the bracelets of the Riegsee horizon: *Chvojka 2006*; copper distribution: *Kmošek et al. 2020*), the Krtely collection confirms the strong orientation of the inhabitants of South Bohemia (not only) in the Late Bronze Age towards the south, into the present-day Bavarian and Austrian Danube regions and the Alpine areas.

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ONDŘEJ CHVOJKA, Institute of Archaeology, Faculty of Arts, University of South Bohemia, Branišovská 31a, CZ-370 05 České Budějovice, Czech Republic; ochvojka@ff.jcu.cz
LUBOŠ JIRÁŇ, Institute of Archaeology of the CAS, Prague, Letenská 4, CZ-118 01 Praha 1, Czech Republic jiran@arup.cas.cz
JAN JOHN, Institute of Archaeology, Faculty of Arts, University of South Bohemia, Branišovská 31a, CZ-370 05 České Budějovice, Czech Republic; jjohn@ff.jcu.cz
MATĚJ KMOŠEK, Institute of Archaeology of the CAS, Brno, Čechyňská 363, CZ-602 00 Brno, Czech Republic kmosek@arub.cz
RICHARD THÉR, Department of Archaeology, Philosophical Faculty, University of Hradec Králové, Rokitanského 62, CZ-500 03 Hradec Králové, Czech Republic; richard.ther@uhk.cz
TOMÁŠ ZACHAR, Archaeological Heritage Office of Saxony, Zur Wetterwarte 7, D-01109 Dresden, Germany tomas.zachare@gmail.com

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

On the origin and cultivation of grapevine in Bohemia, Moravia, and Slovakia

K otázce původu a pěstování révy vinné na území Čech, Moravy a Slovenska

Michaela Látková

The study addresses the history of grape cultivation and viticulture in Czech-Slovak territory and examines the related economic and ecological aspects in individual historical periods – from the first finds of grapevine to the Early Middle Ages, when wine was an important liturgical symbol associated with Christianisation, to the high medieval and modern periods, when viticulture became an important economic sector. The paper discusses methods of identifying archaeobotanical grapevine finds, which had been problematic due to morphological changes caused by diagenetic processes. Although the accuracy of morphometric methods is low when coupled with the macroscopic assessment of finds, they can be effective for distinguishing between cultivated forms of grapevine and their wild counterparts. Despite the difficulties in classifying the finds, archaeobotanical studies are an important source of information on the history of viticulture and grapevine cultivation in the region.

grapevine – archaeobotany – Mikulčice – Early Middle Ages – morphology

Studie se zabývá problematikou historie pěstování vinné révy a vinohradnictví v česko-slovenském prostoru, zkoumá ekonomické a ekologické aspekty v jednotlivých historických obdobích – od prvních nálezů révy přes období raného středověku, kdy se víno stalo důležitým liturgickým symbolem spojeným s christianizací, až po vrcholně středověké a novověké období, kdy se vinařství stalo významným hospodářským odvětvím. Článek diskutuje metody identifikace archeobotanických nálezů révy, které byly problematické kvůli morfologickým změnám způsobeným diagenetickými procesy. Přesnost morfometrických metod se ukázala být nízká, ale ve spojení s vizuálním hodnocením nálezů mohou být efektivní způsobem, jak odlišit pěstované formy révy od divoké. Navzdory obtížím při klasifikaci nálezů jsou archeobotanické studie důležitým zdrojem informací o historii vinohradnictví a pěstování révy v regionu.

vinná réva – archeobotanika – Mikulčice – raný středověk – morfologie

Introduction

The common grapevine (*Vitis vinifera*), which is native to the Levant (*Zohary – Spiegel-Roy 1975*; *van Zeist 1991*), ranks among the oldest domesticated and cultivated crops in the world (along with other species such as olives, dates, figs, and pomegranates). Grapes have a high content of sugar (15–25%), vitamins, and minerals (*Hajnalová 2001*, 64), which probably explains their popularity with the first farmers once the species was domesticated. In addition to fresh fruit, grapevine is also the source for highly storable raisins, grape juice and, naturally, the traditional product – wine. From a botanical perspective, two subspecies of *Vitis vinifera* are usually distinguished: *Vitis vinifera subsp. vinifera* (cultivated grape) and *Vitis vinifera subsp. sylvestris* (wild grape). They are often referred to in the literature

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as *Vitis vinifera* (for cultivated grapevine) and *Vitis sylvestris* (for wild grapevine) and we will also adhere to these names and their use in this article. The specific genes of the wild form of grapevine are found in the genotypes of the current cultivated forms of *Vitis vinifera subsp. vinifera*, where they were inherited during the domestication process from *Vitis vinifera subsp. sylvestris* (C. C. Gmelin). Before establishing a vineyard, the land must be prepared for up to two years. The first harvest can be expected after three years, but better results are usually achieved only after five years of growth. During this entire period, intensive care must be given to the vineyard, including demanding tasks such as ploughing, pruning, tying, fertilising, and watering. Vineyard locations on sunny southern slopes are preferred, while unsuitable habitats include northern slopes, shallow soils with insufficient nutrients, areas with high water tables, farmyards (contaminated by chicken droppings) and manure pits.

Vitis vinifera sensu stricto (*s.s.*), known as grapevine, is a cultivated form of grapevine and is closely related to wild grapevine, *Vitis sylvestris sensu stricto*, which occurs in various forms in many parts of Europe. Spontaneous crossbreds between the two species are fertile (*Webb 1968*). Today, wild grapevine is spread between the 38th parallel north and the 49th parallel north (*Arnold et al. 2017*, 1).

In the natural world, wild grapevine is found from the coast of the Atlantic Ocean through Southern Europe, the Black and Caspian Sea regions to the western Himalayas and Tajikistan. It stretches all the way to Central Europe along the Danube and Rhine rivers (*Hajnalová 2001*, 65). The wild grapevine, morphologically and genetically very similar to the cultivated form, is not currently found in the Czech Republic (*Maděra – Martinková 2002*, 484), but in Slovakia its occurrence has been proven in the Danube and Nitra River regions (*Látková et al. 2019*). Wild grapevine was identified in the territory of Slovakia in 2018 on the basis of morphological and ampelographic characteristics; a total of 325 individuals were found at 13 sites in the Morava, Hron, Ipeľ, Váh, Laborec, and Latorica river basins (*Pospíšilová – Šimora 2019*). In some cases, grape cultivars can spread from controlled habitats, and reverted individuals can be mistaken for wild forms. Factors that can affect the spread include pip dispersal by animals, the influence of wind or situations in which vineyards are left untended and vines spread uncontrollably (*Zecca et al. 2010*, 558). The transformation of grapes into an alcoholic beverage – wine – is an extremely complex process requiring a variety of skills depending on whether the wine is made from imported grapes, produced locally from gathered wild grapes, or from grapes that are cultivated locally. This may be influenced by the economic and social requirements of a given community, or may itself influence these factors. According to archaeological evidence, local cultivation and wine production appear to be related to agricultural specialisation and a higher level of social organisation. However, it is important to first determine whether the fossilised archaeological material comes from wild or domesticated plants, and whether there is archaeological evidence suggesting local cultivation of some of these forms. The fruit of wild grapevine is typically more acidic than that of its cultivated relative, *Vitis vinifera*. Nevertheless, wild grapes are suitable for human consumption and can be used to make wine, albeit of lower quality. Archaeobotanical finds make clear that the fruits of wild grape vine were collected long before its domestication (*Renfrew 1973*, 73).

In this context, recent archaeological excavations in Greece (*Valamoti et al. 2020*; *Pagnoux et al. 2021*) are important sources of information. These discoveries provided hard archaeobotanical data that proved to be important in discussing the contribution of local wild forms of grapevine to the process of domestication outside the primary domestication area, i.e. 'parallel domestication'. It is also important to note that cultivated forms of grapevine are not necessary for making wine; this previously held belief was disproved long ago by finds from the Dikili Tash site in northern Greece (*Valamoti 2015*; *Valamoti et al. 2015*; *Miller 2008*). Finds of grape pips from Dikili Tash are the earliest evidence of the use of grape juice or wine in the eastern Mediterranean during the Neolithic period (second half of the 5th millennium BC).

Various methodological and scientific approaches are used in an attempt to answer questions concerning the origin, character, and possibility of grape cultivation. In older literature, it is generally held that the culture of drinking wine and growing grapes reached the territory of Central Europe under the influence of the Roman Empire (*Kolník 1971*, 519; *Beranová 2000*, 106) because in the first four centuries AD the borders of the Roman Empire were in close proximity to the territory of Slovakia and the Czech Republic. Ancient written sources support this notion, as in 276–282 AD, Roman Emperor Probus issued a decree to plant vineyards in the Roman transalpine colonies, primarily in Austria (*Kraus 2009*, 45). Evidence of wine consumption (especially drinking sets) and dining in the Roman style among the Germanic ruling class is more indicative of the cultural influence of the Roman Empire and Romanisation than the cultivation of grapes itself (*Krekovič 2000*, 48). Similarly, archaeobotanical finds of grape pips from Roman sites seem to suggest the importation or trade of wine as a finished product (*Hajnalová 2001*, 66).

The discovery of evidence of the presence of grapevine in the territory of today's Czech Republic and Slovakia begins in the Early Middle Ages and increases in intensity (*Hajnalová 2001*, 66). The beginnings of viticulture were apparently influenced by the church and Christianisation, as wine was associated with Eucharistic symbols (*Beranová 2000*, 106; *Meduna 2017*). *Meduna* (*2017*, 15) assumes that during the 9th century AD the cultivation of grapevine and the production of wine spread to the region of Bohemia from the southeast, specifically from the Danube Region. The process took place during the period in which Bohemia came under the political influence of the Great Moravian Empire and the Přemyslid ruling dynasty adopted Christianity. At this time, the cultivation of grapes was not primarily economic but more for liturgical purposes. Naturally, it is not ruled out that fruit, juice, or wine were also consumed outside liturgical acts. In the Early and High Middle Ages, grapevine cultivation was associated with the nobility, monasteries, and wealthy burghers from royal cities (*Frolec 1973*). King Charles IV played a significant role in the expansion of viticulture and on 16 February 1358 issued a decree to establish vineyards for Prague and its surroundings (*Kraus 2009*, 83). With a second decree on 12 May 1358, he extended the validity of his original decree to the entire territory and to all clergy and lay persons (*Kraus 2009*, 84). In the 17th and 18th centuries, even ordinary people in the countryside were involved in viticulture (*Frolec 1973*). An interesting discussion in this area is provided by *Tomková* (*2021*), who analyses the relationship between archaeobotanical finds of grapevine and historical sources regarding the establishment of vineyards and wine production. A stark disparity becomes apparent when these two datasets are compared. A considerable number of vineyards are documented in written sources for the period of the Early Middle Ages, but archaeobotanical finds of grapevine are recorded at only a relatively small number of archaeological sites. Only finds from the historic centre of Prague deviate from the described trend (*Tomková 2021*, 322).

'Vineyard knives' are closely related to the issue of the history of grapevine cultivation and viticulture. In the archaeological literature, these finds are often considered evidence of grapevine cultivation (*Měřínský 1972*; *Tejral 2002*; *Beranová – Kubačák 2010*, 136). However, the occurrence of these knives is relatively rare in the Czech and Slovak environments (*Borzová 2005*, 51–52; *Turčan 2012*, 54), and their function is also discussed (*Borzová – Pažinová 2010*). This artefact can be considered multifunctional and could have been used to cut willow twigs, to gather tree shoots and leaves for fodder, but also to prune grapevines (*Borzová – Pažinová 2010*, 182). Therefore, it is not possible to directly connect finds of these knives with the cultivation of grapevine. Evidence of local grapevine cultivation takes the form of a greater concentration of pips, pomace, rachises (evidence of grapevine processing) and conserved wood (carbonised or waterlogged), which indicate the presence of whole plants, not just fruits, which could have been imported (*Hlavatá 2015*).

The oldest archaeobotanical evidence of grapevine in the Czech-Slovak area comes from the Eneolithic site in Hlinsko near Lipník, where the finds were identified by morphometry as *Vitis sylvestris* (*Opravil 1977*, 363; *1985*). Dated to the period of the Maďarovce culture (Early Bronze Age in Slovakia), one grape pip was found at the Trnava-Modranka site and determined as probably *Vitis vinifera* (*Hajnalová 2012*, 86). However, these finds are rare in the region and therefore their dating is questionable without the absolute dating of specific finds.

At the turn of the Bronze Age and the Iron Age, Central Europe was on the outskirts of ancient Mediterranean cultures. The western Hallstatt sphere became a key node for trade with commodities such as wine, bronze, ceramic vessels, and exotic objects. In this period, wine flagons imported from Etruria appear in princely graves as early as the 6th century BC, and from the 5th century they formed a fundamental element in Hallstatt culture. The components of drinking sets (flagons, sieves, ladles, kraters, situlae and others) were used for the consumption of wine in their native northern Italy (*Rebay-Salisbury 2003*). However, pollen and chemical analyses of these finds in Central Europe demonstrate that most of these vessels contained mead, not wine (e.g., Hochdorf: *Stika 1999*; Glauberg: *Rösch 2002*). Only a bronze bottle from a grave in Dürrnberg was shown to have contained spiced wine, which was probably of southern European origin (*Stöllner 1993*; *2002*).

Archaeobotanical finds of grapevine from the Iron Age in Central Europe come from the sites of Stillfried an der March, dated to 992–810 BC (*Köhler-Schneider 2001*, 147–149; *Köhler-Schneider 2003*), Zagersdorf (*Rebay-Salisbury 2002*), and Nußdorf (*Facsar – Jerem 1985*). Finds from Slovakia and from Bohemia and Moravia are missing, with the exception of one find from South Bohemia, specifically from the Zahrádka site (*Šálková et al. 2015*). The occurrence of grape pips in this region began sporadically only in the later Roman Period – Bratislava, Rusovce – Tehelný hon, Nitra, Veľký Cetín, Iža-Leányvár (*Hajnalová 2001*, 66), Zohor, Hurbanovo (*Krčová 2016*) and Stillfried (*Köhler-Schneider 2001*, 147–149; *Köhler-Schneider 2003*).

Grapevine also appears sporadically in archaeobotanical finds from the period from the 6th to the 12th century AD: Nitra (3 sites), Bratislava (2 sites), Mužla-Čenkov (*Hajnalová 2001*, 66), Lovosice (*Čulíková 2008*, 67), Břeclav-Pohansko (*Opravil 1985*, 46–74), Žatec, Ledčice, Libice, Olomouc, Prague (Foundry Yard, Lesser Quarter, Hartig Palace), Přerov, Ústí nad Labem (*Čech et al. 2013*, 26), Mělník (*Bernardová et al. 2010*), Statenice (*Komárková 2005*), unpublished find from Dolánek – Rubín hillfort (*Tomková 2021*). In terms of the occurrence of grape pips, Mikulčice-Valy is an exceptional place among medieval sites (*Látková et al. 2019*). An extensive assemblage of grape pips – nearly 2,000 finds – was found at this Great Moravian site. The pips come from almost all the investigated parts of the agglomeration and are documented in all states of conservation (*Opravil 1972*; *2000*; *2003*; *Látková 2017*). The legitimacy of this dating is also confirmed by absolute dating of pips retrieved from the defunct riverbed that surrounded the stronghold (*Barta et al. 2014*, 121).

From the 13th century AD, when the cultivation of grapevine became an important economic factor, it is possible to observe a substantial increase in the number of archaeobotanical finds, including pips, rachises, but also pomace. According to *Hajnalová* (*2001*, 67), there are roughly 42 sites with high medieval settlement in Slovakia where these finds are known. Approximately 30 sites are listed from the Czech Republic (*ArboDat database*; *Pokorná et al. 2011*).[1] From this period, we have in particular extensive collections of plant macro-remains from waste pits situated within medieval plots of urban areas (*Rzehak 1909*; *Fietz 1941*; *Kočár et al. 2014*). In addition to archaeobotanical finds, we can also assume the cultivation of grapevine near the royal cities based on extensive written sources (*Dřímal 1965*). However, the only indisputable evidence that confirms the cultivation and processing of grapevine directly on high medieval plots in royal cities is the mass discovery of 67,000 grape pips together with stalks in Brno at the Pekařská Street site (*Kočár et al. 2014*, 143).

The breeding process of grapevine produced many clones that differ from each other in various phenotypic qualities, but also in the overall shape of the pips. For this reason, it is very challenging to identify different grape varieties using archaeobotanical material (*Terral et al. 2010*). Grape pips retain their characteristic shape well, which is recognisable even when the pip shells are heavily damaged. Therefore, some archaeobotanists (*Stummer 1911*; *Mangafa – Kotsakis 1996*; *Terral et al. 2010*; *Bouby et al. 2013*; *Pagnoux et al. 2015*) try to demonstrate and characterise the biodiversity of the genus *Vitis* L. using various, primarily mathematical, methods. The traditional morphometric approach (*Stummer 1911*; *Mangafa – Kotsakis 1996*) tried to differentiate the pips of cultivated and wild grapes. These methods allow distinction based on the measurement of different parts of the pips and the calculation of indices from the measured values. Yet, these methods are often criticised due to morphological changes on the pips during carbonisation and a demonstrated lack of ability to distinguish cultivated cultivars from wild grape vine species (*Logothetis 1970*; *1974*; *Bouby et al. 2013*, 2).

Grape pips were also in the centre of interest of Czecho-Slovak archaeobotanists. *Hajnalová* (*1989*) tried to identify 14 basic morphological groups based on 10 measured features based on an extensive collection from various phases of the settlement of Bratislava in the High Middle Ages (*Hajnalová 1989*, 175). In the Czech environment, *Opravil* (*1963*; *1965*; *1977*; *1980*; *1985*) devoted himself to a more detailed evaluation of grape pips. This author also applied the morphometric approach to archaeobotanical finds from Czech sites (*Opravil 1972*; *1977*; *2000*). Opravil is the only Czech archaeobotanist who critically used the morphometric approach and was able to define the differences between grape pips. He attributed the differences in pip shape to differences in their origin/species (*Vitis vinifera*

[1] There will probably be more sites, given the updated data from the ArboDat database.

versus *Vitis sylvestris*). In the large collection of pips from the Great Moravian site of Mikulčice-Valy (n = 1512), which he collected over roughly 40 years of archaeological and archaeobotanical research, Opravil identified up to 49% of the total number of finds as *Vitis sylvestris* (*Opravil 2000*, 353).

The aim of this study is to discuss the issue of grapevine from the perspective of economy and ecology in individual historical periods. Viticulture was an important part of agriculture and produced a number of commodities such as wine, fresh fruit, grape juice, and raisins, important products for many historical peoples and archaeological cultures. As such, the demanding cultivation of grapevine proves the economic character of the agriculture of the given communities. The second aspect is the ecological nature of wild grapevine, which grows naturally in periodically flooded riparian forests with a humid climate in warmer regions. Therefore, it is not ruled out that wild grapevine occurs in archaeobotanical assemblages from certain regions of Moravia and Slovakia, taking into account its ecological requirements (*Hajnalová 2001*, 65). Considering the factors above, it is clear that for the archaeobotanical research in the Czech Republic and Slovakia, it is very important to define precisely whether archaeobotanical finds of grape pips represent evidence of cultivated fruit or are wild species in nature. It is also necessary to establish their mutual relationship at specific archaeological sites and in different time periods.

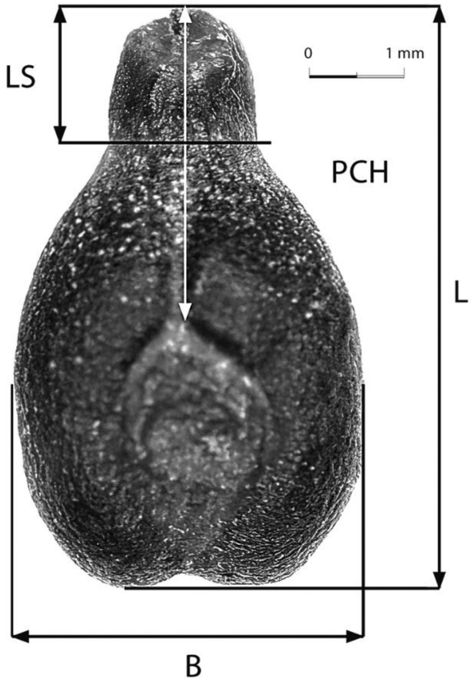
Methodology and material

In the field of archaeobotany, there are many methodologies that try to determine whether the find is a cultivated variety or a wild species based on the measurement of individual parts of the pip (e.g. length, width, etc.) and its dimensions (*Stummer 1911*; *Mangafa – Kotsakis 1996*). As part of this study, metric methods were used to identify the finds, which make it possible to distinguish wild from cultivated forms based on the measurement of several parameters of the pips and the calculation of indices (*Hajnalová et al. 2023*). Two morphometric methods were applied on the archaeobotanical finds from all the investigated archaeological sites (*Online Supplementary Material 1*) and also on the recent pips of wild grapevine (*Stummer 1911*; *Mangafa – Kotsakis 1996*). The overall length of the pip (L), the length of the stalk (LS), the distance from the base of the chalaza to the tip of the stalk (PCH) and width were measured (B; *Fig. 1*).

The first method that distinguishes cultivated and wild forms of grape vine is based on the ratio of width to length (B:L*100) of the pip (*Stummer 1911*). Pips with a 'Stummer index' value in the range of 76–83 can be considered wild grapevine (*Vitis vinifera subsp. sylvestris*), while values in the interval 44–53 indicate cultivated forms (*Vitis vinifera subsp. vinifera*). The application of this method on carbonised material is heavily criticised (*Logothetis 1970*; *1974*; *Smith – Jones 1990*; *Terral et al. 2010*; *Bouby et al. 2013*; *Pagnoux et al. 2015*).

The authors of the second method (*Mangafa – Kotsakis 1996*, 414) created four formulas that use all the aforementioned dimensions, which eliminates the deviation caused by carbonisation and is therefore also suitable for material conserved in this manner. This method works on a similar principle to the previous one, i.e. based on the calculation of the equation and the index obtained, which can be classified into one of the four groups created by the authors, thus classifying each find of grapevine pip.

Fig. 1. Grape pip and dimensions measured on the dorsal side. L – overall length; LS – stalk length; PCH – location of chalaza; B – overall width (after *Mangafa – Kotsakis 1996*).



Statistical analyses

The character of grape pips was investigated here using the method of multivariate statistics, specifically detrended correspondence analysis (DCA) and two-step discriminant analysis in the CANOCCO software (*ter Braak 1996*). Various ratios of four dimensions were included in the analysis–pip length (L), pip width (B), the length of the stalk (LS), and the distance of the upper/lower part of the chalaza (PCH).

Archaeobotanical material

The material that was evaluated in this study comes both from earlier excavations processed by E. Opravil and E. Hajnalová, and from current excavations of various sites, which were analysed by M. Látková, M. Hajnalová, J. Hlavatá, and J. Mihályiová. The collected material represents a relatively rich spectrum of archaeological structures in which the pips were found (wells, defunct river beds, waste pits, manure pits, graves, pits of various types, residential features, etc.).

Recent material

The pips of wild grapevine were obtained from living plants at four locations in Slovakia. The pips were collected in September 2015 and flowers in May 2016 in the cadastres of Mužla and in the Veľký les Nature Reservation situated in the cadastre of Úľany nad Žitavou in Slovakia (*Látková et al. 2019*). Herbarium specimens are stored in the herbarium of the Slovak University of Agriculture and in the collection of Eva Hajnalová.

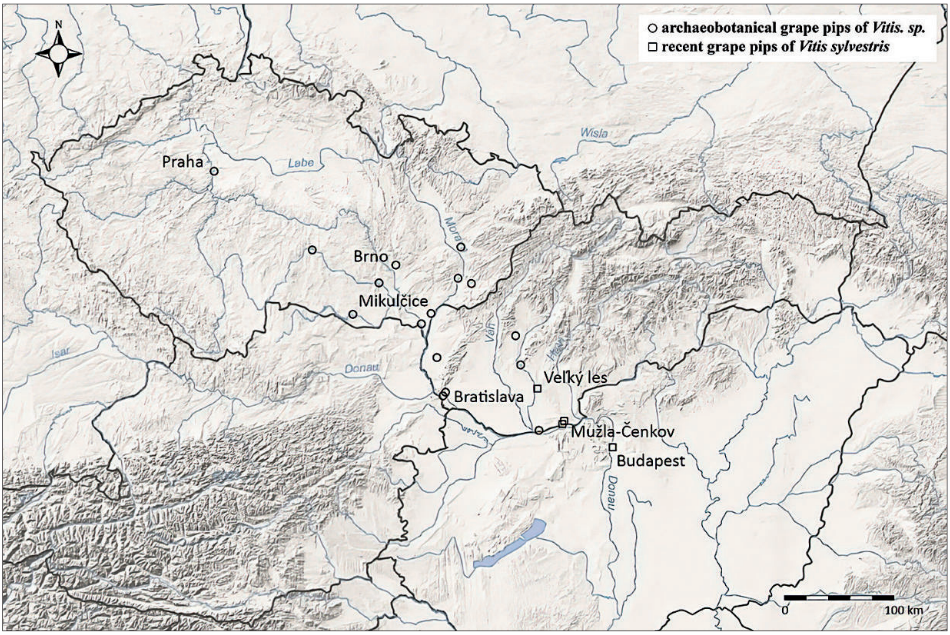


Fig. 2. Map of archaeological sites and places of recent wild grapevine (*Vitis sylvestris s.s.*) occurrence from which grape pips were examined.

Results

Twenty-eight archaeological sites with finds of grape pips in Bohemia, Moravia, and south-western Slovakia were included in the analysis (*Fig. 2*).[2] In most cases, these are standard archaeological sites where plant macro-remains represent waste or by-products of the processing of various crops, i.e. common settlement waste. From a spatial perspective, the dataset includes sites where grapevine cultivation does not have a long history due to unsuitable environmental conditions (e.g. Jihlava, Hulín). Sites dated from the 13th to the 15th century AD were the most numerous, i.e. 16 sites (Prague – Jungmann Square, Týn Courtyard, Ungelt Theatre; Jihlava – Masaryk Square, Brno – Goat Market, Mečová Street, Veselá Street; Uherský Brod – People's House, Soukenická Street, Uherské Hradiště – Hradební Street, Bratislava – Klariská Street, Primacial Square, Jirásek Street, Nálepková Street, Zámočnícka Street, Bridge of the National Uprising). Finds dated to the 16th and 19th century are represented by five sites (Ivančice, Hulín-Nivky, Uherský Brod, Bratislava – Kapitulská and Panenská Street), and finds from the 8th to 9th century AD are also represented by five sites (Mikulčice-Valy, Břeclav-Pohansko, Znojmo – St Hypolite hill-fort, Bojná-Valy I, Malacky-Vinohrádok). Grape pips dated to Roman times come from two sites (Rusovce – Tehelný Hon and Iža-Leányvár). The number of pips at individual

[2] The map does not express the overall state of occurrence of grape pip finds in the territory of Bohemia, Moravia and Slovakia, but documents the sites from which the material evaluated in this study was acquired.

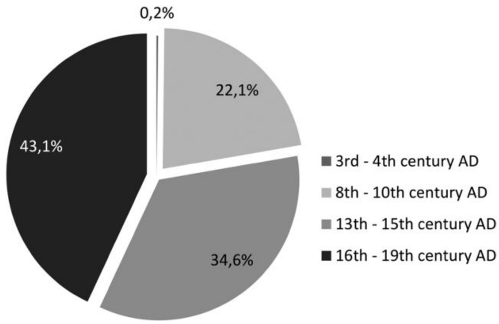


Fig. 3. Representation of grape pips in the dataset according to their chronology (in centuries).

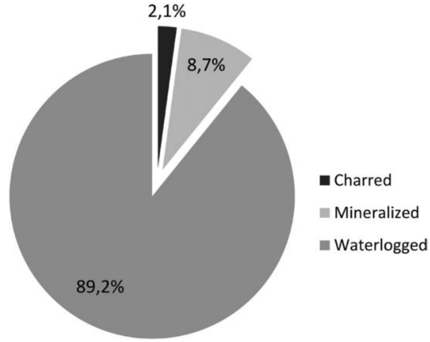


Fig. 4. Representation of grape pips according to the state of conservation.

sites varies significantly. In terms of the number of pips that were suitable for measurement, the largest collections were documented in Mikulčice-Valy (208 finds from the 9th century AD measured) and Ivančice near Brno (143 finds from the 16th–17th century AD measured).

Similar to the number of sites, the number of grape pips analysed is dominated by finds dating from the 13th to the 15th century AD, with a total of 475 finds from this period being examined. A total of 360 well-conserved pips from the period of the 16th to the 19th century AD were measured and evaluated. While 239 pips from the Great Moravian period were analysed, the majority of finds with this dating come from Mikulčice (*Fig. 3*). In terms of percentage, the pips from Mikulčice make up 87% of all Great Moravian finds.

All three types of plant material preservation (carbonised, mineralised, and waterlogged) are represented in the dataset. The most numerous were grape pips conserved by water (*Fig. 4*), which were found at every investigated site. Pips conserved by mineralisation were documented at nine sites. Pips conserved in this way occurred quite rarely among finds, and only in the case of two sites (Bratislava – Primacial Square and Brno – Mečová Street) were all finds conserved exclusively in this manner. Pips conserved by carbonisation were the least frequent in the evaluated group, and material conserved in this way was documented at only three sites (Mikulčice-Valy, Bojná-Valy I and Rusovce – Tehelný Hon). Mikulčice was the only site out of the entire evaluated collection where all three types of conservation of the examined archaeobotanical material (including grapevine) were documented.

The measured values with regard to their method of conservation show considerable variability. Carbonised and mineralised pips can be considered the 'smallest' (*Tab. 1*). It is clear from the literature and from archaeobotanical experiments that these types of conservation generally affect a change in size and shape of plant pips and their dispersion (*Smith – Jones 1990*; *Boardman – Jones 1990*). The material conserved in this way has dimensions similar to the measured pips of recent wild grapevine (*Vitis sylvestris s.s.*; cf. the table). The median of the stalk length is the closest to the dimensions of the wild grapevine stalk. However, the other observed dimensions (total length, width, and location of the chalaza) in carbonised and mineralised pips are similar to those of fully grown wild grapevine.

Charred	L	LS	PCH	B
Min	2.66	0.47	1.59	1.85
Median	5	1.15	2.43	2.8
Mode	5.8	1.5	3.5	3
Max	6.1	2	3.5	3.9
Mineralised	**L**	**LS**	**PCH**	**B**
Min	3.77	0.5	1.78	2.48
Median	4.91	0.95	2.51	3
Mode	5.79	0.86	2.29	2.58
Max	5.94	1.52	3.27	4.26
Waterlogged	**L**	**LS**	**PCH**	**B**
Min	3.15	0.39	0.82	1.62
Median	5.41	1.39	3	3.29
Mode	5.74	1.38	2.92	3.24
Max	7.74	2.68	4.95	5.26
Recent VS	**L**	**LS**	**PCH**	**B**
Min	3.63	0.39	1.68	2.52
Median	5.21	1.05	2.65	3.48
Mode	5.44	1.21	2.88	3.33
Max	6.41	1.86	4.63	4.38

Tab. 1. Basic characteristics of input data used in the following analyses with regard to the method of conservation. Key: same as *Fig. 1*.

Compared to the other material conserved in another way, the waterlogged pips appeared to be the 'largest' based on the measurements. These finds differed the most from the recent material not only in mean values, but also in maximum and minimum values. Notably, the waterlogged pips collected in this study can be considered smaller with relatively long stalks compared to the recent material, which is also a trait of cultivars.

Although waterlogged material appears to be the most suitable for morphometric analysis, under certain circumstances this conservation process can significantly distort the original shape of the pips. Plant macro-remains are most frequently (but also best) conserved in waste pits from the High Middle Ages (*Rzehak 1909*; *Fietz 1941*; *Kočár et al. 2014*). Waste pits are closed features of a faecal-waste character with specific physical-chemical environmental conditions that preserve plant macro-residues. Although grape pips are well-conserved in various types of sediments due to their hard sclerenchymatous tissues, their shells can corrode under certain circumstances. The epidermis of grape pips consists of four layers that have a different thickness depending on the specific part of the pip (*Fig. 5*). Empirical observations of archaeobotanical material damaged in this way show that it is usually the thickest on the stalk (*Fig. 6*). An example illustrating the width of the pip with the casings and the width of only the sclerenchymatous tissue comes from a waste pit in Bratislava – Zámočnicka Street (15th–16th century AD). The difference in width between the two measurements is 0.48 mm, and there is also a gradual increase towards the stalk. Such a large difference in measurements could result in misinterpretation in the morphometric approach in grape pip analysis, with the cultivated cultivars being considered wild grapevine. Morphometric methods cannot be applied to pips affected by shell corrosion due to the relatively large deviations from the original size. Pips that were damaged in this manner were excluded from further analyses.

It became clear during the initial evaluation of the collected material that there are significant differences in the shape and size of the grape pips between the individual sites.

Fig. 5. Detail of damaged shell of grape pip.

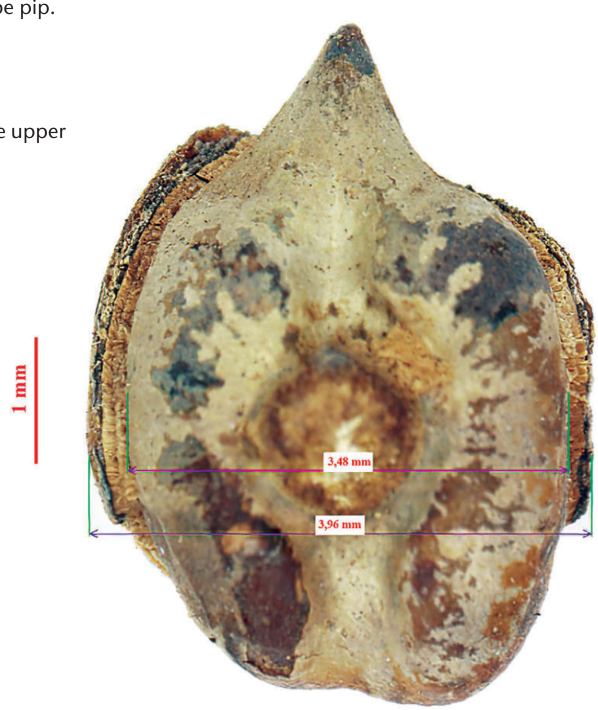


Fig. 6. Damaged grape pip missing the upper layer of shell in several places.

These differences were observed not only between archaeobotanical and recent material, but also between finds from archaeological sites from different time horizons. By analysing the basic dimensions of the pips using multivariate statistics, it was possible to search for trends, dependencies, and the arrangement of data in a relatively robust set. All wild

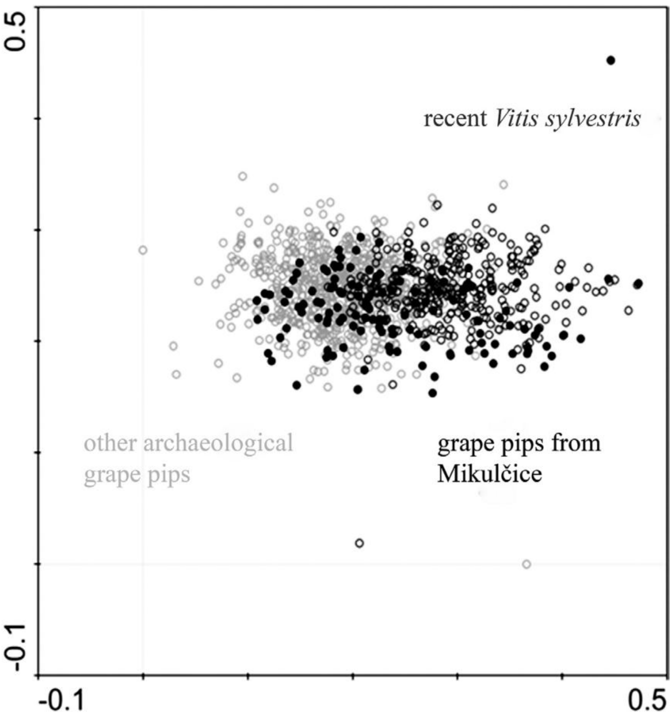


Fig. 7. DAC analysis. Relationship between archaeobotanical grape pips and recent wild grape pips and based on dimensions.

grape pips and finds from archaeological sites were kept in the examined matrix. Their basic dimensions (mean length, length, chalaza diameter and width) were determined as variables. The resulting analysis was subsequently classified according to a factor that could have a major influence on the classification of the samples.

The evaluated finds are classified according to their origin. The graphic visualisation shows that the samples are arranged according to dominant morphological characteristics, with each group being dominated by another. This factor is crucial in arranging the samples in the DCA analysis. Despite the fact that all samples represent one cluster, it is possible to observe trends that indicate significant differences between individual sites. It is clear that there are significant differences in the dimensions and morphology between archaeobotanical finds and recent pips (*Fig. 7*). A distinctive group of finds is the Mikulčice grape pips, which are equally represented both in the group of other archaeobotanical finds and among recent wild grape pips. Although the analysed material seems to form a homogeneous group, it is clear that the individual groups differ from each other, and therefore these groups were compared with each other in further analyses.

Measurement dispersion (box plot)

The basic distinguishing criterion of grape pips for cultivars and wild grapevine is that cultivated grape pip finds should be longer, more elongated, and with a long stalk (beak). Box plots were used to compare and assess the obtained measurements of different parts of the pips. The goal was to evaluate the entire dataset, identify outliers, assess the sym-

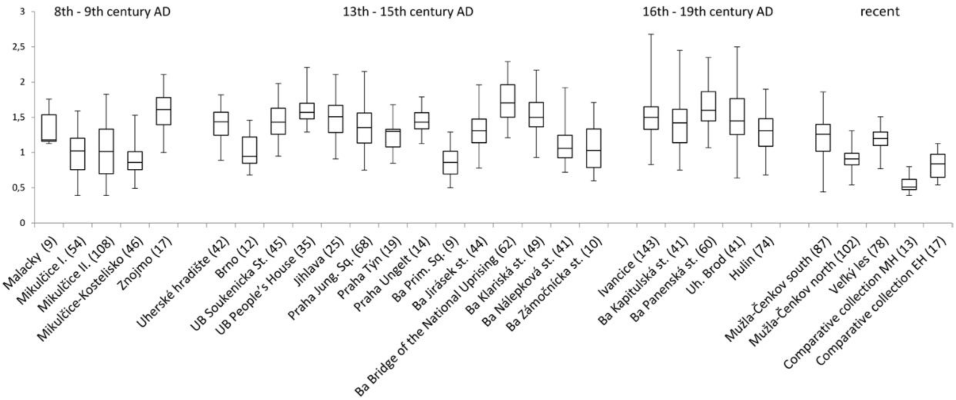


Fig. 8. Histogram of the dispersion of stalk length (LS) of grape pips. The number in parentheses represents the absolute number of finds from the analysed site. Key: VV – *Vitis vinifera*; cf. VV – probably *Vitis vinifera*; VS – *Vitis sylvestris*; cf. VS – probably *Vitis sylvestris*.

metry of the data distribution, and compare the variances of the values at the sites. The basic dimensions were obtained according to the basic method of measuring grape pips (*Bouby et al. 2013*, 6, fig. 2).

During the evaluation, the data were arranged chronologically and divided into four groups. The group of 'oldest' finds is represented by sites dated from the 8th to the mid-10th century AD, while the second group consists of sites dated from the 13th to the 15th century AD. The following group is composed of finds that are dated from the 16th century to the middle of the 19th century AD. The last group is composed of recent grape pips identified as *Vitis sylvestris s.s.*[3]

By comparing the dispersion of stalk length from a chronological point of view, it is possible to observe striking differences across the investigated periods (*Fig. 8*).[4] Stalks gradually lengthen over time, which is one of the basic signs of cultivation (*Bouby et al. 2013*, 2). The largest variances are observed at the youngest sites (16th–19th centuries AD), which could indicate the cultivation of a broad spectrum of grape varieties in this period. In this chronological group, the pips also have the longest stalks, which are the closest in size to grapevine varieties cultivated today.

Noteworthy in this context are finds from Znojmo – St Hypolite hillfort, which the archaeological context dates to the period between the 9th century to the first half of the 10th century AD (*Klíma 2011*, 213). However, compared to other contemporary finds, they differ in the length of the stalk. From a morphological point of view, but also on the basis of their state of preservation (the pips were neither carbonised nor mineralised), it is not possible to assume that they were conserved as a result of a high water table. In addition, all the pips had an almost perfectly conserved shell, which is not common in 'dry' types of

3 The average length of the recent pips of *Vitis vinifera s.s.* is 6.4 to 7 mm and *Vitis sylvestris* s.s. 4 to 6 mm (*Bojňanský – Fargašová 2007*, 429).

4 The average length of the stalk of pips of *Vitis vinifera s.s.* is 2 mm, of *Vitis sylvestris s.s.* 0.4 mm (*Köhler-Schneider 2001*, 147).

archaeological contexts dated this early. As such, it can be assumed that they are probably not early medieval finds.

The length of the stalk of the recent wild grapevine (*Vitis sylvestris s.s.*) is significantly smaller in the context of the evaluated archaeobotanical finds. However, just like the total length of the pips, it is similar to the finds from Mikulčice (all three studied agglomeration parts). Some sites with a recent occurrence of wild grapevine (Mužla-Čenkov, South and Veľký les location) even have higher values of median stalk length than finds from the early medieval period, a result that can be interpreted as evidence of the more primitive nature of the Mikulčice finds. The Mužla-Čenkov site was situated in a habitat suitable for the occurrence and optimal growth of *Vitis sylvestris s.s.*

Given that it is not clear if the examined archaeobotanical material is a cultivated or wild grapevine, it can be assumed based on the morphological criteria (*Bouby et al. 2013*, 2) that the archaeobotanical material is from different cultivars. A general view of the dispersion of the index sizes makes it clear that the recent wild grapevine shows the aforementioned features characteristic of *Vitis sylvestris s.s.*, which differs from the archaeobotanical finds. However, the differences within the individual chronological stages vary significantly, which is probably caused by the cultivation process, the growing of different varieties at the sites, or habitat conditions.

Over time, the process of grapevine cultivation can be observed on the basis of morphological changes that reflect the variance of measurements at individual sites. Smaller and wider shapes with a short stalk are more characteristic of the earlier period (8th–9th century AD). However, in the following period (13th–15th century AD) there is a noticeable increase in more elongated and slender shapes with a longer stalk. The most recently examined period (16th–19th century AD) is characterised by the high variability of dimensions, where even the largest specimens are found. In terms of size, the finds from this period are most similar to the pips of currently cultivated grapes.

Vitis vinifera and *Vitis sylvestris*

Unfortunately, the traditional approach, i.e. determination based on the morphology, cannot objectively distinguish cultivated forms of grapevine (*Vitis vinifera s.s.*) from wild grapevine (*Vitis sylvestris s.s.*) in the archaeobotanical material. For this reason, morphometric methods were applied to the examined material in an attempt to distinguish cultivars from wild species by calculating indices. It is also important to bear in mind that in the following analyses, it is not possible to understand the determination of grape pips in the *sensu stricto* sense, but rather in the broader sense of the word, as *sensu lato* (*s.l.*).

Stummer method

The first method that distinguishes between cultivated and wild forms of grapevine is based on the ratio of width to length (B:L*100) of the pip (*Stummer 1911*). Calculation of this Stummer index was performed only for waterlogged and undamaged material. The result is surprising (*Fig. 9*). Most of the evaluated finds have an index value that cannot be clearly assigned to either the cultivated or wild form (indifferent). Between 70 and 90% of the pips were labelled using this method. *Vitis sylvestris s.l.* is documented at sites where its occurrence was proven (e.g. Mikulčice-Valy), but also in places where, in terms of its

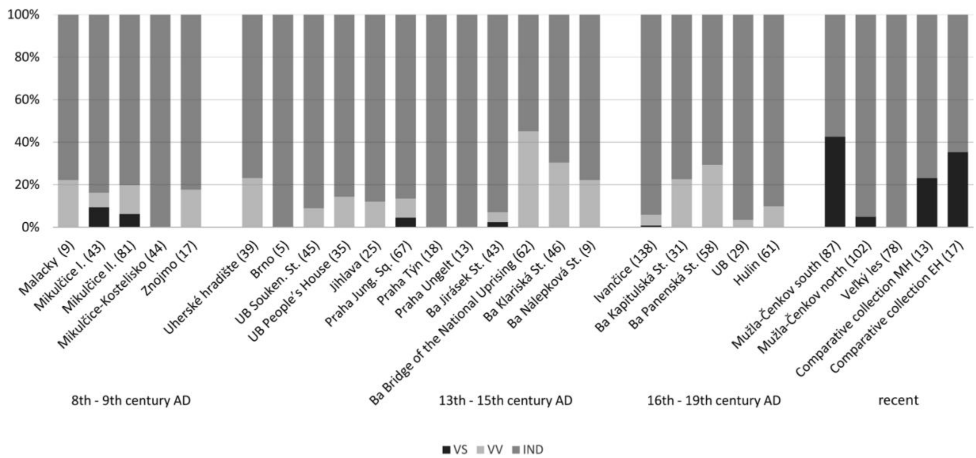


Fig. 9. Interpretation of the character of grape pips according to Stummer's index. The number in parentheses expresses the absolute number of finds from the analysed site. Key: same as *Fig. 8*.

habitat requirements, it probably could not grow (e.g. Prague – Jungmann Square, Bratislava – Jirásek Street). According to this method, wild grapevine (*Vitis sylvestris s.l.*) occurs at archaeological sites only to a limited extent (3–10%), with these pips coming primarily from the oldest studied phases of the Early Middle Ages: Břeclav-Pohansko and Mikulčice-Valy.[5] At the other sites, 5–50% of the pips were identified by this method as cultivated grapevine (*Vitis vinifera s.l.*). At the evaluated sites with a recent occurrence of wild grapevine (*Vitis sylvestris s.s.*), this method also classifies wild grapevine pips (60–90%) as a clear result. Pips that can be characterised as wild grapevine are documented here in a smaller share (4–40%). It is noteworthy that at the sites from which the pips of wild grapevine came, individuals that could be interpreted as cultivated grapevine (*Vitis vinifera s.l.*) were not identified by the Stummer method.

Mangafa–Kotsakis method

The second method of Mangafa–Kotsakis takes into account other measured dimensions (stalk length and distance from stalk to chalaza) and their ratios (*Mangafa – Kotsakis 1996*). The calculation of all indices based on the equations developed by the mentioned authors was calculated only for carbonised, waterlogged, and undamaged material.

The method of *Mangafa* and *Kotsakis* (*1996*) is based on calculating index values by four different formulae, using three basic parameters (L, LS, and PCH) and/or their indexes, and incorporates several constants. Calculated index values of each formula are compared with given thresholds and the pip is classified as wild, probably wild, probably cultivated, or cultivated. Unlike Stummer's method, neither formula uses width (B), as this measurement was thought by the authors to be the most affected by charring.

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[5] Unfortunately, not all sites included in the database are presented in graphic form. These sites did not produce enough finds for this form of visualisation as they mostly had just one find (e.g., Bojná-Valy I, Rusovce – Tehelný Hon, Břeclav-Pohansko, Iža-Leányvár, and Nitra-Castle).

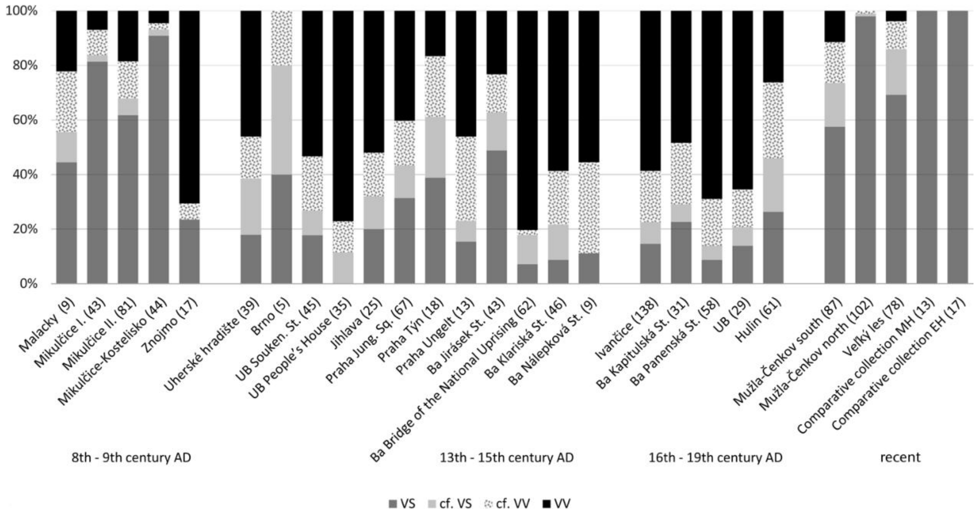

Fig. 10. Interpretation of the character of grape pips according to the Mangafa–Kotsakis method, formula 1. The number in parentheses expresses the absolute number of finds from the analysed site. Key: same as *Fig. 8*.

The authors of the second method (*Mangafa – Kotsakis 1996*) developed four equations:

Formula 1

-0.3801 + (-30.2 × LS/L + 0.4564 × PCH – 1.386 × L + 2.88 × PCH/L + 9.4239 × LS)

Formula 2

0.2951 + (-12.64 × PCH/L – 1.6416 × L + 4.5131 × PCH + 9.63 × LS/L)

Formula 3

-7.491 + (1.7715 × PCH + 0.49 × PCH/L + 9.56 × LS/L)

Formula 4

0.7509 + (-1.5748 × L + 5.297 × PCH-14.47 × PCH/L)

Formula 1: The results of using the first formula demonstrate a different picture of the classification of grape pips than with the Strummer method (*Fig. 10*). The highest occurrence of pips marked as wild grapevine (*Vitis sylvestris s.l.*) is in the earliest observed period of the Early Middle Ages (sites Bojná-Valy I, Malacky-Vinohrádok, and Mikulčice-Valy). Among the sites dated to the Early Middle Ages, similar to the evaluation of the dispersion of measurements (box plots) of pip parts, the finds from Znojmo – St Hypolite hillfort deviate from the period trend. Nearly 80% of the finds from Znojmo were determined to be pips of cultivated grapes (*Vitis vinifera s.l.*); the dominance of cultivated grapes is not documented at any other contemporaneous site. The image provided by the finds from Znojmo is again more characteristic of the later period. According to this method, the occurrence of wild grapevine (*Vitis sylvestris s.l.*) also ranges from 5 to 50% at other later sites. At most of these sites, wild grapevine (*Vitis sylvestris s.s.*) does not occur naturally (e.g., Prague, Jihlava). According to this method, the highest occurrence of wild grapevine (*Vitis sylvestris s.l.*) during the High Middle Ages is recorded at the sites from which material from waste pits comes (Brno, Prague – Jungmann Square, Týn Courtyard, Bratislava –

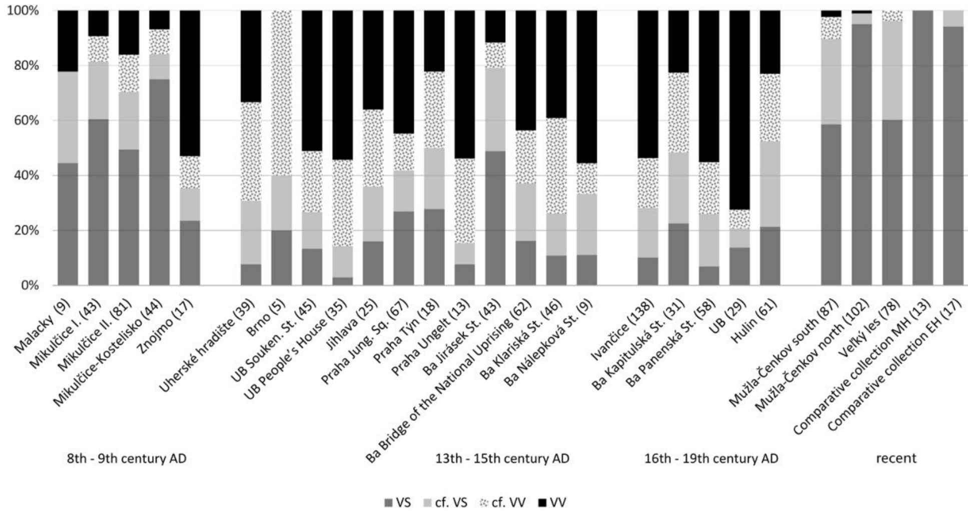

Fig. 11. Interpretation of the character of grape pips according to the Mangafa–Kotsakis method, formula 2. The number in parentheses expresses the absolute number of finds from the analysed site. Key: same as *Fig. 8*.

Jirásek and Kapitulská Street). The change in the size of the plant material can also be related to the physical-chemical environmental conditions in the waste pits.

By comparing pips in terms of chronological development, it is possible to observe an interesting trend, namely an increase in the percentage of pips determined as cultivars (*Vitis vinifera s.l.*) and simultaneously a decrease in pips determined as wild grapevine (*Vitis sylvestris s.l.*). In the earliest studied period (8th–9th century AD), up to 68.6% of the pips were determined by this method to be wild grapevine (*Vitis sylvestris s.l.*), while at sites dated from the 16th to the 19th century AD, only 16.4% of finds are determined in this way. Cultivated grapevine (*Vitis vinifera s.l.*) is most often found in the latest investigated period (16th to 19th centuries AD). Cultivars account for up to 54% in this period, while in the Early Middle Ages, the share of cultivars is only 17.5%.

The pips of recent wild grapes (*Vitis sylvestris s.s.*) evaluated by this method were in nearly the majority of cases correctly classified as wild grapevine. However, there were individuals found at the Mužla-Čenkov, South and Veľký les subsites that were evaluated by this method as cultivated grapevine (*Vitis vinifera s.l.*). Based on this, it can be assumed that even among wild grapes (*Vitis sylvestris s.s.*) there may be pips whose dimensions are similar to those of cultivars (*Vitis vinifera s.s.*).

Formula 2: Using the second formula, which takes into account other variables, the result is similar to the first (*Fig. 11*). Similarly, finds that were identified as wild grapevine (*Vitis sylvestris s.l.*) have a dominant position in the earliest investigated period, while the difference of the pips from Znojmo is also evident. The outlined trend of the increasing share of pips that these methods characterise as evidence of cultivars (*Vitis vinifera s.l.*), is also apparent with this formula. The highest share is reached by pips in the latest observed period (16th to 19th century AD) up to almost half (46.68%), while in the Early Middle Ages it is 16%. Pips identified as wild grapes (*Vitis sylvestris s.l.*) make up the

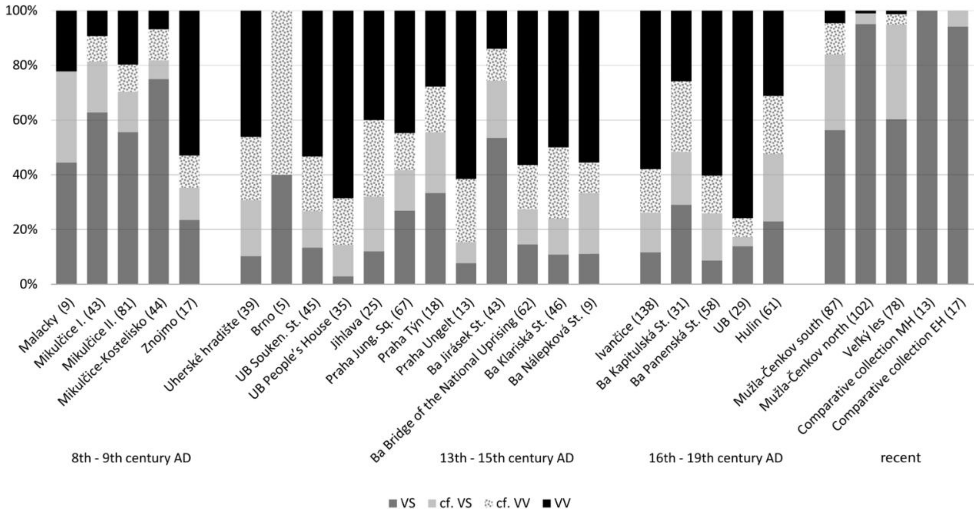

Fig. 12. Interpretation of the character of grape pips according to the Mangafa–Kotsakis method, formula 3. The number in parentheses expresses the absolute number of finds from the analysed site. Key: same as *Fig. 8*.

majority (55.15%) in the Great Moravian period, while in the 16th to 19th century AD, finds identified in this way make up 13.2%. From the perspective of the occurrence of wild or cultivated grapevines, the period of the High Middle Ages (13th to 15th century AD) is more similar to the period of the Late Middle Ages to the modern era. When using this equation, the share of finds that could not be clearly attributed to cultivated or wild grapevine also increases.[6]

In the case of recent pips of wild grapevine (*Vitis sylvestris s.s.*), the result is also similar to the first equation. A significant difference when using this approach is that some pips labelled in the previous analysis as cultivated grapes (*Vitis vinifera s.l.*) were reclassified and identified as probably wild grapevine (cf. *Vitis sylvestris s.l.*).

Formula 3: The use of the third formula yields an image almost identical to the previous analysis performed by formula 2. Relatively few finds were reclassified by this method, having no significant effect on the results (*Fig. 12*).

Formula 4: The results of the fourth formula are significantly different (*Fig. 13*), presumably due to the fact that, unlike the previous equations, measurements of stalk length (LS) are not included in this equation. For this reason, it is clear that the material has the highest incidence of finds that were determined only with a degree of probability (*cf.*). Pips that were determined by this method as *cf. Vitis sylvestris s.l.* have up to 91% probability that they are *Vitis sylvestris s.l.* (*Mangafa – Kotsakis 1996*, 415). With such a high probability, it is clear that even when using this formula, the analysed pips show the same trend as in the previous cases (see Formula 1–3).

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[6] Pips with this determination were labelled with the abbreviation *cf.* (*confer*).

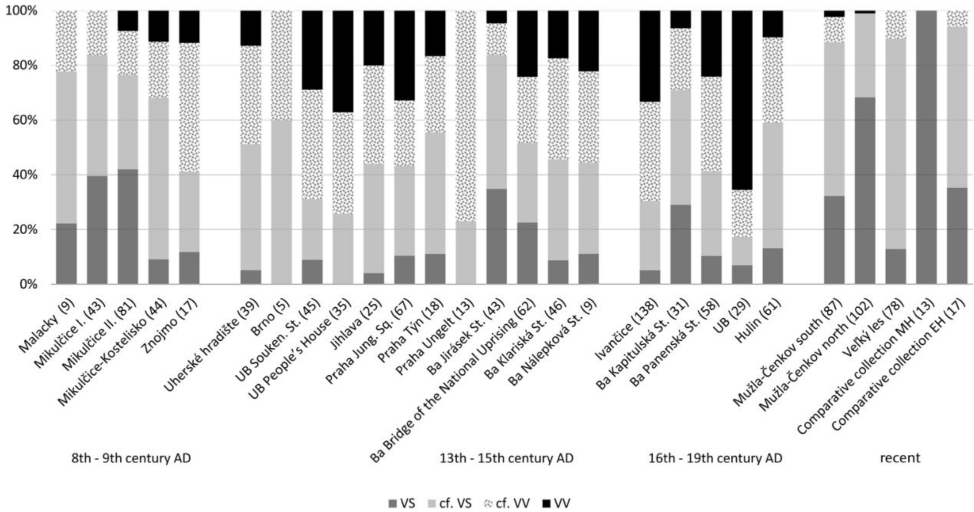

Fig. 13. Interpretation of the character of grape pips according to the Mangafa–Kotsakis method, formula 4. The number in parentheses expresses the absolute number of finds from the analysed site. Key: same as *Fig. 8*.

The obtained results of the morphometric measurement of grape pips indicate that individual specimens were repeatedly reclassified depending on the method or equation used. It is therefore not possible to clearly determine which method most accurately characterises the origin of the pips. This uncertainty was also presented for the wild grapevine finds (*Hajnalová et al. 2023*). Despite the fact that the presented methods have a tendentious character, it is possible to observe certain trends in the archaeological material suggested by morphometric methods.

Discussion

The acquired results can be interpreted mainly from a chronological point of view. The material shows an increasing trend of finds that can be characterised as cultivated (*Vitis vinifera s.l.*) and at the same time a decrease in the share of wild grapevine (*Vitis sylvestris s.l.*). This trend can be observed in each analysis separately and even in the overall interpretation of the pips for each site. The gradual lengthening of the body and stalk of the pip reflects the process of grapevine cultivation and the development of the cultivation of different varieties.

The oldest (and undamaged) find that was evaluated in this study comes from the Iža-Leányvár site (Late Roman Period) and was classified as a cultivated grapevine (*Vitis vinifera s.l.*) by all the applied methods. This lone pip comes from a well (*Hajnalová – Rajtár 2009*, 200) situated in a Roman border military camp. The database also includes another similarly dated pip find classified as wild grapevine and retrieved from the Rusoviec – Tehelný Hon site, which was interpreted as a villa rustica (*Varsík 2020*). It is noteworthy that in the Czech Republic, no finds of grape pips from the Roman Period are available

(*ArboDat database*), which is probably related to the state of research, since grape pip finds from that period also come from a nearby site in Austria–Stillfried (*Köhler-Schneider 2001*, 147–149). The same analyses of finds of grape pips from Roman times were carried out at the mentioned site, and were classified as cultivars (*Vitis vinifera s.l.*). While rare finds from the Roman Period probably do not testify to the local cultivation of wine, as written sources document, they probably indicate trade with this economically important commodity (*Hajnalová 2001*, 66).

In the later part of the Early Middle Ages, grape pips were quite rare at most archaeological sites, as their finds were recorded at only six sites (Nitra-Castle, Břeclav-Pohansko, Mikulčice-Valy, Malacky-Vinohrádok, Bojná-Valy I, and Znojmo – St Hypolite hillfort). However, an analysis was performed on pips from three sites dated to the Early Middle Ages (Mikulčice-Valy, Malacky-Vinohrádok and Znojmo – St Hypolite hillfort). More than half (60%) of the pips from Mikulčice evaluated using morphometric methods were classified as wild grapevine (*Vitis sylvestris s.l.*), while only 11% were determined as cultivars (*Vitis vinifera s.l.*). A similarly high occurrence (44%) of pips characterised as wild grapevine (*Vitis sylvestris s.l.*) was recorded at the Malacky-Vinohrádok site, which was dated to the 8th century AD (*Hajnalová – Elschek 2015*, 155). In the context of evaluating the character of grapevine from early medieval sites, the pip finds from Znojmo are exceptional. The shape, size, and state of conservation of these finds resemble those from later periods (see above).

In the Early Middle Ages, grape pips began to appear more often at archaeological sites, which is probably related to the beginnings of grapevine cultivation in this area linked with gradual Christianisation (*Hajnalová 2001*, 44). As one of the main Eucharistic symbols, wine demonstrates, among other things, the major influence of the church on the beginnings of winemaking. In this period, the cultivation of grapevine was probably not pursued for economic reasons, but wine served primarily for liturgical purposes–for communion under both kinds.

The High Middle Ages and the modern age are characterised by a great increase in the number of grape pips (*Vitis vinifera s.l.*) classified as cultivated. Morphometric methods showed that almost all sites had a high share of these pips (50–75%), for example in Ivančice and Uherský Brod – House of Culture, many of these finds being classified as grapevine cultivars. Nevertheless, some sites had a high share of pips classified as wild grapevine (*Vitis sylvestris s.l.*), which seems to contradict the written sources and laws addressing viticulture in this period (*Frolec 1973*). Viticulture became an important economic factor in the 12th and 13th centuries AD, but until the 17th and 18th centuries the area was dominated by monasteries and wealthy burghers from the royal cities. The peak of viticulture was reached in the 17th century AD during the Thirty Years' War (1618–1648), after which vineyards fell into disrepair and disappeared due to climate change and labour shortages. The renewal of vineyards came only in the 19th century (*Frolec 1973*).

The development outlined by historical sources is reflected to a certain extent, or even illustrated by, archaeobotanical finds of grapevine. On the basis of a detailed assessment of the accuracy of morphometric methods on recent wild grape pips (*Hajnalová et al. 2023*), it is clear that the results of these methods cannot be accepted unequivocally and uncritically. Although the majority of grape pips were correctly classified by all methods, morphometric methods also classified a high share of pips (15–25%) as domesticated forms of grapevine. The analysis shows that wild grapevine in Slovakia produced a higher number

Stummer	Formula 2	Formula 3	Number	% Ratio
VV	VV	VV	6	2.75
IND	VV	VV	17	7.8
VV	IND	IND	5	2.3
VV	IND	VS	2	0.9
VV	VS	VS	5	2.3
IND	IND	VV	2	0.9
IND	IND	VS	4	0.18
IND	VS	VS	116	53.2
VS	VS	VS	21	9.6
IND	IND	IND	40	18.3

Tab. 2. Resulting interpretation of character of archaeobotanical grape pips using the Stummer and Mangafa–Kotsakis methods for the 8th–9th century AD group. Key: VV – *Vitis vinifera*; cf. VV – probably *Vitis vinifera*; VS – *Vitis sylvestris*; cf. VS – probably *Vitis sylvestris*; IND – indifferent.

Stummer	Formula 2	Formula 3	Number	% Ratio
VV	VV	VV	40	9
IND	VV	VV	122	27.5
VV	IND	IND	19	4.3
VV	IND	VS	1	0.2
VV	VS	VS	6	1.35
IND	IND	VV	20	4.5
IND	IND	VS	6	1.35
IND	VS	VS	105	23.64
VS	VS	VS	5	1.1
IND	IND	IND	120	27

Tab. 3. Resulting interpretation of character of archaeobotanical grape pips using the Stummer and Mangafa–Kotsakis methods for the 13th–15th century AD group Key: same as *Tab. 2*.

Stummer	Formula 2	Formula 3	Number	% Ratio
VV	VV	VV	27	7.5
IND	VV	VV	121	33.7
VV	IND	IND	7	1.94
VV	IND	VV	3	0.83
VV	VS	VS	3	0.86
IND	IND	VV	13	3.62
IND	IND	VS	7	1.94
IND	VS	VS	71	19.7
IND	VS	IND	1	0.27
VS	VS	VS	1	0.27
IND	IND	IND	105	29.24

Tab. 4. Resulting interpretation of character of archaeobotanical grape pips using the Stummer and Mangafa–Kotsakis methods for the 16th–19th century AD group. Key: same as *Tab. 2*.

Stummer	Formula 2	Formula 3	Number	% Ratio
VV	VV	VV	27	7.5
IND	VV	VV	121	33.7
VV	IND	IND	7	1.94
VV	IND	VV	3	0.83
VV	VS	VS	3	0.86
IND	IND	VV	13	3.62
IND	IND	VS	7	1.94
IND	VS	VS	71	19.7
IND	VS	IND	1	0.27
VS	VS	VS	1	0.27
IND	IND	IND	105	29.24

Tab. 5. Resulting interpretation of character of recent grape pips (*Vitis sylvestris s.s.*) using the Stummer and Mangafa–Kotsakis methods. Key: same as *Tab. 2*.

of pips with characteristics similar to cultivated forms. On the other hand, in the presence of atypical wild grapevine pips, both methods are prone to classification errors. While morphometric methods significantly help in the determination of pips of the genus *Vitis*, it is necessary to remember that the character, shape and condition of archaeobotanical finds are influenced by a range of factors (genetics, environmental, habitat conditions during growth, method of preservation, context, and diagenetic processes).

It is clear from the results of the analysis that the majority of finds were repeatedly incorrectly classified (*Tab. 2–5*). A detailed assessment of the accuracy of morphometric methods (*Hajnalová et al. 2023*) showed that these approaches have a high rate of misclassification of the pips of recent wild grapevine, which was also identified on the basis of vegetative characteristics as *Vitis sylvestris s.s.* Despite the high error rate, these methods can be effectively used in the identification of archaeobotanical finds in conjunction with the macroscopic evaluation of specific finds. However, the greatest problem is that in some cases the finds are evaluated by one method as wild grapevine and another as cultivated and *vice versa*. Nevertheless, such cases are quite rare. The results of Stummer's method differ the most from the second and third formulas of Mangafa–Kotsakis. In some cases, however, the results also differ between the individual Mangafa–Kotsakis formulas. For this reason, when evaluating larger sets of grape pips from a specific location, it is appropriate to evaluate the sites as a whole by multiple methods and visual evaluation. In conclusion, for a better understanding of the character and development of grape pips at archaeological sites, it would be appropriate to employ a more comprehensive approach. Of all the possible combinations, the combinations IND/VV/VV, IND/VS/VS and IND/IND/IND occurred most often in archaeobotanical and recent material.

Although the results for the Roman Period are not presented in the text due to the small number of finds (see *Online Supplementary Material 1*), the obtained finds demonstrate that in this period the macro-remains from the Iža-Leányvár and Stillfried sites were mainly classified as IND/VV/VV. The only find from the Rusovce – Tehelný Hon site was classified as IND/VS/VS, which may be related to the proximity of riparian forests in Lower Austria.

Finds from the Znojmo – St Hypolite hillfort were also left out the table for the Early Middle Ages due to serious doubts over their accurate dating (see the text above). Finds from this site are most inclined to IND/VV/VV combinations, but in four cases there were also finds marked as IND/VS/VS.

In the evaluated set, the greatest re-classifications and errors occur in the period from the 16th to the 19th century. The highest number of different classifications based on the morphometric approach are recorded in this time horizon. In each of the observed horizons, combinations of classifications referred to as 'similar' dominate. The number of grape pips that would clearly be classified as cultivated (using the three formulas) is relatively low in all horizons. In the horizon between the 13th and 15th centuries, such pips made up 9%, while they were completely absent in the group of recent finds. On the other hand, finds that would be unequivocally marked as wild clearly dominate among recent pips (14.76%) and their lowest occurrence is in the horizon from the 16th to the 19th century, where such finds make up 0.27%.

The occurrence of a combination in which the finds cannot be clearly classified by any of the possible formulas is relatively high (IND). Finds marked in this way usually form the second most frequent possible combination in all analysed horizons (with a variance from 19.46% to 29.24%). A high share of these finds also appears among recent pips, which can be connected with the limited descriptive scope of Stummer's method unable to classify the majority of all examined finds unambiguously.

Apart from Stummer's method, it is clear that the morphometric Mangafa–Kotsakis method (especially the second and third formulas) was able to classify a relatively high share of finds. However, it correctly classified as wild species up to 59.06% of all recent pips which were also botanically identified as wild grapevine (*Vitis sylvestris s.s.*), but mistakenly classified three specimens as a cultivated form of grapevine. From the assemblage of archaeobotanical finds, relatively large groups of finds were identified as cultivated or wild grapevine forms. The highest occurrence of pips that were classified as wild grapevine is up to 53.2% in the high medieval period, which is the second highest occurrence after the group of recent finds. In this time horizon, finds classified as a cultivated form of grapevine make up 7.8%, which is, on the other hand, the lowest occurrence in the studied time horizons. In contrast, it is clear that in the period from the 16th to the 19th century, the highest occurrence of finds that were classified as a cultivated form of grapevine (33.7%) and the lowest number of finds labelled as wild grapevine (19.7%) are recorded.

The prevailing opinion in earlier archaeobotanical literature was that the wild grapevine (*Vitis sylvestris s.s.*) was more abundant in the evaluated territory (*Opravil 1965*; *1977*; *1980*; *1997*; *Hajnalová 2001*, 66). The argument that earlier botanists from the last century (*Hegi 1925*) found riparian forests in a 'virgin' state and were able to record plant species that no longer exist there (*Opravil 1977*, 361) has several ambiguities. Archaeobotanical sampling of archaeological sites in the Czech Republic and Slovakia has a relatively long tradition (more than 60 years, the first meeting of the IWGP was held at Kačina Château in 1968), which resulted in extensive assemblages of plant macro-remains of a various nature. If wild grapevine (*Vitis sylvestris s.s.*) were to occur in the territory as a wild species of riparian forests, it would probably be identified at more intensively sampled prehistoric or high medieval sites. The fact that grape pips at some sites (Mikulčice-Valy, Hlinsko near Lipník, Plzeň – Solní Street, Prague – Jungmann Square, Prague – Malá Strana, Olomouc – Školní Street and Opava – 1. Máje Square) were designated as wild grapevine probably points to the sound ability of archaeobotanists to observe and recognise the specific character of certain pips in the material. Institutions that have historical herbarium collections of pips and fruits, as well as vascular plants (Herbarium Collection of Seeds and Fruits at Charles University, Herbarium Collection of Seeds and Fruits of the Institute of Botany of the Czech Academy of Sciences, the Herbarium Collection of the PRA) were approached to obtain comparative material for wild grapevine. Unfortunately, wild grapevine diaspora are not among the items available from the addressed institutions – only cultivated forms.

Conclusion

The paper presented an analysis and interpretation of the origin of grapevine pips from the Early Roman Period to the 19th century AD in the territory of Bohemia, Moravia, and Slovakia. The applied analysis was based on the principles of morphometric methods. A total of 1387 grapevine pips were included in the analysis, the parts of which were measured, and of this number, there were 1,090 archaeobotanical finds and 297 recent pips identified as wild grapevine.

The aim of this study was to determine whether the archaeobotanical finds of grape pips represent evidence of cultivated fruit or wild species. Based on the variance of the measurements and the comparison of the archaeobotanical finds and recent pips of wild grapevine, it is clear that the archaeobotanical material represents a variety of grape cultivars. The dispersion of the measurements of parts of the pips at sites points to a higher variability of sizes in archaeobotanical finds compared to recent wild grapevine.

The results of morphometric analyses of pips (*Stummer 1911*; *Mangafa – Kotsakis 1996*) prove that the highest occurrence of pips labelled as wild grapevine (*Vitis sylvestris s.l.*) was recorded in the Early Middle Ages. Finds from sites dated to this period also show a higher dispersion of pip stalk measurements. However, finds from Znojmo – St Hypolite hillfort deviate from this trend, which suggests that it might involve contamination of Great Moravian graves. These finds from Znojmo are more characteristic of the later period, and therefore it can be assumed that the grape pips stones arrived there later. One of the possible explanations for how the pips reached Great Moravian graves is the fact that the author of the study also identified the remains of a vineyard from the High Middle Ages stratigraphically above the burial site, from where most of the grape pip finds come. This vineyard has been dated to the 14th century AD based on an associated coin (*Klíma 2001*, 45).

By comparing the grape pips from the perspective of chronological development, a trend can be observed of an increase in the percentage of pips determined according to this method as cultivars (*Vitis vinifera s.l.*) and at the same time a decrease in the number of specimens determined as wild grapevine (*Vitis sylvestris s.l.*). In the period (8th to 9th century AD) wild grapevine (*Vitis sylvestris s.l.*) was dominant among all finds according to this comparison, while at sites dated from the 16th to 19th century AD only a third of the finds are determined. The most commonly cultivated grapevine (*Vitis vinifera s.l.*) is found in the latest investigated period (16th to 19th century AD). At this time, cultivars make up more than half, while in the Early Middle Ages, the share of finds identified in this way is one-third.

The pips of the recent wild grapevine (*Vitis sylvestris s.s.*) evaluated by this method were in most cases correctly classified as wild grapevine. However, at the sites of Mužla-Čenkov, South and Veľký les subsites, there are specimens that the mentioned method evaluated as cultivated grapevine (*Vitis vinifera s.l.*). Based on this, it can be assumed that even among wild grapes (*Vitis sylvestris s.s.*) there may be individuals whose dimensions are similar to those of cultivars (*Vitis vinifera s.s.*).

The applied morphometric methods are based on recent observations of local grapevine in areas where these methods originated. Apparently, this factor also contributed to the existence of several inconsistencies in the examined archaeobotanical material, as the size of the pip changes due to environmental conditions, though not its original shape. Using the overall character of the pip (*Terral et al. 2010*; *Bouby et al. 2013*; *Pagnoux et al. 2015*), in the case of some of the investigated finds, it is possible to consider that it is a cultivated grapevine of a more primitive character or local cultivars.

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MICHAELA LÁTKOVÁ, Institute of Archaeology in Brno, Czech Academy of Sciences, Čechyňská 363/19, CZ-602 00 Brno, Czech Republic; latkova@arub.cz

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Food detection in medieval acoustic vessels: A case study from the early gothic churches in Myšenec and Kovářov (South Bohemia)

Detekce zbytků potravin ve středověkých ozvučnicových nádobách: Případová studie z raně gotických kostelů v Myšenci a Kovářově (jižní Čechy)

Filip Facincani – Jaroslav Pavelka

The subject of the article is two systems of acoustic vessels from the Church of St. Gall in Myšenec, which is associated with the production of the so-called Zvíkov and Písek architectural workshop, and All Saints Church in Kovářov in South Bohemia. These vessels, built into the vault, were placed with their rim facing the interior of the presbytery and their bottom in the space of the attic at the same time as the construction of the vault and were probably intended to improve the acoustics of the interior of the presbytery. In the foreign synthesising literature, examples are described of custom-made vessels as well as secondarily used household vessels, i.e. those primarily intended for food storage. The paper aims to precisely determine the primary role of the vessels found in the two studied churches by detecting the hypothetical presence of food residues in them. Samples were taken from the inner surfaces of the vessels and their analysis showed a weak signal of casein (*milk*) *in one case and a strong signal of gliadin* (*grain*) *in the other. The multiple potential functions of the vessels embedded in the vaults are discussed in the context of Czech examples and foreign research on acoustic vessels.*

acoustic vessels – food residues – ELISA – medieval architecture – Myšenec – Kovářov

Předmětem příspěvku jsou dva systémy ozvučnicových nádob, evidované v kostele sv. Havla v Myšenci (*okr. Písek*)*, spojovaného s produkcí tzv. zvíkovsko-písecké hutě, a kostele Všech svatých v Kovářově* (*okr. Písek*)*. Tyto nádoby byly vezděny hrdlem do interiéru presbytáře a dnem do prostoru krovu současně s konstrukcí klenby a měly sloužit jako prostředek ke zlepšení akustiky presbytáře. V zahraniční syntetizující literatuře jsou doloženy jak příklady na míru zhotovených nádob, tak nádob druhotně užitých, tj. primárně určených pro uchovávání potravin. Ambicí předkládaného příspěvku bylo určit právě primární roli nádob, vezděných ve dvou studovaných kostelech, a to za pomoci detekce hypoteticky přítomných zbytků potravin. Z vybraných nádob byly odebrány vzorky z jejich vnitřních stěn, jejichž analýza prokázala v jednom případě slabý signál caseinu* (*mléko*) *a ve druhém silný signál gliadinu* (*obilí*)*. V kontextu českých příkladů a zahraničních výzkumů akustických nádob je diskutováno více možných funkcí nádob zabudovaných do kleneb.*

akustické nádoby – potravinové zbytky – ELISA – středověká architektura – Myšenec – Kovářov

Dedicated to Therese Emanuelsson-Paulson and Jakob Lindblad.

Introduction

Built-in ceramic vessels preserved in the vaults of several medieval churches in the Czech Republic are generally accepted to be *acoustic vessels* (also known as *acoustic jars*, *resonant*

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cavities), in other languages as *les vases acoustiques* (French), *Schalltöpfe* (German), *Ljudkrukor* (Swedish). Such vessels were likely intended for improving the acoustics of the interior, and thus they should be contemporary with the vault construction. Nevertheless, there is also evidence of vessels that were added later (*Desarnaulds – Loerincik 2001*, 67). In two local cases, vessels were found in a perimeter wall. The issue of acoustic vessels in medieval churches has been widely discussed (*Arns – Crawford 1995*; *Desarnaulds – Loerincik 2001*; *Brüel – Zaveri 2008*; *Palazzo-Bertholon – Valière 2012*; *Valière et al. 2013*; *Đorđević et al. 2017*) and has its traditional place in art historian, acoustic, and archaeology studies. Czech literature has dealt mostly with individual finds and records of embedded vessels. Only *Petr* (*1957*) and *Špaček* (*1963*) considered the wider European literature and critically presented all the hypotheses about the function of the vessels.

In the first part of the paper, the results of sampling for food detection in ceramic vessels will be presented using two case studies from the Church of Saint Gall in Myšenec and All Saints Church in Kovářov (both in the Písek district, South Bohemia). The second part of the paper presents the known examples of ceramic vessel systems found in the Czech Republic. As local examples have not been included in foreign catalogues (see *Arns – Crawford 1995*; *Desarnaulds – Loerincik 2001*; *Palazzo-Bertholon – Valière 2012*), this paper aims to fill this gap and review them here as well. We will discuss existing theories based on an investigation of these vessels and examine a hypothesis suggested by older Czech and recent European research that some examples did not have to improve acoustics but could have been functional openings, serving as grommets or as air circulation vents.

Research question and its testimonial value

Through the interdisciplinary collaboration of an art historian and a molecular biologist, this paper aims to determine whether the artefacts were primarily used for food storage and embedding them in the vault structure was the second stage of their use, or if they were manufactured specifically for this purpose. Given the numerous foreign examples of household, storage or transport vessels being used as acoustic jars, we believe that this practice can also be assumed for certain Czech examples. In the absence of tangible attributes of household pottery, the detection of food residues seems to be the only available option to confirm or refute this hypothesis. It may well be that in some cases the vessels in which beverages for craftsmen had been stored on the building site were embedded in the vault. With slight exaggeration, we can mention in this context the paintings from Teruel Cathedral (Spain, 13th century), which roughly show us such a practice. Here, we can see several carpenters working the beams and another one in the middle, who distributes drinks to refresh them. This is exactly the scene we verify with our research – a vessel, intended for the storage of drink and analogous in shape to those we record, was hypothetically walled up as soon as it was finished and the stage of vaulting proceeded.

The shape and especially the appearance of the external decoration and the funnel or handle setting on the embedded vessel could indicate its secondary use. However, these attributes of household pottery do not necessarily imply that the vessels were actually used to store food – only that they were made for that purpose. It is, therefore, still necessary to distinguish between the primary function as fulfilled or unfulfilled. However, only in the absence of any of these visual clues can food residues be the clue to determining which type of production was chosen. Establishing the primary function of the vessels is crucial for an interpretation of their incorporation into the building design and contributes to the understanding of medieval building practices in general.

The initial theory about the secondary use of ceramic vessels originated from the common (and not only medieval) practice of recycling. Such an example is the secondary use of timbers from previous roof trusses, older or broken architectural parts, reused in a new structure as a common building material replacing a regular brick or a stone block. Given the European analogies, where vessels of household production (whether used or not) have been embedded as acoustic vessels (*Yates 1897*; *Arns – Crawford 1995*, 115; *Desarnaulds – Loerincik 2001*, 68; *Tallon 2016*, 269), confirming or disproving the secondary use of the studied vessels would be another piece in the mosaic of contemporary knowledge about medieval building practices and construction procedures. The economic choice of recycling older vessels or ordering common household production speaks volumes about the thinking of the master builder and gives an idea of the time required to apply this specific technological solution. Simplified – using stock pieces had to be faster and cheaper than ordering custom production.

At the outset, it is important to note some of the postulates that will be discussed throughout the text. The embedding of the vessels itself could have been motivated by concerns about the acoustic quality of the building, as well as by an order or a desire to provide the building with an exclusive technological solution that a master builder had seen or heard about, for example. Such a situation was documented in the 1430s in Metz (*Petr 1957*; *Dragoun 1994*, for mentions from the 16th and 17th centuries, see *Desarnaulds – Loerincik 2001*, 69), when the prior recommended fitting the vault with pots to improve the acoustics; however, he had only seen such an arrangement once before and the local master builder, if not being familiar with such a procedure, had to rely not on experience but solely on intuition.

However, it should also be noted that the acoustic role of ceramic vessels is just an assumption that cannot be confirmed without reservation for all the examples known so far. In addition, the positive or negative signal of food residues does not preclude the use of the vessels as acoustic ones, but it says a lot about how the chosen technological solution was achieved and the modelling of the building project itself. It is also important to point out that even if the vessels could not improve the acoustics, it does not mean that they were not fitted for that purpose. Even though the role was intended to be acoustic, there are still several possibilities as to what kind of vessel to use for these purposes (*Fig. 1*).

Material and Methods

Selected churches

For the purpose of this study, churches in Myšenec and Kovářov were selected based on the similar time of their construction in the second half of the 13th century, geographical proximity of about 50 km, and the apparent contrast in the quality of the vessels and the quality of the buildings themselves. Four vessels were found in the vault of the Myšenec church (*Varhaník – Zavřel 1989*); in the Kovářov church, ten complete vessels and one imprint were recorded (*Sommer 1997*). Thus, in Myšenec, a relatively small number

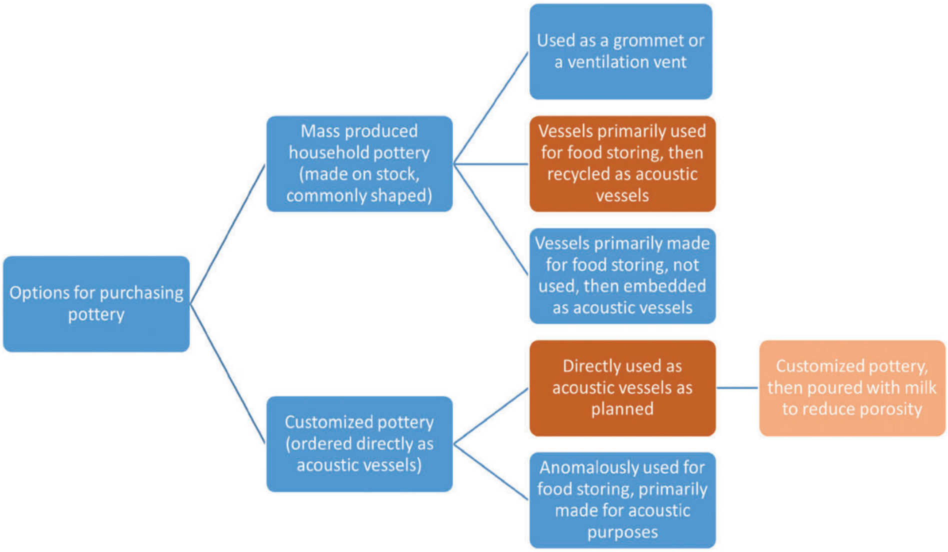

Fig. 1. Diagram indicating the possibilities for how vessels were used. Orange colour indicates the cases record in Myšenec and Kovářov.

of vessels were placed without any recognisable pattern (*Fig. 2*); in Kovářov, the vessels were arranged in a roughly regular way aligned to the longitudinal axis of the presbytery (*Fig. 3*).

These particular churches were also chosen because of the obvious contrast in the quality of the vessels used. In fact, the rustically made vault of the church in Kovářov was fitted with thin-walled vessels made from a single piece. On the contrary, in the exclusive realisation of the Myšenec church, associated with the activity of the well-known Zvíkov and Písek architectural workshop (see *Kuthan 1975*), massive vessels (atypically made of two parts) were used. The vessels in Kovářov thus appeared to be an example of mass production due to their obvious quality, while the vessels in Myšenec appeared to be a customised order.

Case study A – The Church of St. Gall in Myšenec

The Church of St. Gall in Myšenec is located in the very centre of the village, south of the remains of the Přemyslid royal residence. It is a single-nave church with a polygonal presbytery, a rectangular sacristy at its southern wall, and a western front tower (*Fig. 2*). The nave is aligned on a west-east axis, with the chancel and sacristy set back from the axis to the north. The western part of the rectangular unvaulted nave features a tribune divided into three bays with cross-rib vaulting. The sacristy, formerly considered to be the original church and now accepted as contemporary with the choir, is vaulted with a barrel vault.

The main structure is dated to the late 1250s or 1260s by previous research (*Kuthan 1994*), but it is necessary to assume a more complicated building history (*Adámek – Sommer 1998*). Based on its geographical proximity to Písek, historical property relations, the

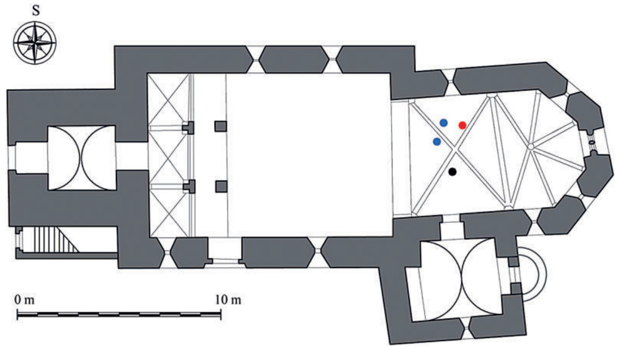

Fig. 2. Church of St. Gall in Myšenec, ground plan with vessels marked. Black – unsampled vessels; blue – vessels with a negative result; red – vessel positive result (according to *Varhaník – Zavřel 1989*, modified).

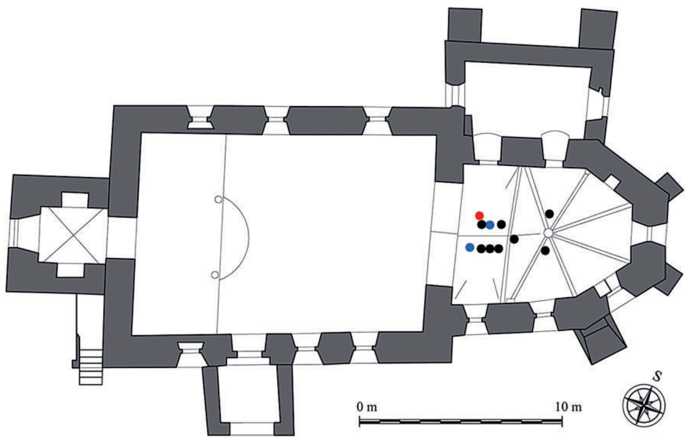

Fig. 3. All Saints Church in Kovářov, ground plan with vessels marked. Black – unsampled vessels; blue – vessels with a negative result; red – vessel positive result (according to *Sommer 1997*, modified).

existence of the royal residence nearby, and above all its morphological characteristics, the Myšenec church was generally accepted as a product of the so-called Zvíkov and Písek architectural workshop. This idea was also supported by the appearance of a mason's mark on the southern portal. A similar mark was also recorded on the southeastern corner of the royal palace and in the northern wing of the courtyard arcade of Zvíkov Castle (*Kuthan 1975*).

In the case of Myšenec, Jan Sommer pointed out the use of prefabricated architectural elements, which were implemented differently than for what they were initially modelled (*Adámek et al. 2001*). This note about the nature of the vault is crucial when the embedding of acoustic vessels is investigated. The contrast in the angle of the rib directions on the wall consoles and the vault ribs themselves shows that the consoles of the transition between the choir and the presbytery were designed for a space with a greater length. Thus, the console ribs spring at a sharper angle with the perimeter wall than the vault ribs, which were placed on the wall consoles in the last building phase after the original roof truss was built. The prefabrication of the unified architectural elements was further evidenced, again in connection with the Zvíkov and Písek architectural workshop, by the relationship between the wall consoles and the perimeter wall of the choir of St. Catherine's Church in Varvažov (*Sommer et al. 2003*), located 25 kilometres from Myšenec. Altogether, they

Fig. 4. Church of St. Gall in Myšenec, attic, brick vault of choir with embeded-ded vessels (photo by F. Facincani).

Fig. 5. Church of St. Gall in Myšenec, vessel no. 1 (photo by F. Facincani).

may indicate the production of uniformly shaped architectural elements manufactured for stock. Equally, it may simply be evidence that the consoles were made for this particular church, the ground plan of which was changed before the construction began. At the last moment, it may have been decided to shorten the length of the presbytery, as is expected in the Church of St. Dominic in Strunkovice nad Blanicí. However, this would have meant that the consoles would have had to be made before the foundations were laid.

Four ceramic vessels are preserved in the choir vault of the Church of St. Gall in Myšenec (*Fig. 4*). Here, the vessels were placed asymmetrically near the top of the vault. They

Fig. 6. Church of St. Gall in Myšenec, vessel no. 3 (photo by F. Facincani).

Fig. 7. Church of St. Gall in Myšenec, detail of vessel junction (photo by F. Facincani).

were made of two pieces; the neck as an individual part was pressured into the body, jointed by an unknown rectangular tool. There are even two anomalous joining methods that are visible. Quite deep rectangular traces at the point of the junction of the neck and the body are prevailing (*Fig. 6*; *Fig. 7*, noticed by *Varhaník – Zavřel 1989*), but in one case the joint is smooth with just one wide curvilinearly-shaped depression (*Fig. 5*). Thus, we can see two different and not common types of junctions caused by the cooperation of two potters or an alternative technological method. Considering that the rectangular joints would have been possibly visible from the outside, their appearance could also signify that the vessels were not ordinary household pots.

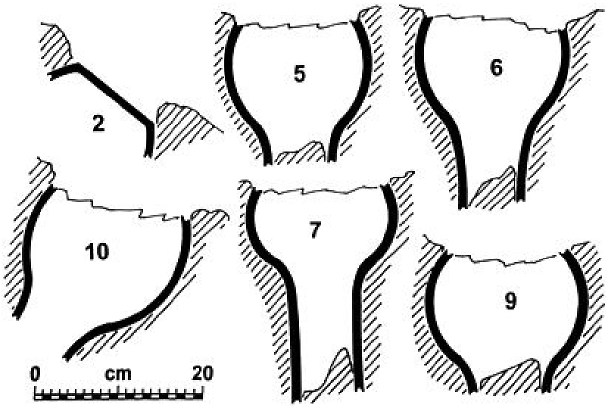

Fig. 8. All Saints Church in Kovářov, cross sections of vessels (according to *Sommer 1997*).

Case study B – All Saints Church in Kovářov

The oldest structures of All Saints Church of in Kovářov date back to the end of the 13th century (*Sommer 1997*). It is a single-nave church with a polygonal presbytery, sacristy, and a western front tower. The nave is not vaulted. The chancel is divided into a rectangular choir bay, with a pointed barrel vault, and a ribbed vault towards the polygon itself. The choir vault, described in detail by *Sommer* (*1997*), is very steep and placed on the more rustic architectural elements of basic and ordinary shapes. The top of the vault overhangs the crown of the perimeter wall of the choir.

The ceramic vessels set into the vault of All Saints Church in Kovářov were first published in a short study by *Sommer* (*1997*); quite rightly, he labelled them as a *system* of acoustic vessels, alluding to the fundamental difference in their number and arrangement in contrast to Myšenec. Compared to the vessels in Myšenec, the vessels in Kovářov are smaller in size, thin-walled, made of a single piece, and seem to be an example of a much higher quality pottery production than in Myšenec. In the set from Kovářov, vessels are similar in shape but vary in size and proportion (*Fig. 8*, see *Adámek – Sommer 1997*, 11).

Enzyme-linked immunosorbent analysis

There are several analytical approaches for the detection of food residues (lipids) in ceramics, but in this case, only the detection of proteins proceeded. This method of sampling was already described in detail by the co-author of this study (*Pavelka 2020*). Microsamples were taken from three vessels for each site. The easily accessible inner surfaces of the vessels were chosen, where the highest concentration of food residues could also be expected. However, it has to be mentioned that the surface layers are almost always heavily contaminated – possible recent contaminations usually represent human keratin from the skin. Nevertheless, it can be easily excluded from the results. The sampling spot was first cleaned by fine grinding of the surface dirt with sandpaper. Using a scalpel, approximately 0.3–0.5 g of the sample (in an area of c. 2 cm^2) was then collected in a plastic resealable tube as dust particles and each sample was assigned a unique registration number.

Methodologically and methodically, the presented research followed the previous works given for Czech environment, mainly by the studies of the co-author of this paper

(*Pavelka – Vařeka 2008*; *Pavelka – Orna 2011*; *Pavelka et al. 2016*; *Kučera et al. 2018*; *Pavelka et al. 2020*). A competitive enzyme-linked immunosorbent assay (ELISA) was used to analyse the collected samples. Tests were made using Veratox® for Gliadin R5 (see *Lupo et al. 2013*) and Veratox® for Casein (Neogen company). The manufacturer recommends a concentration for gliadin detection of 2 g of sample per 20 ml of extraction solution (60% ethanol), which for small amounts is 2 mg per 200 µl (and then diluted 1:50 with PBS solution before use), or 0.25 g per 10 ml of solution (2.5 ml PBS, then 7.5 ml 80% ethanol) corresponding to 2.5 mg per 100 µl (and dilute in PBS in a ratio of 1:12.5 before use). In the case of casein, it is recommended dissolving 5 g in 125 ml of PBS, which corresponds to 5 mg in 125 µl of PBS (Neogen company manufacturer's instructions). We used approximately 2 mg of the crushed and ground sample for the analyses, mixed with 150 µl of extraction buffer (allergen extraction buffer without additive, concentration 1:10), mixed vigorously using a vortex and then heated to 60 °C for one hour. After incubation, the sample was cooled to room temperature and centrifuged for 2 s at low speed (1000 RPM). Then, 100 µl of supernatant was used for the ELISA competitive test. In both cases, specific LG-biotin was added to the extract solution as the secondary antibody. Samples were compared with positive and negative controls. The intensity of the reaction is indicated by the intensity of the colour, which is then measured using a spectrophotometer. The samples were measured using an ELISA reader VERSAmax™ (Molecular Devices, San Jose, CA, USA) at 450 nm (see *Pavelka et al. 2011*; *Kučera et al. 2018*). For gliadin, the quantification range is 2.5–40 ppm. For casein, the quantification range is 2.5–15 ppm. Below 2.5 ppm, neither gliadin nor casein can be detected (Neogen company manufacturer's instructions). The tests were repeated twice for control.

It should be noted that the LC-MS/MS or MALDI-TOF methods are currently more preferred over antibody-based protein detection, especially for ancient proteins. In the past, antibodies to ancient proteins have not been very successful. However, this was because antibodies developed for recent native proteins were used, so they reacted poorly to degraded ancient proteins. Therefore, after a number of experiments, we use antibodies developed for degraded proteins. These were created for cooked foods, so some work well for ancient proteins from ceramics. Mass spectrometry and antibody detection are complementary and often confirm each other (see *Pavelka et al. 2016*; *Kučera et al. 2018*; *Pavelka et al. 2020*). Mass spectrometry captures a wide range of proteins, but identification of, e.g. milk to species is so far handled less well or not at all. Because the method is well validated using the antibodies detected, it was used in this study. For larger studies, we plan to use both methods simultaneously.

Results

From the six tested samples, only two were positive, one for each site (*Tab. 1*; *Fig. 2 and 3*). In the case of Kovářov, we managed to detect a relatively strong signal for gliadin, which points to the presence of grain in one of the vessels. In Myšenec, casein residues were found again in only one vessel, proving the presence of mammalian milk (we did not attempt to determine the species).

It should be emphasised that the samples from both sites were taken from an area of the vessel body close to the bottom. The specific attic temperature conditions may have caused

	Sample number	Casein (milk)	Gliadin (grain)
Myšenec *Church of St. Gall*	1	0	0
	2	+	0
	3	0	0
Kovářov *All Saints Church*	1	0	++
	2	0	0
	3	0	0

Tab. 1. Results of immunological analysis of samples from medieval acoustic vessels. 0 – negative result; ++ – positive result; + – weakly positive result.

the absence of other positive results. High temperatures in the summer in the attic do not favour the preservation of proteins, so testing was only performed when there was a chance of obtaining results. For further testing, it would be appropriate to try to find lipids in the ceramics and analyse their origin.

The way the body and the neck of the vessels were connected in Myšenec suggests that they were not made for sale or had any aesthetic appeal. Indeed, as earlier research suggested (*Varhaník – Zavřel 1989*), they seem to have been made specifically for construction purposes as customised pottery. Although the circumstances are somewhat unclear, it seems they were installed without a deeper knowledge of using such a system. As one of the examined vessels provided a weak casein signal, at least one of them was occasionally used for storage or at least came in intense contact with mammalian milk. It is, therefore, a question as to whether these vessels were custom-made and unexpectedly used for storing milk during construction or household vessels of questionable quality. The atypical method applied during their manufacturing indicates custom-made production, which at first glance is inconsistent with the weak traces of milk. A third possibility to explain this deadlock situation is a technological process whereby the porous ceramic was filled with milk to reduce its porosity (*Čiperová 2015*, 35; *Čiperová et al. 2015*; *Hlásek – Pavelka 2016*).

In Kovářov, traces of gliadin were found in one of the three sampled vessels (out of a total of eleven). It can be assumed that this vessel was used for storing an unspecified liquid grain product. Given the vessel's shape, it can be cautiously assumed that it was a beverage, likely an ale or some sort of grain brew. The technological nature and various sizes of these vessels combined with the presence of gliadin in one of them seem to be the convincing arguments for a broadly documented working process, whereby the Kovářov vessels were bought ready-made, primarily used, and then recycled. Even vessels used on the building site might be embedded in the vault.

Discussion

In this section, we discuss two topics. In the first part we focus on the custom of recycling of household pottery, proven above, and present the foreign context for it. In the second part, we relativise the established assumption that ceramic vessels served without exception as resonators, and present clues that may speak in favour of vessels perforated immediately after their embedding to serve as ventilation vents or grommets.

Site	Patrocinium	Placement	Number	Chronology
Červená nad Vltavou	St. Bartholomew	choir vault	-	13th century
Dobrš	Annunciation of the Virgin Mary	choir vault	1	14th century
Cheb	Minorite Monastery Church	choir vault	8	13th century
Jílové u Prahy	St. Adalbert	choir vault	3	14th century
Kovářov	All Saints	choir vault	11	13th century
Myšenec	St. Gall	choir vault	4	13th century
Ostrov u Davle	monastery church	perimeter wall	1	12th century
Pošná	St. Bartholomew	choir vault	8	13th century
Prague	Rotunda of the Holy Cross	perimeter wall	2	12th century
Rychnov nad Kněžnou	St. Gall	choir vault	20	14th century
Vitice	St. Simon and Jude	choir vault	-	14th century
Vrchotovy Janovice	St. Martin	choir vault	4	14th century

Tab. 2. Alphabetical list of acoustic vessels recorded in the Czech Republic until 2024.

Previous local research on acoustic vessels in the Czech Republic

A pair of ceramic vessels built into the perimeter wall of the nave and apse of the Rotunda of the Holy Cross in Prague was already recorded by J. E. Vocel in 1865 (see *Dragoun 1994*). A study by *Petr* (*1957*) on the vessels in the vault of the square presbytery of the Church of St. Bartholomew in Pošná can be considered as the beginning of systematic research, which was followed by the essays on the Ostrov Monastery (*Špaček 1963*), the Church of St. Gall in Myšenec (*Varhaník – Zavřel 1989*), the Church of the Annunciation to the Virgin Mary in Dobrš (*Fröhlich 1990*), the Rotunda of the Holy Cross in Prague (*Dragoun 1994*), the Church of St. Adalbert in Jílové u Prahy (*Jesenský 1995*), the church of the Minorite monastery in Cheb (*Varhaník 1997*), and All Saints Church in Kovářov (*Sommer 1997*). Along with these, vessels of this type were documented in Vrchotovy Janovice, and, according to historical photo documentation, in the vault of the choir of the Church of St. Bartholomew in Červená nad Vltavou (*Varhaník 1997*; *1998*). Recently, ceramic vessels embedded in the vault were documented in the Church of St. Gall in Rychnov nad Kněžnou (*Prix et al. 2020*; *Bláha – Slavík 2022*) and most recently in the Church of Saints Simon and Jude in Vitice, identified by Jan Kypta and Jan Veselý (pers. comm.). Above all, a brief summary of local research and an exemplary documentation of vessels from Rychnov nad Kněžnou have been presented by *Bláha* and *Slavík* (*2022*). The nature of the ceramic vessels found during the archaeological excavation in Kladruby Monastery is still unclear, although their context may suggest that they are acoustic jars (*Nováček et al. 2010*, 100). To date we are aware of 12 examples of embedded ceramic vessels, not including a questionable example from Kladruby (*Tab. 2*).

Almost in all cases, the vessels had been partially destroyed. In the Ostrov Monastery, the bottomless vessel was excavated. On the other hand, there are two vessels with a bottom preserved, posted beneath the vault surface in Kovářov. In the Rotunda of the Holy Cross, the mass of a perimeter wall protects the vessels. A few vessels are fully preserved in Rychnov and Kněžnou. Based on the paper by *Petr* (*1957*), we can assume that vessels were still fully preserved in the vault of the Church of St. Bartholomew in Pošná in 1957.

Unfortunately, in the 1990s, the vault was almost completely covered with concrete. We did not find any photographic or written documentation from before this inappropriate intervention, which destroyed possibly the most intact and fully preserved vessels in the Czech Republic.

The earliest local systematic research on ceramic vessels in churches already proposed three basic functions for them primarily based on foreign examples (*Petr 1957*; *Špaček 1963*). According to the collected opinions, the vessels could either lighten the vault, protect the interior from moisture, or improve the interior's acoustics (also *Desarnaulds – Loerincik 2001*, 69).

Concerning the first function, it should be mentioned that using ceramic vessels as the sole or filling component for vault construction is a well-known technological practice (see *Lancaster 2009*; *Caroscio 2010*; *Volfová 2018*), but it differs significantly from the way these examples were used in the investigated buildings and therefore is irrelevant to this paper. As for the acoustic and ventilation benefits of the pots, it is critical to point out that they could have served as resonators only if they were not blinded (plastered) from the interior and their bottoms were intact on the attic side. Conversely, they could improve air circulation without plastering on the interior wall but with opened bottoms towards the attic space, i.e. in a modified form. And while the ventilation and acoustic interpretations need not be mutually exclusive, the Czech research community has widely accepted the latter option and identified ceramic vessels as acoustic jars. Local scholars have expressed various opinions on the origins of these vessels. Z. Dragoun assumed that in the case of the examples dated from the 13th century they were made as custom-made pottery, while for the Rotunda of the Holy Cross from the 12th century, he posited the secondary use of vessels (*Dragoun 1994*, 118). Thus, if we accept that their primary use was intended for acoustic purposes, it could have been motivated by a concern that the acoustic qualities of the building (still under construction) would be inadequate or a master builder wanted to add and present some trend they had heard about. *Špaček* (*1963*, 139–140) commented on the use of either recycled or custom-made vessels. *Jesenský* (*1995*, 53–54) suggested, in connection with the research on the Church of St. Adalbert in Jílové u Prahy, that the vessels were installed in response to the non-axial junction of the nave and presbytery, which could have had a negative effect on the acoustics. We also know this kind of uneven junction between the nave and presbytery from both Myšenec and Kovářov. In the case of Myšenec, the rustic manner of processing the vessels, the local origin of the temper and the variable thickness of the walls point towards the interpretation that the pots were neither the product of a specialised workshop nor an import (*Varhaník – Zavřel 1989*) and were made from local material. In contrast, J. Sommer interpreted the vessels from All Saints Church in Kovářov as special, directly commissioned customised orders. Also, L. Čapek commented on the intention of the secondary use of household pottery and its recycling, and he included these examples under the term *cultural remains* (*Čapek 2010*, 21), mentioning both the vaults of pottery kilns (see *Volfová 2018*) and acoustic vessels.

Food storage as the primary function of acoustic vessels in Europe

According to R. G. Arns and B. E. Crawford, in 41 out of 52 cases of vessels that appear to be acoustic '…utilitarian pottery produced in the area at the time of the construction of the structure…' was used and the rest '…made for the specific purpose; either the shape or details of construction make it clear that they [vessels] were made for installation in the church walls.' (*Arns – Crawford 1995*, 114). Gordon Hills mentioned four vases built into the 15th-century wall of a church in East Harling, Norfolk (see *Yates 1897* and *Arns – Crawford 1995*). These were identified as burial urns from 4th or 5th century AD, meaning that the vessels had been used secondarily. Other acoustic vessels were found in Mancroft (1850) and Mountergate (1860), both in Norwich, and were described by G. C. Yates in 1897 (*Yates 1897*). The construction solution is the same in principle for both, in Mancroft doubled in plan. Here, the vessels were found without any supplements added. On the other hand, the vessels from Mountergate were furnished with handles. This does not mean these vessels were actually used as food containers, but they were initially made for that purpose. According to P. Carvalho and colleagues, 'René Floriot noted that the pottery used in the churches was common and of all types, and did not correspond to any specific production intended for this use.' The authors also pointed out that 'the vessels are ceramics for domestic use' and 'the two examples studied show traces of use in a fire' (*Carvalho et al. 2009*, 10, translated; see illustration n. 2 of a *vase d'église de Fiquefleur-Equainville* with a handle, see also *Desarnaulds – Loerincik 2001*, 68). Another built-in vase with a spout and a handle was already mentioned by Floriot in Villeneuve les Avignon (*Floriot 1964*, cited by *Tallon 2016*) and recalled by Andrew Tallon in his study about the 19th century *caveau phonocamptique* of Noyon Cathedral (*Tallon 2016*, fig. 12). As in the previous cases, Tallon mentioned that 'as in the chamber at Noyon, common household pots, often with pouring spouts, were standard' (*Tallon 2016*, 269). In summary, we can say that both customised and household vessels were commonly used. In the latter case, we can distinguish whether they were directly used before their secondary use or if they were just made for storage purposes but never served as such. Food remnants could be another clue of their household use if the tangible attributes are not visible were never there actually there (or if the shape of the vessel itself offers no clues).

Irregular placement and the number of vessels as possible indicators of secondary use

In Vrchotovy Janovice, we can see three vessels at the very top of the choir vault and one at the top of a vault of a polygonal presbytery. The latter was squeezed between the rib and the ridge rib, near the keystone. Aside from the fact that this particular placement is random, we can distinguish similar but still variable sizes of the vessels that were used. This kind of irregular placement of ceramic vessels, including in Myšenec and Vrchotovy Janovice, leads us to the question: why doesn't the number of vessels match the number of webs in the vault? It may appear reasonable if the number of vessels installed was limited by how many were on hand at the building site for storing purposes. In that case, the vessels would not have been ordered according to the number of planned vaults as a custom order but were installed in the number that was available. This would perhaps explain why three of the four were put into the choir area and one into the presbytery in Vrchotovy Janovice. The number of available household vessels could directly determine all of these awkward and irregular placements. At least we can say that financial limits were not the reason for installing three vessels instead of four.

Compared to foreign examples, the number of vessels in the Czech Republic is average or below average, which may be due, among other things, to the size of the built spaces.

Fig. 9. Church of Saint Mary in Kamień Pomorski, vault (photo by M. Kubínová).

For example, the survey by *Desarnaulds* and *Loerincik* (*2001*) recorded at least five vessels (Villette), with an average of 20. According to *Arns* and *Crawford* (*1995*, 114), the minimum was three, the maximum 113, with an average of 22. We also know of lower numbers of vessels preserved in Serbia (*Đorđević et al. 2017*, 112–117). For the Czech examples, the number varies and not always in direct proportion to the size of the vaults or the presbytery. In the case of vessels embedded in vaults, their number rarely exceeded 10. Of the sites where the original number could be reconstructed,[1] the minimum was one (Dobrš), the maximum 20 (Rychnov nad Kněžnou), with an average of six. However, it must be pointed out that such statistics are in a way irrelevant if we consider that we can see just an incomplete system and some of the recorded systems served to improve acoustics, but others only as air circulation systems or grommets for hanging chandeliers, etc.

On the island of Gotland, for example, only three vessels were recorded by *Lagerlöf* and *Svahnström* (*1991*) in Akebäck Church, set in a row at the top of the barrel choir vault. However, the similarly designed church at Ganthem has a single vessel, as does the younger church at Stenkumla. Eleven vessels were also described in Dalby Church, Skåne. *Brycki* (*2018*) analysed the reverberation time and compared the acoustic conditions of Dalby Church in the 15th century and today. As a result, he summarised that the number of vessels is too small to improve the acoustics. According to Brycki, we should consider another possible function of the so-called acoustic vessels. As an alternative, he proposes the use of holes for anchoring scaffolding or structures related to the construction of the vault (see also *Sommer 1998*, 83). For example, the regular pattern of rectangular holes in

[1] The authors are not aware of the number of vessels in Červená nad Vltavou and Vitice. In the former case, photographic documentation is insufficient, thus we cannot specify the exact number of vessels. *Varhaník* (*1998*, 299) compared this situation with Pošná example, so we can only hypothetically assume that there were 8 vessels in Červená nad Vltavou. However, other local examples teach us that a regular system may not have been applied.

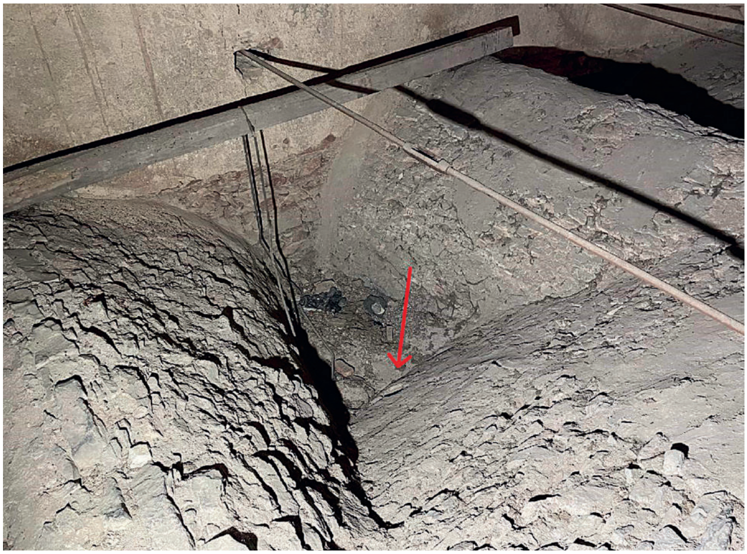

Fig. 10. Church of Saint Adalbert in Jílové u Prahy, vault of choir with a vessel marked by an arrow (photo by F. Facincani).

the vault webs of St. Mary's Chapel in St. Nicholas Church in Stockholm (Storkyrkan) is interpreted in the same way. We also know a similar situation from St. Mary's Cathedral in Kamień Pomorski (*Fig. 9*). Here, rectangular holes set in the same position are emphasised by painted faces with open mouths and a yelling expression. This decoration itself may indicate an awareness of the acoustic role of the holes. However, the setting of the ceramic vessels in this church precludes their rectangular shape.

An interesting example is an interpretation of seven, also rectangular, holes in a vault of St. Catherine's Rotunda in Znojmo (11th century). They were interpreted as functional openings used for fixing the wooden structure during lantern construction (*Konečný 2005*, 32). However, *Sommer* (*1998*, 81; see also *Konečný 2005*, 35) pointed out that their plastering had a bad effect on the interior mural paintings, due to the increasing humidity. These cases illustrate very well the understandable lack of clarity in any interpretation.

Ceramic vessels as ventilation vents – Jílové u Prahy as a key case?

Three ceramic vessels were found in the choir vault of the Church of St. Adalbert in Jílové u Prahy and published by Vít Jesenský in 1995. As previous research suggested, their bottoms were probably destroyed during some later reconstruction of the roof truss (*Jesenský 1995*, 52). However, the bottoms of the vessels are broken off quite regularly and their rims are evenly aligned with the surface of the vault. No remains of broken sherds were preserved in the rubble or inside the vessels. This situation raises the question of whether it is really the result of the vessels being accidentally stepped through during the more recent reconstruction. At the same time, the vaults in Jílové are extremely steep (*Fig. 10*) and it is very difficult to get directly to the vessels, not to mention how difficult it would be to step through such a vessel and how likely it was that they would be destroyed all at once. These indications suggest that the vessels were not broken accidentally, but on purpose and as soon as the mortar set. On the other hand, *Vít Jesenský* (*1995*) considers the secondary breakage to be a misunderstanding of the acoustic role and an attempt to use the newly created openings as ventilation vents. Both options are naturally possible. When we accept the ventilation function, it is also important to record empty vault webs, i.e. missing vessels in an otherwise regular pattern. The course of original service footbridges above the vault and in the attic should be considered. In Jílové u Prahy and in Cheb, the vessels were installed in all vault webs except those over which the service footbridges lead. It is probable that such movement structures were also placed here in the Middle Ages. Omitting the vessel under the footbridge would then have prevented dirt from falling into the interior of the church.

Such a ventilation purpose was already suggested by several scholars such as Jacopo Morelli (*Morelli 1800*, 40–41, see also *Petr 1957*) and Werner Stöckli (see *Desarnaulds – Loerincik 2001*, 69) in the case of embedded ceramic vessels. Stöckli rightly pointed out that a ventilation vent makes sense in a lower part of the vault. The ideal example he was calling for is the situation in Pošná; however, here the vessels were not perforated, which is necessary for a vent.

Whether or not, we must always keep in mind the difference between the ideal situation represented either by the number or the distribution of vessels, and their actual impact. As indicated above, the fact that the vessels could not improve the acoustics does not mean that they were not installed for that purpose. The question of their placement and acoustic or ventilation purposes should be viewed in the same way. It is necessary to study their number, the preservation of the bottom, and their location or position in relation to the design of the vault.

Conclusion

With the present state of knowledge, the so-called acoustic vessels documented in the Czech Republic were all recorded inside sacred architecture. The question is whether this is a consequence of their function, which could have been directly related to the liturgical role of sacred spaces, or whether it is because medieval sacred architecture is generally much better preserved than profane buildings. In the case of the two oldest Czech examples (Ostrov Monastery; Rotunda of the Holy Cross, Prague), vessels were built into the perimeter wall, not the vault. The remaining examples are recorded in the vaults of presbyteries, and thus either in the vault of a square choir, in a polygonal presbytery itself, or both. In the examples observed, it is possible to see a completely regular arrangement, as well as a wholly irregular or incomplete one with an attempt to maintain regularity. The vast majority of the vessels were made as a single piece on a potter's wheel, but in the case of Myšenec, there are two atypical connections of the body and neck. In most vessels, the bulbous modelling of their bodies is also evident; only in the case of Pošná were the vessels of a straight pipe-like cross-section. Most of the vessels were originally or secondarily pierced at the bottom when viewed from the attic and secondarily blinded when viewed from the interior (except Pošná, for example). Based on the earlier evidence (Pošná, Kovářov, Rychnov nad Kněžnou), it must be assumed that in some cases, the vessels were intended to remain complete when viewed from the attic and open when viewed from the interior.

The random placement of the vessels leads to the logical presumption that the master builder was unfamiliar with this practice or did not know it from experience. In the words of N. Kanev, it seems that the use of acoustic vessels was, in many cases, the 'result of orally transmitted tradition, without any real knowledge of their function' (*Kanev 2020*, 400). It is thus possible to imagine that the master builder had only heard of such a phenomenon and wanted or was required to enrich the vault of the presbytery in this way.

Recording food residues or visible attributes such as handles, funnels, or exterior decoration may be evidence of recycling. However, no such surviving attributes have been identified yet in the Czech Republic. Another indicator of secondary use may also be the number of vessels used, especially when confronted with the number of vault webs within the built space. If only three vessels were fitted into a square presbytery of four webs, this speaks more to the fact that only three were available than to financial limits or other factors. In other words, the builders used what they had on hand. It is important to note that the size of the vessel had to correspond roughly to the thickness of the planned vault. This circumstance may also have triggered the need for custom production (Myšenec, perhaps). However, the varying heights of the vessels used (Pošná, Vrchotovy Janovice, Kovářov, etc.) are also another possible indicator of the secondary use of household pottery. Although the bottoms of most vessels are not preserved, their variable sizes are indicated not only by the orifice diameter but also by the size of their bodies and the varying use of mortar beds for their fixation and covering on the reverse of the vault on one building (see *Desarnaulds – Loerincik 2001*, 68, mentioning examples found in Villette; also evident in Vrchotovy Janovice). The use of acoustic vessels may not have had the same purpose in each of the studied buildings. Likewise, the role of each of the churches must be reflected. Thus, it is necessary to distinguish between using acoustic vessels in the presbytery of a mendicant monastic church and a regional church. Similarly, it must be assumed that some acoustic systems were planned from the beginning of the construction, while others were an *ad hoc* response to the specific circumstances of a particular building or an external impulse (building team change for example) – or were not acoustic systems at all.

Previous research naturally accepted all local examples as systems of acoustic vessels and in some cases, there is probably no reason to doubt this. Scholars also assumed that the bottoms of embedded vessels had originally been visible above the vault and were destroyed during some later or even recent reconstruction of the roof truss. Nevertheless, we can suggest that some of the ceramic vessels were broken immediately after embedding and served as a regular framing of the vent to circulate air (Jílové u Prahy, perhaps). The walling of the ceramic vessel was easier than the walling of a wooden log (later pulled out) or leaving the opening rough and irregular, defined only by the rubble masonry. Thus, the vessel would serve as a supporting construction, ensuring the regular shape of the opening and simplifying the mason's work.

Traces of food remnants were found at both analysed sites. A weak signal for unspecified milk was detected in one of the vessels from Myšenec, and a strong signal for grain was detected in Kovářov. The significance of these results increases if compared with the technological design of the vessels. It has already been suggested (*Varhaník – Zavřel 1989*) that the Myšenec vessels were likely custom-made, which is matched by their very rustic design, all the more striking when compared to the high quality of the building itself. The traces of milk can perhaps be explained as evidence of a process whereby the vessels were filled with milk to prevent leakage, i.e. a procedure the potter would have been familiar with and which was applied on all his production. In contrast, the quality of the vessels from Kovářov is much higher, which contrasts with the poor quality of the church vault.

This was already an indication that the vessels may have been recycled household pottery (in contrast, see *Sommer 1997*). This is confirmed for at least one vessel by the evidence of a strong grain signal, i.e. it can be assumed that this vessel was first used to store a grain-based beverage. The presented research expands the possibilities for a broader study of this technological practice and at the same time demonstrates that this phenomenon cannot be viewed in a generalising way.

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FILIP FACINCANI, Department of Art History, Faculty of Arts, Charles University, Celetná 20, CZ-116 12 Praha 1, Czech Republic; filfac@seznam.cz

JAROSLAV PAVELKA, Centre for Biology, Geosciences and Environmental Education, Faculty of Education, University of West Bohemia, Klatovská 51, CZ-306 19 Plzeň, Czech Republic; japetos@cbg.zcu.cz

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Interconnection between house and fenced area: A case study of an LBK settlement in Hostivice-Sadová, Central Bohemia

Propojení mezi domem a ohrazením: Případová studie LnK sídliště v Hostivici-Sadové ve středních Čechách

Petra Schindlerová – Jana Klementová –
Miroslav Popelka – Miroslava Šmolíková

The article aims to examine the relationship between the use of longhouses and adjacent fenced areas at the Linear Pottery culture (LBK) settlement in Hostivice-Sadová. The analysis focuses on house no. 1 and 15 and the rectangular fenced areas defined mainly by single posts that were excavated next to their eastern walls. The study includes representative pottery assemblages from settlement features and construction pits dated to the two subsequent phases in the middle stage of LBK. Formation processes and the proportion of decoration style were analysed in combination with radiocarbon dating. The article also addresses whether fenced areas were later used as refuse disposal spaces. The results show that the fills of the features in the fenced areas were deposited later than the house unit assemblages were formed. In both cases, there is no significant evidence of using fenced areas later for waste disposal. Additionally, the social and economic aspects of these houses are discussed as the construction, length, fenced areas, and concentration of finds indicate their important social and economic role within the settlement.

Linear Pottery culture – Central Bohemia – formation processes – longhouse – fenced area

Cílem článku je prozkoumat vztah mezi využíváním dlouhých domů a přilehlých ohrazených ploch na sídlišti kultury s lineární keramikou (LnK) v Hostivici-Sadové. Analýza se zaměřuje na domy č. 1 a 15 a ohrazené plochy obdélníkového tvaru vymezené převážně jednotlivými kůly, které byly odkryty při jejich východních stěnách. Studie zahrnuje reprezentativní keramické soubory ze sídlištních objektů a stavebních jam ze dvou po sobě následujících fází středního stupně LnK. V kombinaci s radiokarbonovým datováním byly analyzovány procesy formování a podíl výzdobných stylů. Článek se rovněž zabývá otázkou, zda byly ohrazené plochy později využívány jako prostory pro odkládání odpadu. Výsledky ukazují, že výplně objektů v ohrazených plochách byly uloženy později, než se formovaly soubory stavebních komplexů. V obou případech neexistují žádné výraznější doklady o pozdějším využívání ohrazených ploch k ukládání odpadu. Dále jsou diskutovány sociální a ekonomické aspekty těchto domů, neboť konstrukce, délka, ohrazení a koncentrace nálezů naznačují jejich důležitou sociální a ekonomickou roli v rámci sídliště.

kultura s lineární keramikou – střední Čechy – formativní procesy – dlouhý dům – ohrazený prostor

Introduction

Longhouses of the Linear Pottery culture (LBK, 5500/5400–4900 BC) have been extensively studied over the past decades. Their ground plans typically had an approximately north-south orientation, were comprised of five rows of postholes, and sometimes the northern boundary of houses was defined by trenches. Regardless of how well preserved they are or how long they have existed, houses are the most common structures at many LBK

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site	construction of fence	shape	fence area (m^2)	chronology of LBK (stage)	reference
Zwenkau-Hart	single/double posts	oval shape	160	late	*Riedhammer 2003*
Bad Sassendorf	single postholes	polygonal shape	3600	LBK	*Baales et al. 2015*
Bad Sassendorf	single postholes	round-shape	1000	LBK	*Baales et al. 2015*
Harta-Gátőrház	single postholes	rectangular	max 770	middle/late	*Kustár et al. 2014*
Bylany near Kutná Hora (house 41)	single/ trenches	rectangular	600	middle/late	*Pavlů 2000*, 201
Bylany near Kutná Hora (house 912)	single/double postholes	rectangular	192	final	*Soudský 1966*
Vaux-et-Borset "La Chapelle Blanche"	trenches	connected houses/line	444	late	*Riedhammer 2003*
Düren-Arnoldsweiler	trenches	-	-	early	*Hausmann – Cziesla 2014*
Rötha	single/double postholes, trenches	rectangular	300; 600	younger	*Dalidowski et al. 2016*
Praha-Krč, Společenská zahrada	trenches	connected houses, oval shape	230	late	*Vondrovský 2021*, 34–36
Targowisko 12–13 (house 8/9)	postholes	connected houses/line	160/100	late	*Czerniak 2013*
Targowisko 12–13 (house 10)	postholes	rectangular	-	late	*Czerniak 2013*
Hostivice-Sadová D1	single/double postholes	rectangular	1807	LBK	
Hostivice-Sadová D15	single/double postholes	rectangular	813	LBK	

Tab. 1. An overview of the sites with houses and fenced areas and their basic characteristics.

settlements across Central Europe. Although hundreds of finds support the considerable uniformity of Early Neolithic architecture, certain houses built using traditional ground plan concepts have special adjacent structures, originally involving a wooden enclosure or fencing. These fenced areas varied in construction, size and form (*Riedhammer 2003*; *Husmann – Cziesla 2014*; *Kustár et al. 2014*; *Baales et al. 2015*; *Dalidowski et al. 2016*). The construction of fences could consist of single or double postholes, single trenches or combinations of trenches and postholes; the differences in structure can be seen for instance at the Rötha site in Saxony (*Dalidowski et al. 2016*, 72), where all three elements were employed for the fence construction. Fences defined only by postholes next to the house are not numerous within the LBK (*Tab. 1*). The shape of enclosures varies from rectangular to circular, as is documented at the Bad Sassendorf site in North Rhine-Westphalia (*Baales et al. 2015*). Houses mostly had a single fence on one side, but this was not an absolute rule. At the Rötha site in Saxony, two different-sized areas were defined on both sides of a single house (*Dalidowski et al. 2016*, 72). A noteworthy situation is a connection between two houses. At the site of Targowisko 12–13, the houses are connected by two fences, the first connecting to the central and the second to the northern extension of the houses (*Czerniak 2013*). Two ground plans of late LBK longhouses linked by trenches and interpreted as an enclosure were also at Praha-Krč – Společenská zahrada (*Vondrovský 2021*, 317–322). Evidence of single areas that stood separate from houses is also available (Harta-Gátőrház, Hungary: *Kustár et al. 2014*). Like most houses, those with fenced areas can be dated from the early stage (*Husmann – Cziesla 2014*) to the late stage of the

LBK culture (*Riedhammer 2003*, 485). However, they are known from the post-LBK period as well (*Riedhammer 2003*; *Končelová – Květina 2015*; 440).

The functional interpretation of fenced areas has been addressed and while we do not have reliable evidence of crop cultivation or animal husbandry inside these spaces, they are mostly considered gardens (*Baales et al. 2015*), pens for keeping a herd of cattle (*Soudský 1966*, 57–58; *Riedhammer 2003*) or, in specific cases of connected buildings, a meeting place (*Czerniak 2013*; *Vondrovský 2021*, 338). Regardless of the original purposes, fenced areas signify a different socio-economical status of the houses (*Pavlů 2000*, 277). However, to be a 'garden' or 'meeting/ritual point', the fenced area should not feature obstacles like pits. In some cases, such as Bad Sassendorf (*Baales et al. 2015*), Bylany (*Soudský 1966*) or Rötha (*Dalidowski et al. 2016*, 72), there were sunken features inside. It is not clear if and how features in fenced areas related to houses and if they were contemporaneous. How do these special houses fit together in the settlement development?

The main aim of this article is to examine the contemporaneousness of the loam and settlement pits in fenced areas in relation to house occupation. This should be achieved by an analysis of formation processes, relative chronology, and radiocarbon dating in the case study of Hostivice-Sadová (Prague-West distr.), where two houses with adjacent fenced areas were excavated. Based on the results, we discuss these special houses in the context of the settlement area of the Hostivice-Sadová site and their position in Early Neolithic society in general.

Material and methods

Hostivice-Sadová site

The Neolithic settlement of Hostivice-Sadová is part of an area stretching on both banks of the Litovický Stream, which flows through the northwest edge of Prague. The site is located on the right bank of the stream on the southeastern edge of the Hostivice municipality (Prague-West distr.) at an altitude of 341–352 metres above sea level. The rescue excavation performed in 2004 was carried out by I. Pleinerová and J. Klementová from the Central Bohemian Museum in Roztoky near Prague. It covered an area of 7 ha and revealed a multiple-period site (Early and Middle Eneolithic, Early Bronze Age, and late Hallstatt period), where over 100 Neolithic settlement features concentrated in the eastern part of the excavated area were excavated (*Fig. 1*). Certain features were excavated completely, but due to the rescue nature of the campaign other features could be examined only partly (e.g. pit no. 343, 415). The settlement comprised 20 LBK northwest-southeast-oriented longhouses preserved to a greater or lesser degree. In some cases (house no. 1, 3, 9, 15), the houses featured the typical architectural construction of northern trenches and large interior posts in the southern part (*Modderman 1986*; *Coudart 1998*; *Hofmann 2013*).

Two completely preserved houses (no. 1 and 15) were selected for the analysis, as both are adjacent to a rectangular fenced area with sunken features inside. The study thus assesses seven loam pits, 14 pits in the fenced areas, and two sunken features in one house interior (*Tab. 2*). The proximity to the house sets aside feature no. 45 (*Fig. 1*; *Fig. 3*), which was classified as a common settlement pit (*Pavlů 1977*, 21). We analysed the characteristics of pottery fragments in a chronological context divided into three artificial stages.

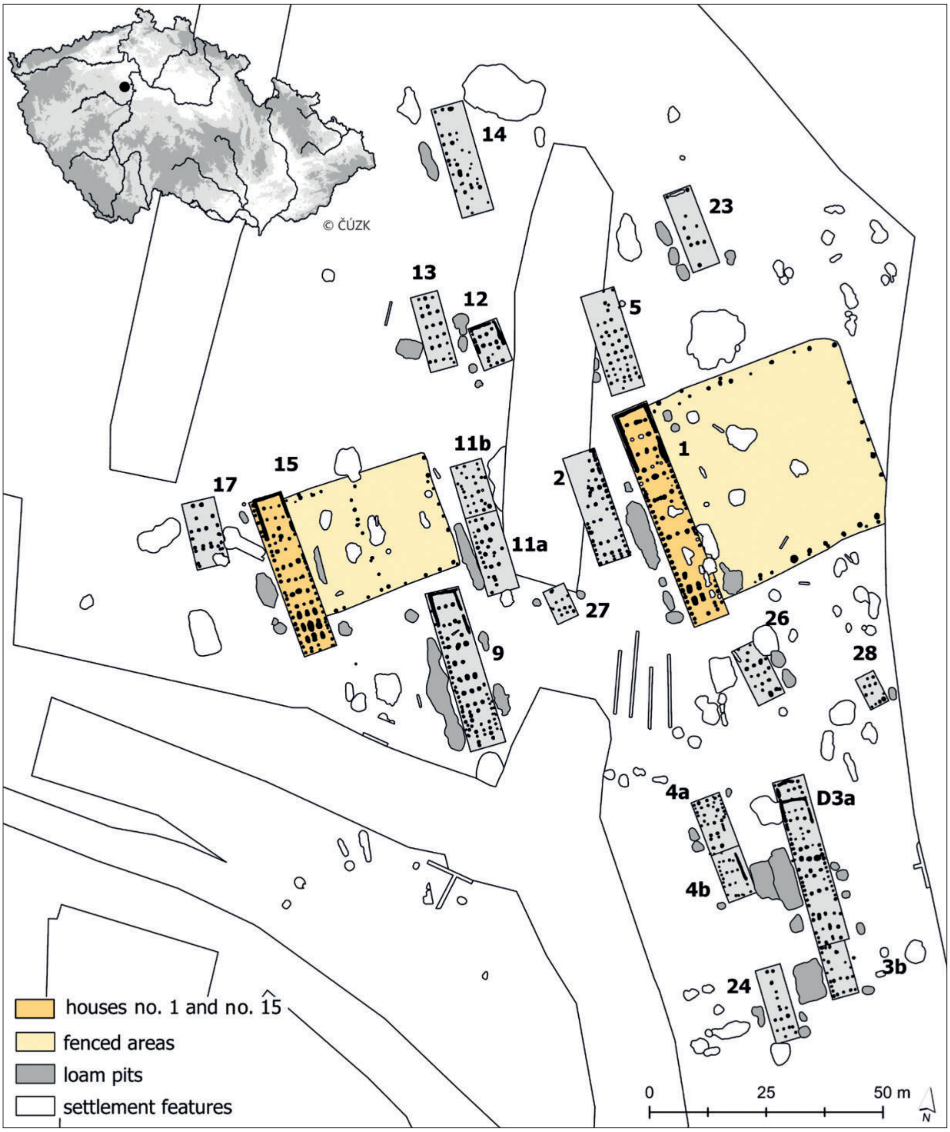

Fig. 1. Location of the Hostivice-Sadová site and overall plan of excavated Early Neolithic features. Analysed houses and fenced areas are in yellow.

This approach enables us to focus on the assemblages' characteristics and to identify potential differences. Feature no. 46 predates the house, as the eastern house wall line of posts intersects the feature. As such, the earliest stage is determined by the assemblage of feature no. 46 (*Tab. 3*; *Fig. 3*). The second stage is represented by individual loam pits adjacent to each house, which are most probably linked to the occupation of the houses (*Pavlů 1977*). It stems from the so-called house unit concept (see below). Here, the loam pits are determined by their functional relationship to longhouses and thus the assumption of a shorter

	feature charakteristics			pottery				chipped stone industry				polished and other industry			daub	animal bone
pit no.	interpretation	max depth [m]	volume [m^2]	weight [kg]	individuals	fragments	average value of the morfometric characteristic	tools with gloss	blades	other retouched tools	flakes	polished tools	hand stones	grinding stone	weight [kg]	weight [kg]
36	feature	1.2	1.70	0.04	4	6	-0.4								0.1	
37	feature	0.7	10.50	1.47	53	65	0.6					1				0.29
39	feature	1.1	1.68	0.05	5	5	-1.1								6.5	
40	feature	0.8	8.04	1.33	54	67	0.5					2		1	0.0	1.17
41	feature	0.3	0.11	0.08	3	3	0.1								0.1	
45	feature	0.5	9.68	1.06	45	65	0.5					1				0.28
46	feature	0.4	3.25	3.87	142	176	0.3				6	1	1	1	3.0	0.31
50	loam pit	1.0	19.51	3.94	146	173	0.8				1	2	1		16.3	5.54
70	interior	0.7	3.78	4.96	184	223	1.2		3	1	4	2			0.8	1.33
72	loam pit	0.4	1.63	0.00	1	1	-1.0					1			0.5	
79	interior	0.7	3.50	0.03	3	3	-0.6									
84	loam pit	1.2	61.36	2.66	113	149	0.9					1		7	34.4	0.18
91	feature	0.5	2.70	0.28	11	12	2.0									
110	feature	1.1	1.43	0.08	3	3	-0.2									
118	loam pit	0.6	3.60	0.41	26	43	1.3	1		1					0.0	0.08
207	feature	0.5	2.60	0.30	12	12	0.2							1		0.66
339	feature	0.4	1.12	0.07	5	7	0.0									
343	feature	0.6	9.06	1.72	50	74	1.1	1		1				2	0.1	0.12
345	feature	0.5	2.08	0.12	5	5	0.0							2	0.0	0.03
346	loam pit	0.5	4.44	0.56	11	16	1.6			1				1		0.07
415	loam pit	0.8	4.59	0.50	18	22	1.6							1	0.2	
430	feature	0.8	4.37	0.47	18	25	1.4	1	1	3	1			1		0.11
438	loam pit	0.4	0.29	0.11	6	6	1.4									0.08

Tab. 2. The list of the basic information about the analysed features and their assemblages.

trajectory of formation arises at least in some cases (*Bickle 2020*, 183–189; *Pilař – Květina 2023*). The fence construction itself is dated by its connection to the building and should be contemporary with the lifetime of the house. However, as the area in one case was more or less empty (*Baales et al. 2015*), we assume, in the same vein as features inside rondels are considered, an asynchronous relationship between pits inside the fenced area and loam pits (*Řídký et al. 2019*, 43–67; *Blažková 2020*; *Vondrovský 2021*, 324–327). Fills of features in the fenced area thus represent the final stage of our artificial chronological framework (*Neustupný 1996*, 496; *Dalidowski et al. 2016*, 74). The pits situated within the longhouse interiors remained unclassified and aside from the chronological framework, as the chronological relationship between these pits and the construction of buildings is generally not clear (*Soudský 1969*; *Lička 2012*; *Bickle 2013*, 155; *Květina – Hrnčíř 2013*, 326).

Pottery assemblages

Pottery sherds are the key find category in our analysis, due to their quantity and mutual comparability (*Květina 2002*, 22). The many formation processes caused the degradation of pottery fragments, and these characteristics can be measured and observed on the level of individual sherds (*Wolfram 2013*; *Vondrovský 2021*; *Pilař – Květina 2023*). In general, these processes divided waste into several general categories: the material deposited directly at the site of activities (primary waste), the assemblages which were purposely moved (secondary waste) and finally, the sherds moved as part of the cultural layer (tertiary waste) by natural processes (*e.g. Schiffer 1972*, 162; *Řídký et al. 2012*; *Kuna 2015*).

The method and speed of filling are crucial for recognising differences (*Bickle 2020*, 186), in this case, between loam pits that flank the longer wall of houses and pits within the fenced area. Although the loam pit assemblages are traditionally considered to reflect house occupation regardless of the proportion of secondary waste and when it was deposited, they should be less influenced by formation processes than assemblages from sunken features opened for a long time (*Soudský 1966*; *Stäuble 1997*, 84; *Květina – Řídký 2017*; *Pilař – Květina 2023*). Of equal importance to the formation processes is the relative chronological development of settlements, analysed based on the occurrence and the ratio of decoration styles. The chronological classification of LBK pottery has been developed over decades (*Soudský 1966*; *Pavlů 1977*; *2000*) and the current perception of the chronology is based on an attempted critical evaluation with regard to the analysis of formation processes (*Květina – Končelová 2011a*; *Vondrovský 2021*, 260; *Pilař – Květina 2023*).

The analysed values of ceramic assemblages were determined from the quantitative and qualitative attributes of pottery fragments (*Wolfram 2013*; *Vondrovský 2021*; *Pilař – Květina 2023*). The fragments were assigned to individual vessels according to the similarity of decoration or pottery material characteristics (*Vondrovský 2021*, 69–82). The density of pottery finds (kg/m^3) was calculated for individual excavated feature parts (*Květina 2010*). These are parameters related to a particular sunken feature. In contrast, formal and metric characteristics were determined for each fragment separately (*Vondrovský 2021*, 69–82). The following categories were determined: weight; the size/wall index (maximum size of the fragment and average wall thickness) expressing susceptibility to breaking (*Květina 2005*; *Květina – Končelová 2011b*, 60–61); concavity; the degree of abrasion; and the shape of the fragment. Concavity represents only a supplementary variable because it was not determined for all fragments. Only fragments with a deflection higher than 5 mm were studied (*Pilař – Květina 2023*, 27). The overall shape of the fragment was classified in terms of polygonal, triangular, and amorphous shapes. Edge abrasions were separated into five categories: unworn edge, slightly worn edge, heavily worn edge, reutilised, and amorphous edge (*Květina 2005*; *Květina – Končelová 2011b*; *Řídký et al. 2012*; *Wolfram 2013*; *Vondrovský 2021*; *Pilař – Květina 2023*).

To address potential value bias arising from the limited dataset of sunken features related to selected longhouses (*Vondrovský 2021*, 77–82), a statistical evaluation of individual morphometric parameters was carried out on fragments from all Neolithic sunken features, comprising 5,179 pottery fragments from 3,988 vessels. As with the Neolithic settlement at Společenská zahrada in Praha-Krč, we reduced data to indexes allowing interoperability of formal and metric values. Nominal values are on a five-point scale. The zero values always represent the median. Higher and lower scores were assigned to the assemblage top

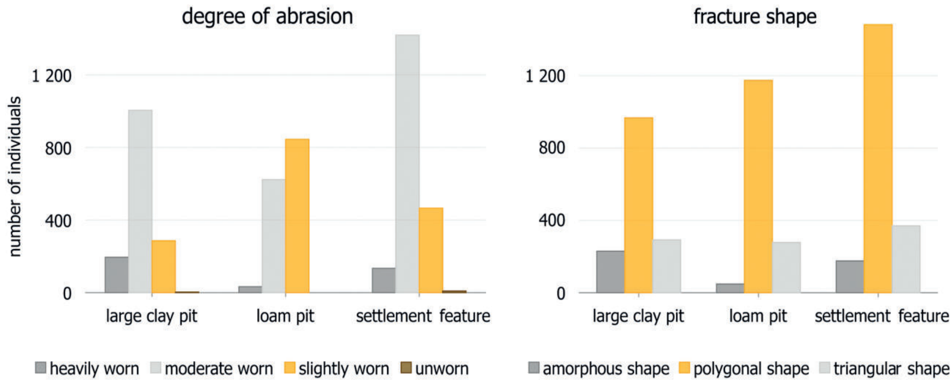

Fig. 2. Overall numbers of ceramic individuals in categories of edge abrasion and fragment shapes from Hostivice-Sadová site (degrees of abrasion: categories of unworn edge and reutilised fragments were not recorded).

and bottom decile (*Vondrovský 2021*, 77–82). For descriptive categories, the zero value determines the most frequently represented type (*Fig. 2*). However, the shape parameter requires reduction, as one category dominates all functionally defined pits (*Vondrovský 2021*, 80). The result is the sum of the individual index values determined for each pottery fragment. The resulting values are determined to be significantly positive (above the third quartile) or significantly negative (below the first quartile). Other values are classified as irrelevant.

The analysed house units and pits in fenced areas comprise 1,161 fragments from 918 vessels. The data were statistically evaluated using the PAST software. The differences in ceramic density and refitting variability were tested using a non-parametric test (Kruskal-Wallis test with post-hoc). The values considered together were only for the analysis of variance due to the minimal frequency of features for the oldest and interior stages.

The relative chronological development was determined according to the style of linear ornamentation on pottery and the quantitative proportions of individual styles previously described for the LBK in Bohemia (*Soudský 1966*; *Pavlů 1977*; *Pavlů et al. 1987*; *Květina – Pavlů 2007*; *Pavlů – Zápotocká 2013*, Fig. 6). However, the most frequent style is a simple incised line (delta12), which is not chronologically significant. The main problem lies in its determination because the simple line could originally be part of another style, which remained unrecognised due to fragmentation. This uncertainty can distort chronological sequences (*Pilař – Květina 2023*). The relative chronology framework is based on balancing sequence accuracy (stage/phase) and formation processes (*Vondrovský 2021*, 260). The reliability factor played a pivotal role in the chronological assessment. This was achieved by implementing formation processes to eliminate fragments with a significantly negative score or featuring irrelevant decoration. Essentially, the morphometric parameters are used in this case study to determine the reliability of assemblages and eliminate those formed by long-term processes characterised by low values. Principally, the relative chronology is based only on significantly positive morphometric parameters. As decorated fragments do not occur frequently in all assemblages, the minimum number of individuals was limited to six.

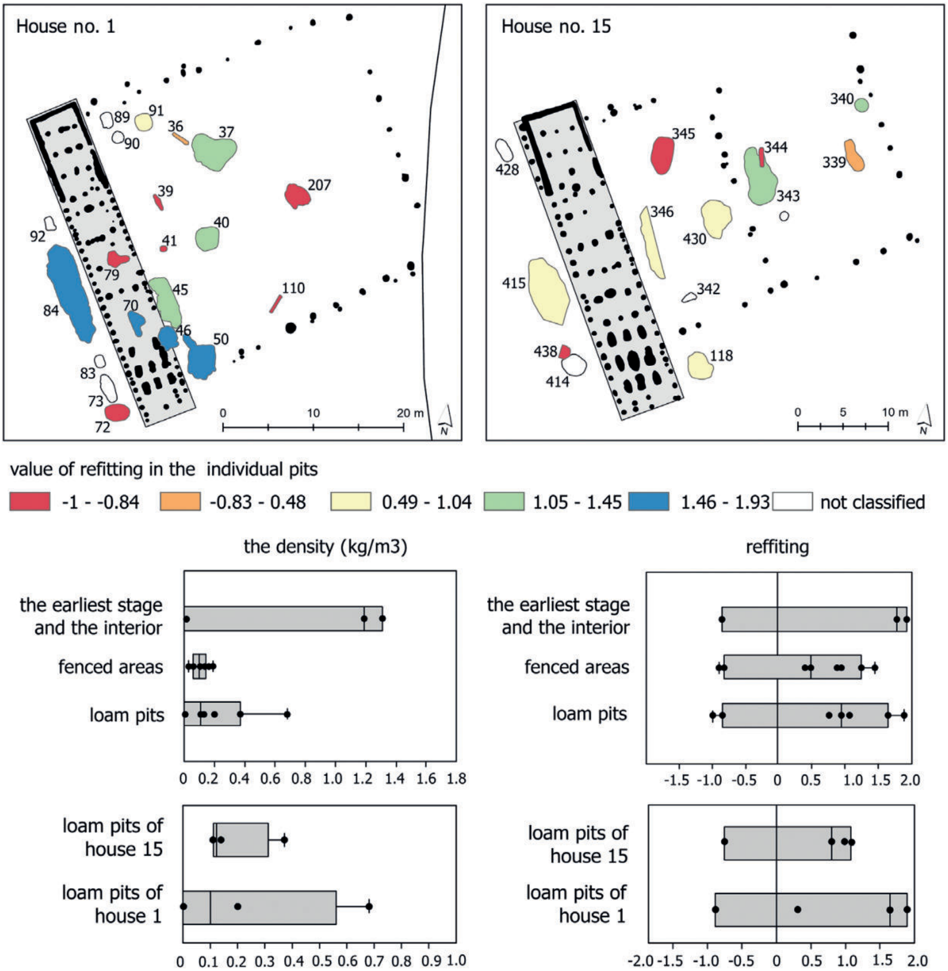

Fig. 3. The refitting value in the individual loam pits and features in the fenced areas of both houses. A box plot and jitter showing the refitting and density values and specific position of the ceramic assemblage at three defined artificial stages and houses.

The concept of the house unit referred to in this study assumes chronological homogeneity of individual loam pits distributed alongside the longhouses (*Soudský 1962*; *Pavlů 1977*; *Allard et al. 2013*). However, the differences in the formation processes of individual loam pits belonging to the same house unit (*Pilař – Květina 2023*) lead us to analyse the house units as individual loam pits and then evaluate their mutual chronological homogeneity. Variance of decorative styles in the multiple loam pits belonging to the same house unit should be further validated. Heterogeneity could be caused by the unrecognised overlapping of pits. Thus, the validation is based on field situations and the distance between houses along with the overall taphonomic trajectory of fills, an approach designed to achieve the highest accuracy. However, sometimes there are not enough significant finds in a single excavated pit to assess the situation reliably. In these cases, we retain the concept of

artificial stage	description	house 1	house 15
1st stage	the earliest feature	feature no. 46	-
2nd stage	house with loam pits and fence construction	loam pit no. 41, 50, 72, 73/74, 83, 84, 89, 90, 92	loam pit no. 118, 342, 346, 414, 415, 428, 438, 439
3rd stage	fenced area infills	feature no. 36, 37, 39, 40, 45, 91, 110, 207	feature no. 339, 343, 345, 430
unclassified stage	interior of the house	feature no. 70, 79	-

Tab. 3. Defined artificial stages and their settlement features.

the house unit as a supplementary approach, which makes it possible to analyse a greater number of house units, albeit with reduced accuracy.

Individual decoration styles and lines beneath the rim were determined. Vessel shapes and decoration motifs are not included in the analysis due to their low diversity and determination rate. The relative chronological development of selected assemblages was analysed using Correspondence Analysis (CA), which shows relationships between categories of variables.

The resulting relative chronology development was validated with radiocarbon dating of animal and human bones excavated in pit fills. The reliability of the features and the availability of osteological material affected the sampling strategy. Samples were obtained from the loam pits of house no. 1 and 15 and the grave situated in large clay pit 343 located in a fenced area next to house no. 15 and were assessed in the context of other radiocarbon dates from the site. The dates were calibrated and modelled using the OxCal 4.4 software (*Bronk Ramsey 2009*) and the IntCal20 calibration curve (*Reimer et al. 2020*).

Results

Formal and metric characteristics

The assemblages exhibit significant fragmentation rate, as nearly 84% of the individuals (reconstructed vessels) featured only a single fragment. In only one case, a refit was observed between pit no. 46 and 70. The refitting of ceramic vessels (H=2.093, p=0.3501) and density of ceramic (H=1.079; p=0.5791) show no significant differences between loam pits and sunken features in fenced areas. Thus, this is evidence of long-term processes that affected most of the pottery fragments. A high pottery density was recorded only in pit no. 70 located in the central part of house 1. In this case, it could be evidence of an intentional relocation of a larger amount of the assemblage. In addition, there are no significant differences between the loam pits of both houses (*Fig. 3*), neither in refitting (H=0.5, p=0.4795) nor in concentration (H=1.125; p=0.2845). The homogeneity could mean that more or less similar fill processes took place at both house units.

The values of descriptive characteristics are different. As a result of the long-term processes causing the shape reduction (*Vondrovský 2021*, 80), polygonal fragments dominate all of the features. The category of abrasion is more heterogeneous. Essentially, only one fragment from the fill of pit no. 46 of the earliest artificial stage represents the category of sherds with unworn edges. The vast majority were classified as moderately worn or slightly worn. Reutilised fragments are absent in the analysed assemblages, and amorphous ones

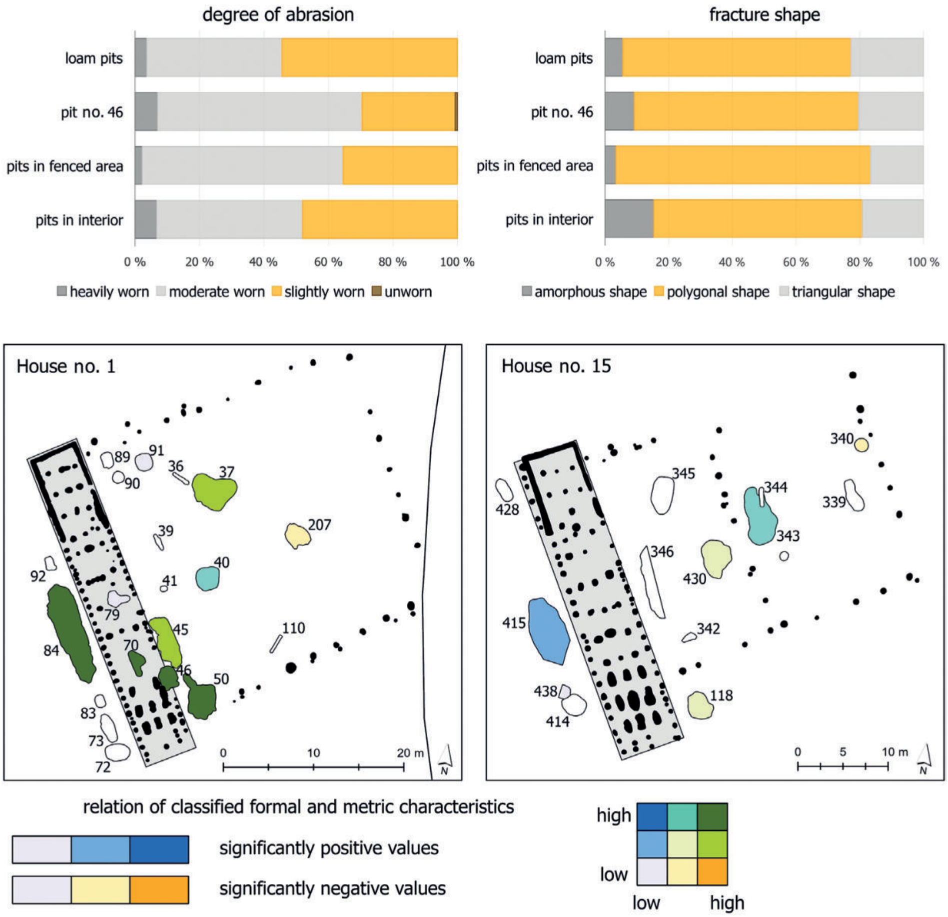

Fig. 4. The proportions of degree of abrasion and fracture shapes in the analysed features. Bivariate plot of significantly positive and negative values at individual features.

are less frequent. However, over half of the fragments from loam pits have slightly worn edges. In contrast, most fragments from the fenced area were characterised by completely worn edges (*Fig. 4*).

The results show the heterogeneity of loam pit fills and sunken features in fenced areas. Moreover, differences in formation processes can be observed between both houses. Significantly negative values are present in the pits in the fenced area of house no. 1 (*Fig. 4*), although slightly worn pottery fragments were more commonly found in the loam pits along the house. As with house unit no. 1, pieces from the loam pits of house no. 15 were less affected by formation processes than the pottery within the fenced area. Several studies have shown that the fill of individual loam pits varies significantly, especially regarding the density of pottery fragments (*Pavlů 2010*, 53–54; *Květina – Končelová 2011a*, 64; *Pilař – Květina 2023*). In addition, the western loam pit of house no. 15 contained completely worn fragments, but their size and weight correspond to positive index values.

Pit no.		46	50	84	37	40	45	70	415	118	343	430
interpretation	The average index of formal characteristics	the earliest stage	house 1	house 1	house 1 – fenced area	house 1 – fenced area	house 1 – fenced area	house 1 – interior	house 15	house 15	house 15 – fenced area	house 15 – fenced area
alfa12	2.15	21.1	22.9	20.0	55.6	36.4	10.0	46.2	50.0	55.6	-	33.3
alfa13	8.10	-	-	-	-	-	-	3.8	-	-	16.7	-
delta12	0.82	73.7	57.1	52.0	22.2	54.5	60.0	40.4	33.3	44.4	33.3	55.6
epsilon0	0.51	-	5.7	8.0	-	-	-	-	-	-	16.7	-
epsilon10	2.75	5.3	14.3	16.0	11.1	9.1	20.0	7.7	-	-	-	11.1
epsilon20	8.43	-	-	-	-	-	-	-	16.7	-	33.3	-
theta	6.53	-	-	-	11.1	-	10.0	1.9	-	-	-	-
analysed LO	3.37	19	35	25	9	11	10	52	6	9	6	9
total LO	1.60	33	62	52	27	20	22	67	6	14	9	12
lines beneath the rim	-	10.5	8.6	12.0	22.2	27.2	-	13.5	-	-	16.6	11.1
hemispherical pots	-	17	14	11	6	5	2	33	2	4	26	6
deep bowls	-	-	-	-	-	-	-	-	-	-	-	-
others	-	4	5	1	1	-	1	2	1	-	-	-

Tab. 4. The average index of metrics and formal parameters of individual decoration styles in analysed features. The quantitative proportion of significantly positive decorated fragments and vessel shapes from the analysed loam pits and the features in fenced areas.

Relative chronology

Formation processes affect the variability of individual linear decoration styles in assemblages (*Květina 2010*, 20). Many analyses refer to a more intricate formation of pottery assemblages, as evidenced by their metric parameters (*Stäuble 1997*; *Květina 2010*; *Pilař – Květina 2023*). The combination of influences affecting the determinability of decoration styles and thus their reliability is demonstrated by the average index of formal attributes.

In any case, the most frequent decoration style was a simple line (delta12). However, as a low average value of the index of formal and metric characteristics shows, it was determined on one of the most fragmented pieces of pottery (*Tab. 4*). The highest values, which are linked with the filled-in band accompanied by musical notes (alfa13) and line with musical notes in closer intervals (epsilon20), are caused by low sherd representation (*Fig. 5*). On the other hand, the differences in the average value of formal and metric characteristics

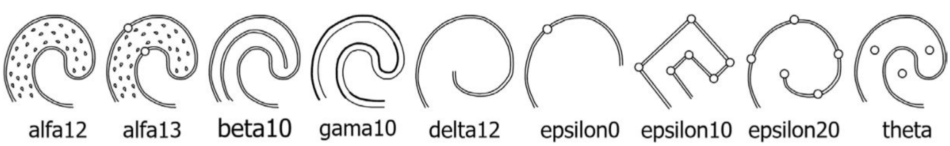

Fig. 5. An overview of the Bohemian LBK decoration styles that are mentioned in the text.

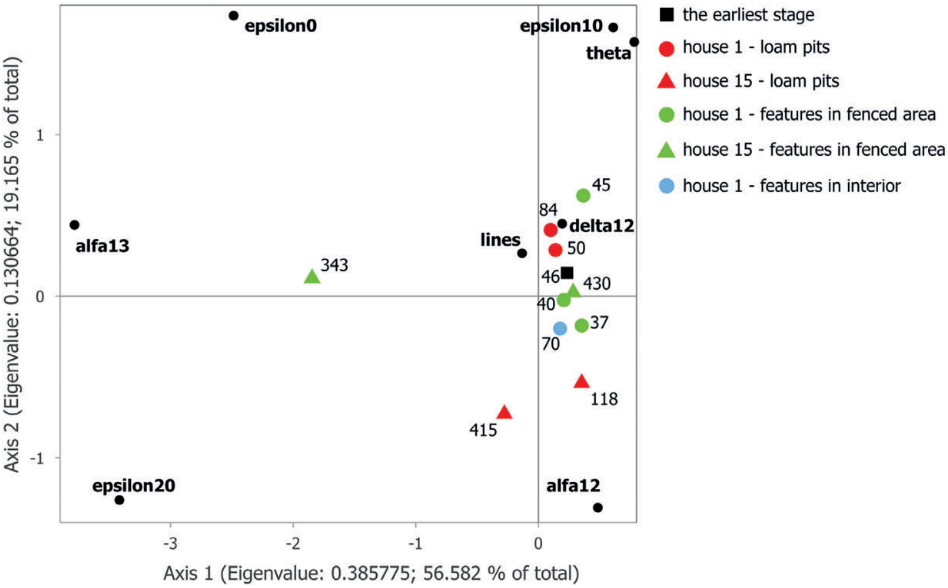

Fig. 6. Correspondence analysis of proportions of decoration styles in individual features in the fenced area and loam pits along house no. 1 and 15. Black – the earliest artificial stage; red – the second artificial stage; green – the third artificial stage; blue – the interior of the house).

are also evident for more frequent styles. As the results showed differences in the values of individual decoration styles, sherds with a long trajectory of formation processes should be eliminated to avoid distortion in the chronological assessment. After this step, only well-preserved sherds with unworn and slightly worn edges remain. Upon analysing the filtered results, it is evident that the decorated assemblages retrieved from the loam pits of house no. 15 were less impacted than those from house no. 1. The almost identical numbers substantiate this when compared to the original collection.

The correspondence analysis shows that the proportion of decoration styles in individual loam pits from both house units is more or less uniform (*Fig. 6*). As pit no. 415 was not excavated completely, we chose pit no. 118, which yielded the most decorated sherds. This makes the chronological framework more robust. In contrast to house units, the distribution of decorative styles among individual fenced area features shows a less uniform pattern. In the case of house no. 1, the fills of sunken features in the fenced area were formed significantly later than in the loam pits. This may be attributed to the high proportion of the filled-in band (alfa12) style in the assemblages from the fenced area (pit no. 37, 40) and the musical notes placed on ends of lines (epsilon10) in pit no. 45. Pottery in this pit corresponds more to the loam pits of house no. 15 than house no. 1., which displayed inconsistent differences from house no. 15 between features in the fenced area and loam pits. The assemblage from pit no. 430 contained a significantly lower portion of the filled-in band (alfa12) than the loam pits of house no. 15. In contrast, the assemblage from pit no. 343 featured fragments decorated by later styles, such as musical notes placed at closer intervals (epsilon20). However, the difference may be caused by a lower occurrence of decorated fragments.

Lab. No.	BP	pit no.	material	depth	interpretation
CRL_22_1782	**6078±30**	362	animal bone	20–40	house no. 13 – loam pit
CRL_22_1783	**6192±28**	353	animal bone	20–40	house no. 11 – loam pit
CRL_22_1784	**6355±38**	128	animal bone	40–60	house no. 3b/24 – loam pit
CRL_22_1786*	**6213±25**	118	animal bone	0–20	house no. 15 – loam pit
CRL_22_1787	**6166±27**	144	animal bone	0–20	house no. 4a – loam pit
CRL_22_2077	**6157±23**	33	animal bone	0–20	loam pit no. 23 – loam pit
CRL_22_2078	**6345±24**	29	animal bone	60–80	pit no. 29
CRL_22_2079*	**6365±46**	84	animal bone	0–20	house no. 1 – loam pit
CRL_22_2080	**6136±21**	150	animal bone	0–20	hit no. 150
CRL_22_2081	**5848±37**	273	animal bone	40–60	hit no. 273
CRL_22_2082*	**6084±20**	H20	human bone	burial at the bottom	grave H20 in pit no. 343
CRL_23_0177	**6210±27**	29	animal bone	0–20	pit no. 29
CRL_23_0178	**6223±28**	324	animal bone	0–dno	house no. 9 – loam pit
CRL_23_0469*	**6203±31**	50	animal bone – large mammal	40–60	house no. 1 – loam pit
CRL_23_0470*	**6287±35**	50	animal bone – large mammal	60–dno	house no. 1 – loam pit
CRL_23_1770	**6154±19**	273	human bone	burial	grave H18 in pit no. 273

Tab. 5. A summary of the radiocarbon samples taken at the Hostivice-Sadová site with details of find context (*samples belong to analysed houses and pits in a fenced area).

The relative chronological assessment reveals that the assemblage from pit no. 70 inside house no. 1 indicates a closer association with house no. 15 than with its original dwelling due to the proportion of the filled-in band (alfa12) and the more significant presence of lines under the rim than in the assemblages of house no. 1. However, both areas and houses could be related to the middle LBK tradition with different proportions of filled-in band (*Pavlů – Zápotocká 1979*; *Trampota – Květina 2020*).

Absolute chronology

Currently, 16 radiocarbon dates are available for the Hostivicie-Sadová site. Samples were retrieved from various contexts comprising nine loam pits related to longhouses (10 samples), three pits (4 samples), and two graves (*Tab. 5*; *Fig. 7*; *Fig. 8*). Focusing on the two analysed houses and their fenced areas, five radiocarbon dates are available (*Fig. 7*). Samples were taken from the bone remains of larger ruminants, except for grave H20, situated in feature no. 343 and buried in pit no. 273. Since there is a chance of being affected by formation processes, only the larger pieces of animal bones were selected. The human remains have been selected as the most reliable. As the human remains in grave H24 situated near the northwest corner of house no. 15 turned out to be very fragmented and with insufficient collagen yield, we could not date them.

Eastern pit no. 50 and western loam pit no. 84 met the general criteria for radiocarbon dating. In eastern pit no. 50, bones from the lower layers (40–60 cm and 60 cm – bottom) were sampled for radiocarbon dating. Western loam pit no. 84 contained animal bone only at the upper layer 0–20 cm. The minimal occurrence of animal bones in individual pits affected the sampling of house no. 15. Thus, we selected loam pit no. 118, as its animal bone

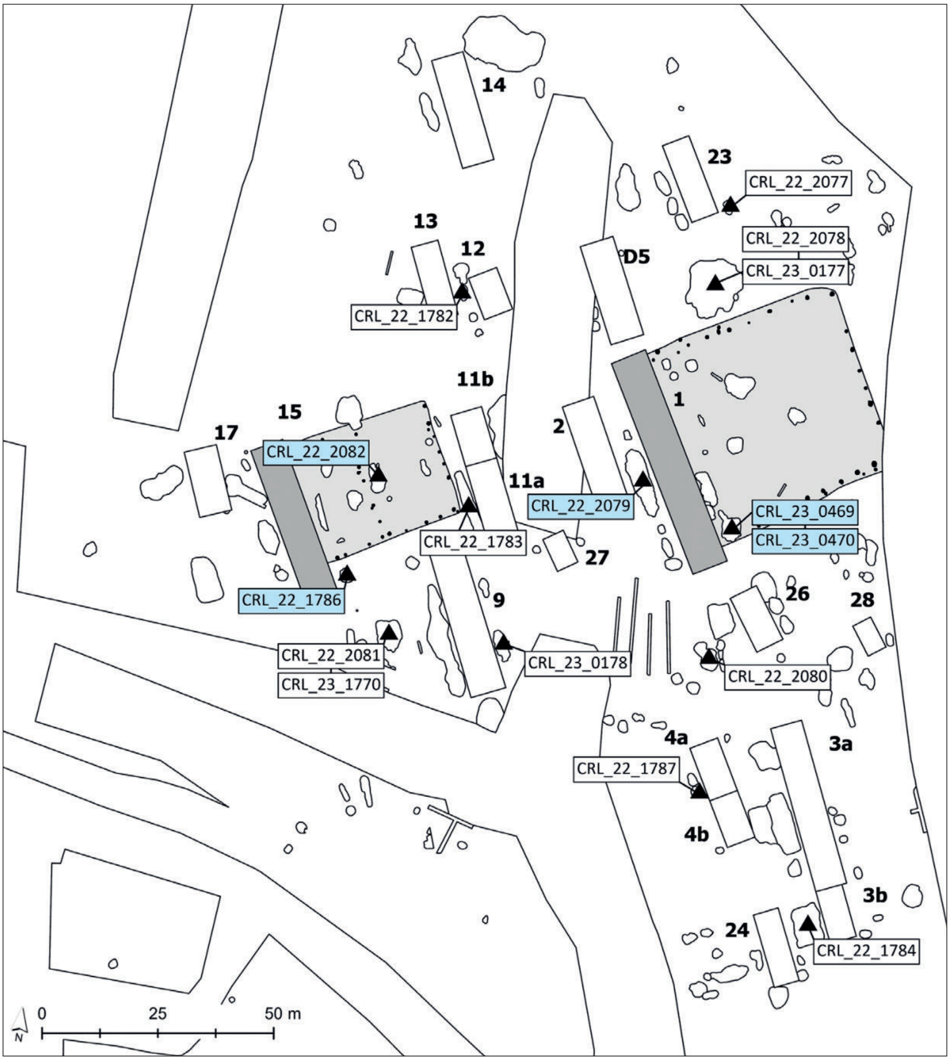

Fig. 7. The distribution of radiocarbon dates at the Hostivice-Sadová site.

assemblage was sufficient for sampling. As the features in fenced areas seem to be more significantly affected by formation processes, we selected pit no. 343 with grave H20 at the bottom layer.

The results of the consistency test, involving two samples from the eastern loam pit of house no. 1, confirmed the statistical consistency of samples (χ^2 test: df=1, T=3.2, T(5%)=3.8). The variability of the formation processes was evident in the western loam pit (χ^2 test: df=2, T=9.1, T(5%)=6.0). As the radiocarbon dating results from both pits are statistically inconsistent at the 5% significance level, sample CRL_22_2079 from the western loam pit is more likely associated with natural processes such as erosion or layer redeposition. Dates from eastern loam pit no. 50 (CRL_23_0469, CRL_23_0470) are statistically con-

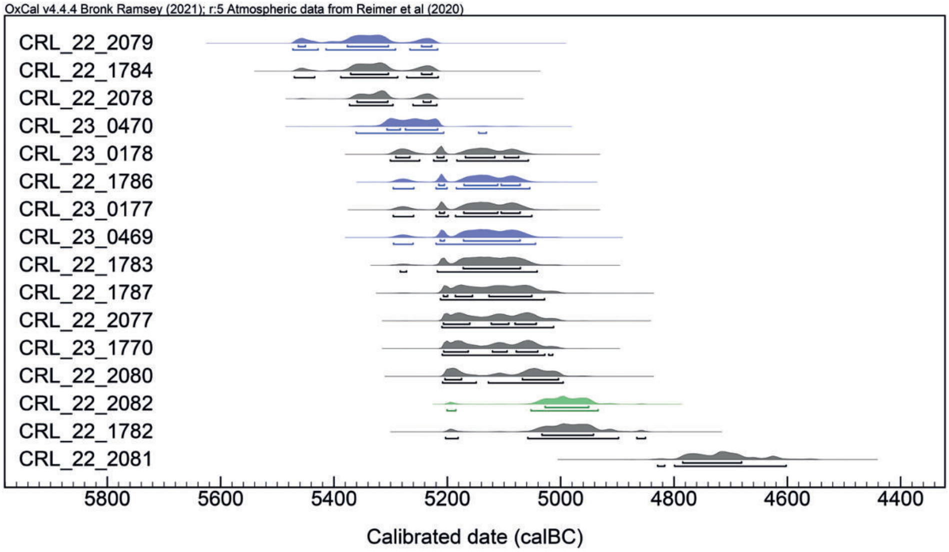

Fig. 8. Calibrated radiocarbon dates from the Hostivice-Sadová site. Blue – samples from loam pits; green – samples from the fenced area; grey – other samples from Early Neolithic contexts.

sistent; therefore, it is possible to date the start of the filling of loam pits around house no. 1 to 5305–5071 cal BC (95.4% probability) or 5300–5128 cal BC (68.3% probability).

At the 95.4% probability level, we can date the loam pit of house no. 15 (CRL_22_1786) to 5296–5055 cal BC, and with a 68.3% probability to 5216–5072 cal BC. The comparison of the dates related to the house no. 15 (CRL_22_1786) and the fenced area (CRL_22_2082) shows that they are statistically inconsistent (χ^2 test: df=1 T=16.291, T(5%)=3.8). Grave H20, situated in large clay pit no. 343, was dated to the interval 5201–4935 cal BC at a 95.4% level of probability, and with a 68.3% probability to 5028–4951 cal BC.

Overall, the radiocarbon dating results suggest continuity of the settlement. (*Fig. 8*). The entire radiocarbon sequence is in the range of 5473–4603 cal BC at a 95.4% level of probability, but the lower boundary spans within the post-LBK development in Bohemia (5000/4900–4400 BC). This is caused by the sample (CRL_22_2081), which came from animal bone from pit no. 273 and its resulting range is consistent with the late stage of Stroked Pottery culture (*Řídký et al. 2019*, Fig. 9.2). However, the second sample from sunken feature no. 273 (CRL_23_1771) associated with grave H18 yielded radiocarbon ranges that are widely apart and statistically inconsistent (χ^2 test: df=1 T=52.918, T(5%)=3.8). The pottery assemblage of feature no. 273 contained only the Early Neolithic fragments without any indication of disturbance; therefore, the risk of contamination was not expected. As the radiocarbon sample from human bone is in agreement with the current Early Neolithic chronology (*Pavlů – Zápotocká 2013*, Fig. 5) and given the taphonomic context of the samples (deliberately deposited burial, disarticulated animal bone), we consider CRL_23_1771 to reflect the pit chronology and CRL_22_2081 to be an intrusion. In view of the above, we assume that the sequence of results from the Hostivice-Sadová site is in the range of 5473–4851 cal BC at a 95.4% probability level.

Discussion

Formation processes in Neolithic houses and fenced areas

As some of the individual parameters (refitting, density of ceramics) do not show any significant differences between loam pits related to selected houses and sunken features in a fenced area, it is essential to compare them with remaining Neolithic assemblages from Hostivice-Sadová to understand the formation processes of four artificial stages better. Overall, the minimal number of reconstructable vessels suggests a lower proportion of secondary waste in all features and in the loam pits of both houses (*Schiffer 1972*, 161). As in previous studies (*Pilař – Květina 2023*), the fills of loam pits seem to be more transformed because the primary deposition of waste likely took place outside the excavation area (*Květina – Hrnčíř 2013*).

Transformation processes at the level of artificial stages were analysed through principal component analysis (PCA). In the scatterplot, three groups of assemblages are apparent (*Fig. 9*). The first group (pit no. 46 and 70) suggests a short-term filling with admixture of secondary waste. The percentages of positively classified fragments remain low, while refitting and density values demonstrate comparatively higher levels. The second group (pit no. 37, 40, 45, 91, 207, 343, 430 and loam pit no. 50, 84, 118) corresponds to the majority of Neolithic sunken features from the settlement. The third group (loam pit 346, 415) is characterised by low-influenced but less-numerous sherds. However, compared to others, the assemblages from the feature inside the building (pit no. 70) and the earliest stage (pit no. 46) were formed by a different mechanism. Although neither complete vessels nor their larger parts were found, the high refitting and density of ceramic fragments could mean that the assemblage was intentionally moved from its original deposition (*Pilař – Květina 2023*). At least in the case of the earliest stage (pit no. 46), the intentional translocation of slightly transformed fragments could have been motivated by the effort to eliminate obstacles near house no. 1 (*Stäuble 1997*). In pit no. 70, the distribution of a decoration style differs significantly from that of the earliest stage, especially by the presence of the filled-in band (alfa12), which suggests the later deposition of the assemblage (*Fig. 6*).

The differences between the two house units are apparent and also the results vary even in individual loam pits. Overall, loam pit no. 50 and 84 related to house no. 1 correspond to the predominant part of the ceramic assemblage, which includes all sunken features from the Early Neolithic settlement. Therefore, they can be related to a longer trajectory of formation processes (*Wolfram 2013*; *Pilař – Květina 2023*), which can also be inferred from inconsistent radiocarbon dating results from both loam pits. At least some components of the fill of loam pit no. 84 could have come from the redeposition of earlier cultural layers or natural processes such as erosion. However, pit no. 50 on the eastern side reveals consistent and more reliable results perhaps formed by a lower proportion of secondary waste. In contrast, the assemblages from the loam pits of house no. 15 had a shorter formation trajectory of fills and probably contained a higher proportion of secondary waste, as reflected by larger, slightly worn pottery fragments distributed with a lower density.

The assessment of the sunken feature fills within the fenced areas, the processes that formed them, and the chronology of those processes is crucial. The analysis of formation processes indicates that the assemblages deposited inside the fenced area were more heavily affected by formation processes than the assemblages of loam pits; they contained tiny,

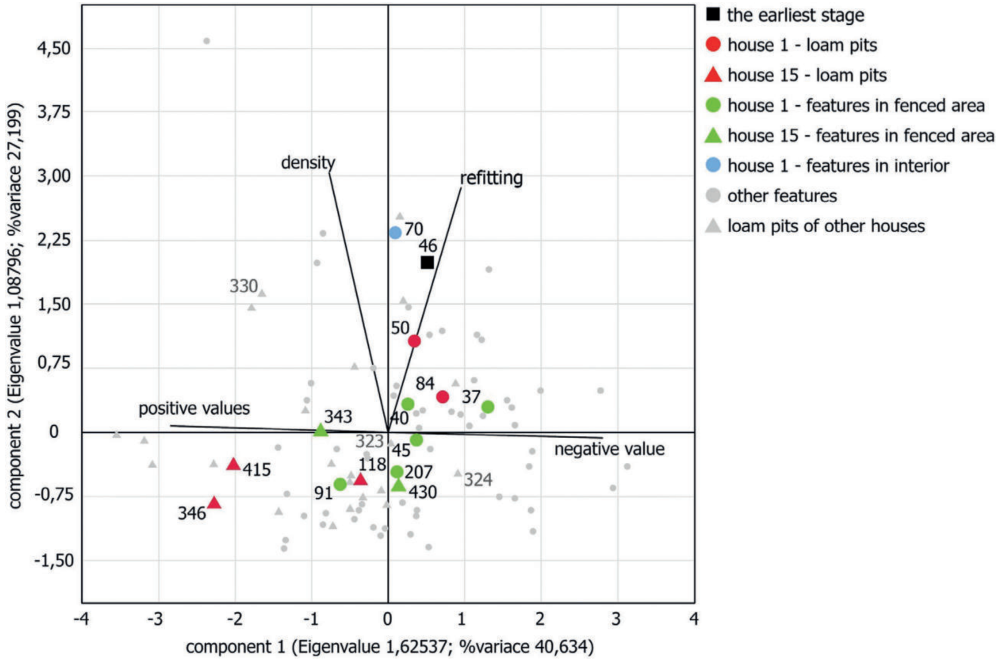

Fig. 9. Principal correspondence analysis (PCA) of the refitting, density, and formal and metric characteristics of ceramic assemblages from pits with more than five individuals from the settlement of Hostivice-Sadová. Black – earliest artificial stage; red – second artificial stage; green – third artificial stage; blue – interior of the house; light grey – other pits; dark grey numbers – individual pits of house no. 9.

moderate or heavily worn sherds indicating longer processes associated with the tertiary waste (*Kuna 2015*). Although the processes appeared similar to those of house no. 1, the chronology assessment suggests they differed. Besides the processes that seem important for the development framework, the typochronological changes play the same role. Previous results showed that the decoration styles found in pit no. 46, 50, and 84 were almost identical in proportion (*Fig. 6*), even though they were influenced by different processes affecting the morphometry of sherds but not the approximate proportion of styles. Even if we eliminate almost half of the assemblages that appear to be affected by a longer formation trajectory, the similarity in proportion of the decoration styles remains. Essentially, we may associate these three assemblages from different artificial stages with one waste area used before the construction of house no. 1 and perhaps after that.

The same principles could be applied to features inside fenced areas and the loam pits. Nevertheless, if the assemblages from loam pits and fenced areas are from one waste area, they should correspond more closely to each other in proportions of decoration styles regardless of influences; likewise, the earliest stage (pit no. 46) and loam pits (no. 50 and 84) of house no. 1 (*Rulf 1997*; *Last 1998*; *Allard et al. 2013*; *Květina – Hrnčíř 2013*). However, more frequent occurrences of the filled-in band (alfa12) can be associated with later deposition, at least in the case of pit no. 37 and 40 inside the fenced area of house no. 1 (*Pavlů 1977*), especially when its occurrence was higher even in the cultural layer that likely formed most of the fills deposited within the fenced area.

In the second case, the later fill of pit no. 343 in the fenced area of house no. 15 is indicated by a few sherds decorated with musical notes at closer intervals (epsilon20) associated with later development of decoration style. In addition, it is supported by radiocarbon dating of the burial deposited at the bottom of the feature. To ensure reliable results, we eliminate insufficient parts (fragments with indexes below the third quartile) of assemblages and discuss the remaining assemblages from the fenced areas (pit no. 45 and 430). In both cases, the proportion of the filled-in band (alfa12) from the loam pits varied. The styles such as musical notes placed aside lines (theta) are present in pit no. 45, suggesting earlier deposition than in the loam pits of house no. 1 (*Pavlů 1977*, 45). In the second case, the difference in proportion of the filled-in band (alfa12) is not significant but essentially indicates earlier or later deposition than in loam pits around house no. 15.

In summary, the chronology and formation process assessment confirms that the fills of features in the fenced area formed later than loam pits. Therefore, it can be considered that the area was without any pits during the period of house occupation.

Assessing LBK settlement phases and decorative traditions

During the middle stage of LBK development in central Bohemia, the proportion of the filled-in band (alfa12) increased and then decreased. The maximum proportion is observed at phase 2B, although it also remained significant in later phase 2D. The musical notes along the line were set closer to each other, replacing the variants with sparser notes (*Pavlů 1977*; *Pavlů – Zápotocká 1979*; *Pavlů – Zápotocká 2013*, 34).

The development of the analysed LBK houses from the settlement at Hostivice-Sadová consists of at least two phases of the middle LBK (*Fig. 6*). This allowed us to validate the relative chronology sequence in the wider context of the settlement development and search for chronological connection between other houses and those with fenced areas. All houses from the Hostivice-Sadová site have a proportion of decoration styles comparable to those from LBK sites in Prague-Liboc (Libocká Street 10 site: *Olmerová – Pavlů 1991*, Šestákův statek site: *Schindlerová 2019*), Roztoky (*Rulf 1991*), Dolní Břežany (*Čtverák – Rulf 1984*), and Praha-Krč (*Vondrovský 2021*) situated in the Prague area close to the Vltava River or in the vicinity of its tributaries. Libocká Street 10 and Šestákův statek located in the Litovický Stream basin are the closest sites to Hostivice-Sadová (*Olmerová – Pavlů 1991*; *Schindlerová 2019*). The settlement from Libocká Street 10 offers only a few sunken features for comparison, so a more significant assessment is given with Šestákův statek (*Schindlerová 2019*, 97). However, the chronological development of Šestákův statek has to be revised, since the local chronological framework was based on a scheme of simplified decoration styles (*Schindlerová 2019*, 93–105), meaning that the earlier style of notes set aside lines (theta) was analysed as a single group along with the later musical note styles (epsilon 0, epsilon 10). Therefore, the results of the correspondence analysis, which includes assemblages with short trajectories of formation processes and where the individual styles were analysed, can vary.

The same characteristics as those of the previous chronological analysis of house units and fenced areas were chosen for evaluation of a wider context. In this case, however, it was necessary to also include vessel shapes in the analysis. It made it possible to compare the Hostivice-Sadová site with the settlement, where deep bowls were notably represented as older vessel shapes (*Pavlů et al. 1987*).

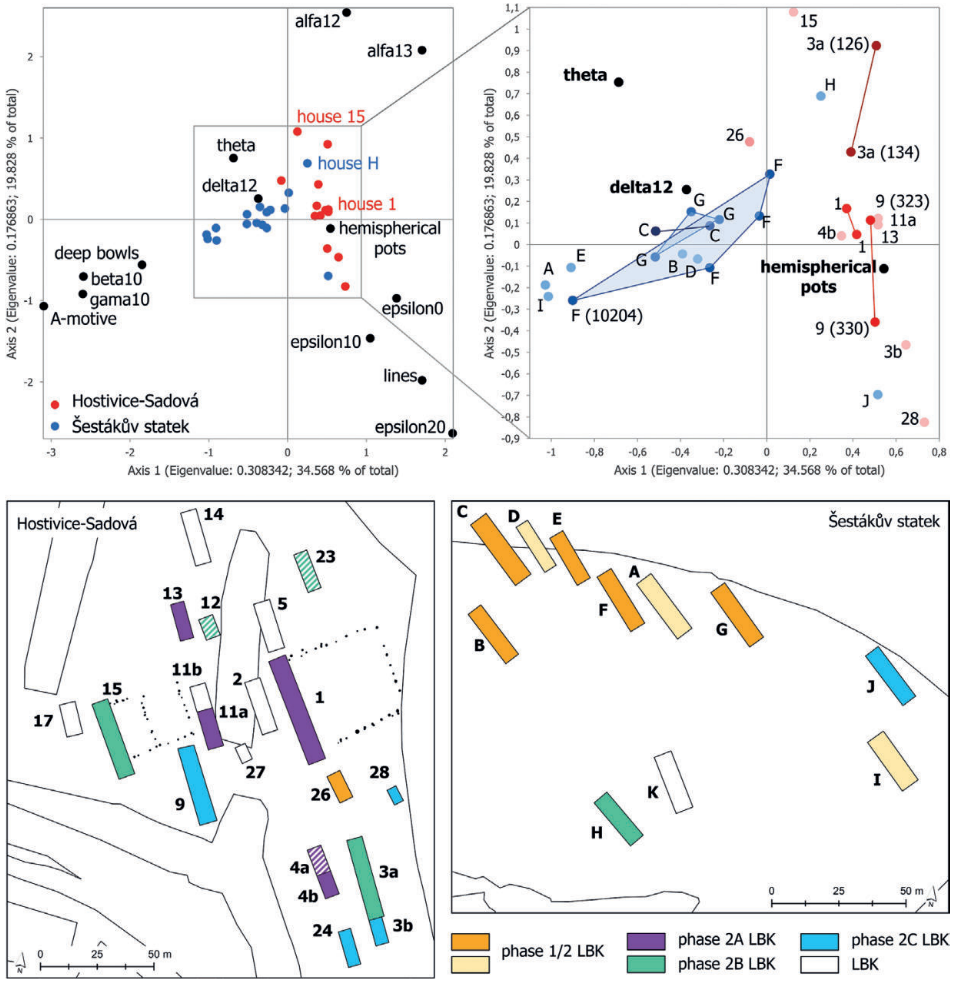

Fig. 10. Correspondence analysis (CA) of individual decorative styles and shapes of vessels from assemblages of settlements at Hostivice-Sadová and Praha-Liboc, Šestákův statek. Development of individual settlements in the Litovický Stream basin microregion (hatched fillings show individual houses dated with lower accuracy).

The development of Hostivice-Sadová features 10 house units analysed at the level of individual loam pits and three based on the house unit concept with lower accuracy. These three houses (house no. 4a, 12, and 23) were not included in the correspondence analysis and were compared separately based on the similarity of style occurrences with more precisely dated houses. The assemblage from Šestákův statek consists of 10 houses, which were analysed on the level of individual loam pits (*Tab. 6*). The correspondence analysis shows (*Fig. 10*) the consistency of individual loam pits of almost every house unit (house no. 1 and 15 from Hostivice-Sadová, houses C and G from Šestákův statek), with the exception of house no. 9 and no. 3a from Hostivice-Sadová and house F from Šestákův statek, which varied in the decoration style of individual assemblages. As loam pit 10204 of

	House no.	loam pit no.	alfa 12	alfa 13	alfa 30	beta 10	delta 12	epsilon 0	epsilon 10	epsilon 20	gama 10	theta	total LO	A-motiv	lines beneath the rim	deep bowls	hemispherical pots	total vessels
Hostivice-Sadová site	1	50	22.9	-	-	-	57.1	-	14.3	-	-	-	35	-	8.6	-	73.7	19
	1	84	20.0	-	-	-	52.0	-	16.0	-	-	4.0	25	-	12.0	-	91.7	12
	3	126	55.6	11.1	-	-	33.3	-	-	-	-	-	9	-	-	-	100.0	7
	3	134	33.3	-	-	-	41.7	-	16.7	-	-	-	12	-	-	-	87.5	8
	3b/24	128	4.3	2.9	-	-	55.7	2.9	22.9	2.9	-	-	70	-	38.6	-	92.9	70
	4a*	131, 144, 239	33.3	-	-	-	66.7	-	-	-	-	-	3	-	33.3	-	100.0	2
	4b	125	21.4	-	3.6	-	71.4	-	3.6	-	-	-	28	-	25.0	4.8	95.2	21
	9	323	25.0	-	-	-	50.0	12.5	12.5	-	-	-	8	-	12.5	-	100.0	3
	9	330	-	-	-	-	58.8	-	35.3	-	-	-	17	-	17.6	-	96.0	25
	11a	353	7.7	15.4	-	-	53.8	-	7.7	-	-	-	13	-	7.7	-	100.0	6
	12*	361, 362	57.1	-	-	-	42.9	-	-	-	-	-	7	-	14.3	-	100.0	3
	13	364	30.0	-	-	-	43.3	-	26.7	-	-	-	30	-	13.3	-	89.5	19
	15	118	55.6	-	-	-	44.4	-	-	-	-	-	9	-	-	33.3	66.7	4
	15	415	50.0	-	-	-	33.3	16.7	-	16.7	-	-	6	-	-	-	66.7	3
	23*	33, 101, 102	83.3	-	-	-	-	-	16.7	-	-	-	6	-	33.3	-	100.0	5
	26	116	25.0	-	-	-	75.0	-	-	-	-	-	8	-	-	25.0	75.0	4
	28	231	-	-	-	-	50.0	-	50.0	-	-	-	6	-	50.0	-	100.0	3
	-	29	3.8	-	-	0.6	53.1	10.0	20.6	7.5	-	3.1	160	-	17.5	1.3	90.1	151
	-	150	24.0	-	-	-	60.0	-	8.0	-	-	-	25	-	-	-	86.4	22
	-	273	42.9	4.8	-	-	33.3	4.8	4.8	-	-	9.5	21	-	-	-	85.7	14
Praha-Liboc, Šestákův statek site	A	10199	-	-	-	12.5	87.5	-	-	-	-	-	8	12.5	-	62.5	25.0	8
	B	10235	-	-	-	11.8	82.4	-	5.9	-	-	-	17	-	-	22.2	66.7	9
	C	10182	-	-	-	-	88.9	-	3.7	-	-	3.7	27	-	-	25.0	50.0	8
	C	10218	-	-	-	10.0	90.0	-	-	-	-	-	10	-	-	33.3	-	3
	D	10154	-	-	-	-	85.7	-	9.5	-	-	-	21	-	-	44.4	33.3	9
	E	10177	8.3	-	-	33.3	58.3	-	-	-	-	-	12	8.3	-	44.4	55.6	9
	F	10204	-	-	-	10.0	80.0	-	10.0	-	-	-	10	10.0	-	63.6	27.3	11
	F	10205	-	-	-	-	83.3	-	16.7	-	-	-	6	-	-	33.3	33.3	3
	F	10211	11.1	-	-	-	77.8	-	11.1	-	-	-	9	-	-	20.0	80.0	5
	F	10267	30.0	-	-	-	55.0	-	10.0	-	-	5.0	20	-	5.0	30.8	61.5	13
	G	20508	4.8	-	-	-	90.5	-	-	-	-	4.8	21	-	4.8	23.1	53.8	13
	G	20514	16.7	-	-	-	50.0	-	16.7	-	-	16.7	6	-	-	66.7	33.3	3
	G	20586	7.1	-	-	14.3	60.7	-	7.1	-	7.1	3.6	28	-	-	31.8	59.1	22
	I	20550	-	-	-	19.0	71.4	-	-	-	9.5	-	21	-	-	63.0	33.3	27
	J	20535	-	-	-	-	16.7	-	66.7	-	-	-	6	-	33.3	18.2	72.7	11
	H*	41224, 41226	55.6	-	-	-	44.4	-	-	-	-	-	9	-	-	-	100.0	5

Tab. 6. The overall proportions of individual decoration styles and vessel shapes from three selected large clay pits from Hosivice-Sadová and individual loam pits of houses from Hostivice-Sadová and Šestákův statek (*houses with lower accuracy, the proportions of which are based on house units; the remaining proportions of vessels belongs to other shapes).

house F from Šestákův statek contains grave H2, and other loam pits are either overlapped by others or close to a house, we prioritise pit 10204 in the chronological framework. Moreover, the assemblage from this loam pit is the most representative. Essentially, individual loam pit no. 126 and 134 of house no. 3a from Hostivice-Sadová were relatively homogenous, although pit no. 134 could have been overlapped by the loam pit of house no. 4b, as the houses are spatially close together. On the other hand, they differ in proportion of decoration styles, which indicates lesser alteration. Thus, the chronology of house no. 3a seems to be better represented by loam pit no. 126. The last evaluation is based on the trajectory of formation processes. In the case of house unit no. 9, we chose the reliable assemblage of feature no. 330, which was least influenced by formation processes, and that is why positive values are present more than in the other loam pits of the house unit (*Fig. 9*).

The development of the filled-in band (alfa12) from Hostivice-Sadová is almost identical to the development in the Šestáků statek assemblages. Differences occur in the proportion of specific decoration styles, such as the 'A style' (beta10), which is missing at Hostivice-Sadová. Musical notes placed at the ends of lines (epsilon10) are, on the other hand, more frequent at Hostivice-Sadová than at Šestákův statek. The start of the development at Hostivice-Sadová is represented by house no. 26 featuring a low proportion of filled-in bands (alfa12) and deep bowls (*Pavlů 1981*). Therefore, house no. 1, 4b, and 11a from Hostivice-Sadová might belong to phase 2A rather than to phase 1/2 of the Bohemian LBK, as the deep bowls and older styles (gama10, beta) are missing here in contrast to Šestákův statek (*Fig. 10*). Notably, a higher proportion of the filled-in band (alfa12) was also observed at Libocká 10 (*Olmerová – Pavlů 1991*, 50). Although the low presentation of decorated fragments could affect the proportion of the filled-in band (alfa12) from house unit no. 15, the assemblages of house no. 15 and probably house no. 3a correspond to phase 2B of the LBK culture in Bohemia, with the maximum occurrence of filled-in band (*Pavlů 1977*; *Pavlů et al. 1987*; *Pavlů – Zápotocká 2013*). Similar values apply to Dolní Břežany III (*Čtverák – Rulf 1984*), the house unit with pit 287 from Roztoky (*Čtverák – Rulf 1984*; *Rulf 1991*, 90), and the Libocká 10 assemblage from pit 1/79 (*Havel – Rulf 1988*).

The high proportions of the significant decoration style (alfa12) were in features within the fenced area of house no. 1, in pit no. 37 and 40 (*Tab. 4*). Therefore, the pit assemblages within the fenced area can reflect phase 2B of the LBK. On the contrary, pit no. 45 may have been later or may have been admixed by material from the nearby pit.

The occurrence of pottery decorated with musical notes placed at the ends of lines (epsilon10) is significant at house no. 9 and 28, and probably two houses (no. 24 and 3b) with a shared loam pit 128 (*Kretchmer et al. 2016*; *Lenneis 2012*). Based on assemblages from Černý Vůl (pit no. 33 and 42; *Řídký et al. 2009*, 187) and Společenská zahrada (pit no. 364; *Vondrovský 2021*, 267), where the occurrence of musical notes placed at the ends of lines (epsilon10) is almost identical, the end of the development of Hostivice-Sadová and Šestákův statek could be dated to phase 2C of the LBK culture in Bohemia. Compared to the loam pit, assemblages of the fenced area associated with house no. 15 were more consistent with phase 2C of the LBK. According to the comparison, the entire development of the Hostivice-Sadová site took place during the middle LBK.

Finally, we will focus on the radiocarbon dating of samples taken from the Hostivice-Sadová site. The data can be assessed within the Bayesian model featuring the sequence

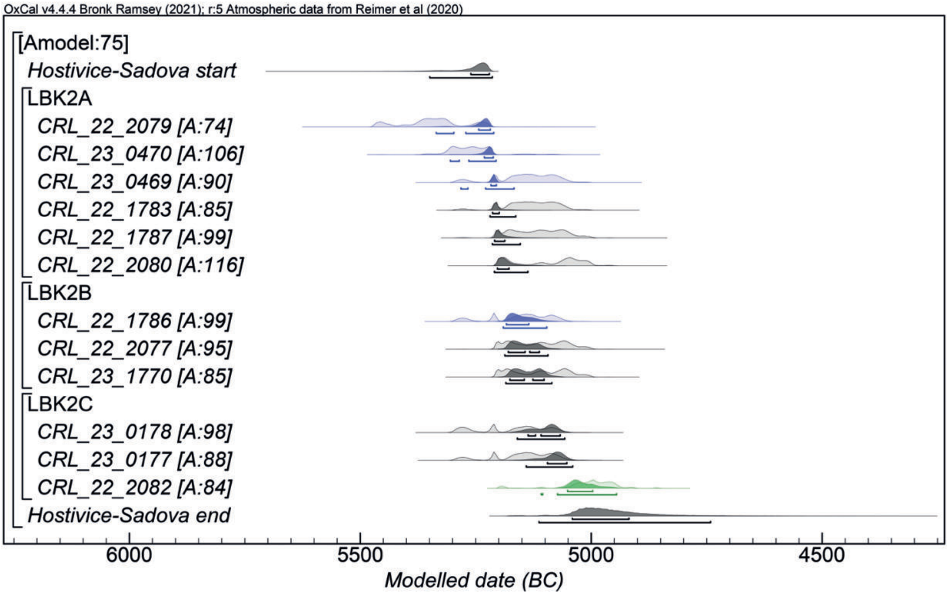

Fig. 11. Radiocarbon model of the Hostivice-Sadová development. Blue – samples from the loam pits of house no. 1 and 15; green – the sample from the pit in the fenced area.

established in combination with the relative chronological information[1] and overlapping ground plans of houses. Although the three large clay pits – no. 29, 150, and 273 – were not involved in the correspondence analysis of houses, they were included in the model because the occurrences of decoration styles were significant. Their relative chronological position in development corresponds to the proportions of decoration style (*Tab. 6*; pit no. 150 corresponded to phase 2A; pit no. 273 with phase 2B and pit no. 29 with phase 2C). The results of Bayesian modelling show sufficient agreement (*Fig. 11*) for the sequence model. Although the probability modelling was distorted by the calibration curve plateau, which occurs roughly between 5200 and 5000 BC, the modelled data supports the relative chronology framework. Moreover, no significantly low agreements were detected. This implies that both houses were used at different times and are non-contemporaneous. In accordance with the chronology framework, the differences between samples from fenced area pit no. 343 and the loam pit of house no. 15 are more apparent. This implies the maximum occurrence of filled-in bands in the Litovický Stream basin in *5191–5086 cal BC* (*95.4% probability*) and likely corresponded to the late stage of the LBK at Bylany (*Pavlů – Zápotocká 2013*, 27). Overall, as the later decoration style (epsilon20) is presented by a few sherds, and the radiocarbon dating of Hostivice-Sadová site shows long settlement continuity, it could suggest the longer duration of the filled-in band tradition (*Trampota – Květina 2020*) in the Litovický Stream basin.

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[1] House no. 4a and 23 are based on sherds from a house unit comprising related loam pits. Proportion corresponds to phase 2A of the LBK culture in the case of house no. 4a and phase 2B of the LBK in the case of house no. 26. Due to the low presence of decorated sherds, they are not considered in the overall development scheme.

The role of fenced areas in Early Neolithic society

Generally, empty fenced areas during house occupation could be similar to the central areas of Neolithic rondels (*Stäuble 2013*; *Řídký et al. 2019*, 43–67; *Blažková 2020*, *Vondrovský 2021*, 324–327). Since we do not have any evidence of activities like crop growing or animal husbandry, we can only suggest how the first farmers used these enclosed areas. One possibility is a social or ritual zone, as is assumed in the case of connected houses (*Riedhammer 2003*, 483–485; *Czerniak 2013*). As these situations are not well preserved, we do not have any reliable evidence of entrances to fenced areas. However, the fenced area of house no. 15 from Hostivice-Sadová could be accessed from the northern part of the adjacent house, as postholes are missing here. On the other hand, the eastern part of the longhouse trenches from Hostivice-Sadová are interrupted, which could have been the entrance allowing access to the fenced area. This position suggests that the fenced areas were reserved for exclusive use by household members because the entrances are located in the northern part of the houses and go directly towards the fenced area (*Podborský 2011*).

Dividing the development of Hostivice-Sadová into four chronological phases, where two entail a house with a fenced area, suggests a potential social or hereditary relationship between these two specific households. Social relations might be indicated by motives in peripheral areas of the vessels. The variability determines the diversity of relation and *vice versa* (*Pechtl 2015*, 566; *Gronenborn et al. 2017*). However, the proportion of the classified secondary ornaments on individual ceramic fragments is not considerable for socio-cultural analysis. On the other hand, the possible inheritance relationship between the longhouses can be seen in their almost identical construction elements. Both houses consist of a ground plan with a tripartite division with double postholes at the southern ends, and the northern ends are defined by a trench with an entrance at the eastern part (the same as for house no. 3 and 9). Although both differ in their total lengths (house no. 1 is 48 m long and house no. 15 is 35 m long), they exceed the limit for extreme houses (*Pechtl 2009*, 188; *Podborský 2011*). It is also noteworthy that the other houses from Hostivice-Sadová dated to phase 2A consisted only of central parts, which supports the distinct perception of house no. 1 and its social or economic significance. The southern and northern section of three-part division of longhouses had their own informative values connected with social-economical differences in Early Neolithic society (*Pavlů 2013*; *Gomart et al. 2015*, 243–245), although the functional interpretation of individual parts is still discussed. Traditionally, a southern section with a greater density of postholes is interpreted as a raised floor or a storage area on the second floor (*Soudský 1966*, 29; *Pavúk 1986*; *Coudart 1998*; *Pavlů 2000*, 218).

Another point of view is a specific economic behaviour displayed in distinct finds accumulated near houses, especially in grinding-milling tools and faunal remains. The number of grinding-milling tool fragments from loam pit no. 84 in house no. 1 may indicate household specialisation in food storage or production (*Hachem – Hamon 2014*). However, the grinding-milling tools were used for a long time and deposited fragments of finds could be associated with the previous stage of settlement (*Květina – Řídký 2017*, 132). In addition, at the Hostivice-Sadová site as at most of other Early Neolithic sites, we do not have evidence of storage pits implying the accumulation of supplies in these unique houses (*Rocek 2020*). In addition to stone artefacts, animal remains play an important role in socio-economical differences. *Hachem* (*2000*) analysed the spatial distribution of wild and domesticated animal remains to investigate the correlation between the archaeozoological assemblage and the dimensions of the domestic structure. As the faunal remains from the Hostivice-Sadová site were almost uniform and with a minimum of wild animals, there seem to be no significant differences in consumption (*Hachem 2000*; *Kovačiková et al. 2012*, 85). Only loam pit no. 50 is exceptional, as it contained a large amount of animal bones (*Tab. 2*). The weight of the archaeozoological assemblage implies that the animal remains could plausibly signify discarded remnants from food preparation at house no. 1. However, we currently lack evidence of specialisation among later households. On the other hand, certain houses with a low occurrence of decorated vessel fragments were not included in the relative chronological framework, but these houses lack evidence of archaeozoological remains or the density of finds were low.

The length of the houses, the construction of the southern ends, and even fenced areas lead to the conclusion that these two households represent the prestige of their inhabitants (*Pavúk 1986*, 373; *Pavlů 2000*, 269; *Pechtl 2009*, 194; *Květina – Řídký 2019*). The fenced areas could be associated with individuals possessing higher social status (*Pechtl 2009*) conferred due to their experience or organisational ability. On the other hand, regardless of the association between houses with fenced areas and particular persons, these special houses could be venues for short-term ritual activities like feasts, ceremonies or even meeting places (*Soudský 1966*, 57; *Květina – Řídký 2019*, 177). Furthermore, long-term site occupation featuring two distinguished houses, each representing a specific decorative style tradition, indicates continuity in traditions reflected by the duration of decoration style.

Conclusion

We aimed to combine the different approaches toward studies of pottery fragments to offer a possible new viewpoint of unusual Early Neolithic longhouses. We generated several results from analysing the sequence of development and the nature of ceramic waste in the case study of Hostivice-Sadová. While the formation processes are complicated, as previous studies have demonstrated, different trajectories can be reconstructed in this case through development based on a defined sequence of the use of the settlement area. The morphometric characteristics of pottery fragments demonstrate that pits in fenced areas were not used for refuse disposal and were filled in later than loam pits alongside the houses. As important records of other parts of the settlement area are missing, we cannot locate the areas of primary deposition. Thus, most of the pit fills have been formed by either intentional redeposition of already transformed waste, natural processes, or combinations of both. However, the earliest artificial stage appears to have been formed more intentionally than the others, which could be interpreted as deliberate filling of the pit before the house construction. As the morphometric characteristics were generally better preserved in the loam pits alongside the houses, these contexts were used as the basis for the relative chronology of the settlement in order to achieve a more accurate model. In both cases, the disproportion in the typochronology and morphometry of pottery, together with intervals of radiocarbon dates, implies that the fenced area was without pits while houses were occupied. Moreover, the ground plans of the houses, their lengths, and fences occurring in the two following LBK phases should be evidence of the extraordinary social status of these selected houses.

The settlement at Hostivice-Sadová is partly contemporaneous with the settlements at Šestákův statek in Praha-Liboc. The proportion of individual decoration styles combined with radiocarbon dating testify to the continuity of a residential area at Hostivice-Sadová during the middle stage of the LBK culture. The result shows a longer duration of a specific decoration style at the Litovický Stream basin, especially at the Hostivice-Sadová site, which could be associated with the social or economic position of houses with fenced areas. This suggests that this decorative style may have held greater significance in the region's cultural context.

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PETRA SCHINDLEROVÁ, Department of Archaeology, Faculty of Arts, Charles University, Celetná 20, CZ-116 36 Praha 1, Czech Republic; schindlerovap@ff.cuni.cz
JANA KLEMENTOVÁ, The Central Bohemian Museum in Roztoky near Prague, Zámek 1, CZ-252 63 Czech Republic; jana.klementova@muzeumroztoky.cz
MIROSLAV POPELKA, Department of Archaeology, Faculty of Arts, Charles University, Celetná 20, CZ-116 36 Praha 1, Czech Republic; miroslav.popelka@ff.cuni.cz
MIROSLAVA ŠMOLÍKOVÁ, Department of Archeology, Prague City Museum, Pod Viaduktem 2595, CZ-155 00 Praha 13, Czech Republic; mirka.smolikova@seznam.cz

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Vývoj raně středověkého centra ve Staré Boleslavi optikou radiouhlíkového datování etážového pohřebiště při bazilice sv. Václava a kostele sv. Klimenta

The development of the early medieval centre of Stará Boleslav revealed by radiocarbon dating of the multi-level cemetery at the Basilica of St Wenceslas and the Church of St Clement

Ivana Boháčová – Nikola Koštová

Conducted in numerous phases, the rescue archaeological excavation of the early medieval Přemyslid centre in Stará Boleslav (central Bohemia) brought, among other things, completely new and fundamental knowledge of the development of the core of the site, where the first collegiate chapter in Bohemia was founded in the years 1039–1046. The establishment of the chapter along with the Basilica of St Wenceslas and subsequently the Romanesque Church of St Clement in its immediate vicinity is also related to the transfer of intensive burial from outside the town to these churches. A test pit dug near the Church of St Clement in the immediate vicinity of the southern apse of the basilica in 2005 captured the multi-level development of this cemetery. The test pit is the only place where it is possible to positively distinguish burials made after the construction of the Church of St Clement (c. first half of the 12th century) from the earlier phase of burial. The superposition of up to 10 graves was used to interpret the development of the site and its chronology. The analysis combines archaeological and historical sources with probabilistic modelling of radiocarbon dates from skeletal remains. The results confirmed the correctness of the previously proposed basic course of the early medieval development of the site and its chronology, but also specified the beginning and end of the burial, which the radiocarbon model pushes deeper into the past than originally assumed. Radiocarbon dates also indicate that the Church of St Clement was built in the period around the middle of the 12th century rather than at its beginning.

Early Middle Ages – central site – multi-level cemetery – radiocarbon dating – Central Bohemia

Mnoha etapový záchranný archeologický výzkum raně středověkého přemyslovského centra ve Staré Boleslavi (střední Čechy) přinesl mimo jiné zcela nové a zásadní poznatky o vývoji jádra lokality, kde byla mezi lety 1039–1046 založena první kolegiátní kapitula v Čechách. Se založením kapituly společně s bazilikou sv. Václava a posléze románským kostelem sv. Klimenta v její bezprostřední blízkosti souvisí i přesun intenzivního pohřbívání z extravilánu k těmto kostelům. V roce 2005 zachytila sonda umístěná při kostele sv. Klimenta v bezprostřední blízkosti jižní apsidy baziliky etapový vývoj tohoto pohřebiště. Sonda je jediným místem, kde lze jednoznačně oddělit pohřby mladší, než výstavba kostela sv. Klimenta (ca 1. pol. 12. století) od starší fáze pohřbívání. Až desetinásobná superpozice hrobů byla využita pro ověření interpretace vývoje lokality a její chronologie. Analýza kombinuje archeologické a historické prameny s pravděpodobnostním modelováním radiouhlíkových dat z kosterních pozůstatků. Výsledky potvrdily správnost dříve navrženého základního členění raně středověkého vývoje lokality a její chronologie, ale také upřesnily počátek i závěr pohřbívání, které radiouhlíkový model posouvá hlouběji do minulosti, než bylo původně předpokládáno. Radiouhlíková data také naznačují, že výstavba kostela sv. Klimenta spadá spíše do doby kolem pol. 12. století, než na jeho počátek.

raný středověk – centrální lokalita – etážové pohřebiště – radiouhlíkové datování – střední Čechy

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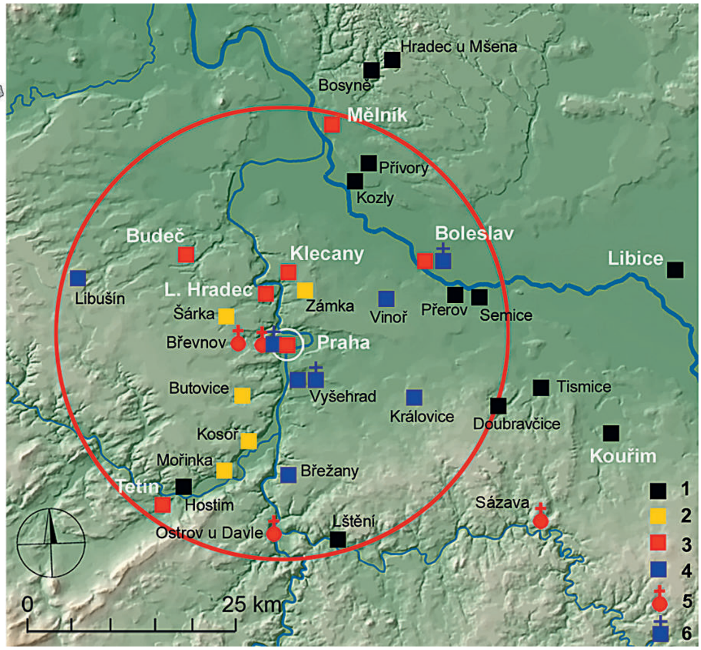
Úvod

Stará Boleslav představuje jednu z centrálních lokalit raného přemyslovského státu. Situovaná byla na severovýchodním okraji jeho krystalizačního jádra (*Obr. 1*). Tento rezidenční hrad nejstarších Přemyslovců patří zejména kvůli vraždě knížete a později hlavního českého světce Václava v roce 935 k centrům, která jsou ve středověkých písemnostech zmiňována nejčastěji. Významnou a z historického hlediska nepřehlédnutelnou událostí je rovněž založení nejstarší kolegiátní kapituly v Čechách, k němuž přistoupil kníže Břetislav I. mezi lety 1039–1046.

Intenzívní archeologická kampaň ve Staré Boleslavi započala koncem 80. let minulého století a kulminovala mezi lety 1991 až 2005. Dosavadní archeologické výzkumy prokázaly, že Stará Boleslav patří k nečetným lokalitám raného středověku v Čechách, jejíž historické terény jsou ve značném rozsahu i mocnosti dochovány v prostoru dodnes žijícího městského historického jádra a nebyly donedávna zasaženy větší stavební aktivitou. Historický vývoj Staré Boleslavi v raném středověku lze na základě dochovaných kulturních vrstev a dosud existujících výjimečných stavebních památek, které jsou s nimi provázány, členit do několika sídelních horizontů. Na základě keramického inventáře z přilehlých souvrství a historické datace staveb je možné dospět k detailnějšímu chronologickému členění raně středověkého vývoje Staré Boleslavi, než jaké by poskytla základní a běžně užívaná archeologická chronologie raného středověku.

Intenzita a členitost osídlení dovolila sestavit relativní chronologickou sekvenci staroboleslavské raně středověké keramiky založenou na nosných stratigrafiích. Ta byla propojena s poznatky z významných stratigrafií Pražského hradu a posléze také z přemyslovské Budče. Vývoj těchto lokalit se jeví z hlediska proměn keramického inventáře jako nápadně synchronní. Relativní sekvence raně středověké keramiky tzv. pražského okruhu byla provázána s nečetnými daty z historických pramenů, případně s ojedinělými daty dendrochronologickými, kterými tyto centrální lokality jako jedny z mála disponují (naposledy *Boháčová 2022b*). Pro závěr středohradištního období a starší fázi období mladohradištního (ca 900–1100) se podařilo ukotvit postupné a jasně definovatelné proměny keramické produkce na ose absolutní chronologie alespoň formou různě dlouhých intervalů. Vzhledem k shodnému vývoji keramiky tzv. pražského okruhu přinejmenším v centrální části Čech lze tyto poznatky využít v rámci komparativního studia sídelního vývoje krystalizační oblasti raného českého státu (např. *Varadzin 2010*; *Štefan – Hasil 2014*, 482–483). K tomuto posunu v poznání českého raného středověku obecně výzkum ve Staré Boleslavi významně přispěl a nová zjištění mohou toto poznání dále prohlubovat. Intervaly, které se dnes pohybují v rozpětí několika desetiletí, je možné v budoucnosti verifikovat, doplňovat i zpřesňovat.

Výjimečnou příležitost k ověření získaných poznatků o vývoji staroboleslavského centra a doplnění nových dat absolutní chronologie přinesl v roce 2005 záchranný výzkum vyvolaný pokračující revitalizací východní části kapitulního areálu. Výzkum se dotkl klíčového prostoru, v němž kostel sv. Klimenta (stavebně historická datace: 1. polovina 12. století) těsně sousedí s jižní apsidou baziliky sv. Václava (výstavba 1039–1046). Výkop zastihl celou sekvenci vývoje lokality od jejích počátků přes založení obou staveb provázených intenzívním pohřbíváním, úpravou ploch i další stavební činností, až po novodobé zásahy. Cílem tohoto příspěvku je verifikovat a upřesnit chronologii vývoje centrální části lokality



Obr. 1. Centrální místa ve středních Čechách v 10. století: 1 – bez jasné datace závěrečné fáze; 2 – horizont I – centra před přelomem 9. a 10. století; 3 – horizont II – centra vzniklá kolem roku 900; 4 – horizont III – centra vznikající od 30. let 10. století; 5 – benediktinské kláštery 10. a 11. století; 6 – kapituly 10. a 11. století. V pražské aglomeraci vyznačen klášter sv. Jiří a kapitula pražského kostela. Upraveno podle *Boháčová 2022a*.

pomocí pravděpodobnostního modelování radiouhlíkových dat získaných z kosterních pozůstatků z pohřebišť, jejichž počátky podle dosavadních pozorování souvisely se vznikem obou sakrálních staveb. Příležitosti, které umožňují dílčí úseky raně středověkého vývoje dokumentovaného archeologickým výzkumem propojit jednoznačně s chronologií v absolutních datech, jsou zcela výjimečné. Získané poznatky z této významné lokality tedy mohou dále prohloubit naše poznání chronologie raného středověku ve středních Čechách i v obecné rovině.

Archeologický výzkum Staré Boleslavi a jeho přínos pro studium raného středověku v Čechách

Základní informace o výsledcích výzkumu v jádru Staré Boleslavi v letech 1988–2005 byly publikovány v kolektivní monografii (*Boháčová 2003a*) i v řadě dílčích studií (např. *Boháčová 2006*; *2010*; *2011a*; *2022a*). Získané prameny pocházejí téměř výlučně z výzkumu záchranného, vyvolaného zejména budováním a rekonstrukcemi inženýrských sítí v historickém jádru dnešního města. Výzkum byl přes omezení vyplývající z jeho charakteru pojat jako systematický. Zaměřen byl na konkrétní otázky vzniku a vývoje lokality a jejích postupných proměn. Proto byla zejména v etapách rozsáhlých rekonstrukčních prací přímo v historickém jádru lokality prosazována metoda detailního výzkumu kvalifikovaně vybraného vzorku míst s nosnými stratigrafiemi, a to včetně výkopů pro inženýrské sítě, v jejichž liniích (šíře v rozpětí ca 100–200 cm) byly historické terény rovněž rozebírány po přirozených vrstvách.

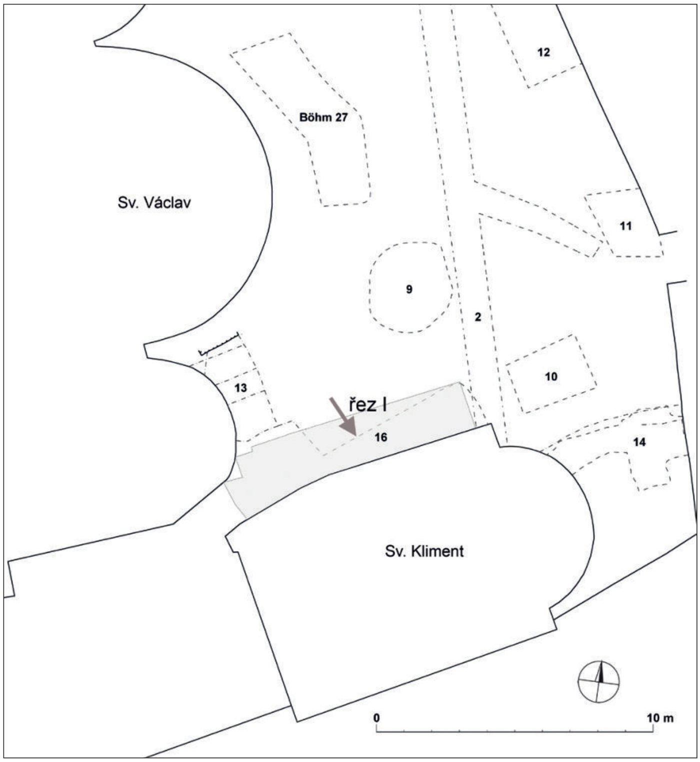
Ke klíčovým poznatkům náleží zjištění prvotního opevnění lokality hradbou s čelní kamennou plentou a dřevěnou výztuží, tj. hradbou typickou pro soudobá středočeská přemyslovská centra, jejíž výstavba spadá přibližně do období kolem roku 900. Neméně důležité je ověření existence i datace unikátní celokamenné hradby na maltu, spojované kronikářem Kosmou se stavební aktivitou Boleslava I. ve druhé třetině 10. století. Překvapivá jsou zjištění týkající se raně středověké sakrální architektury. Výzkum prokázal dochování téměř kompletního půdorysu baziliky sv. Václava (původně sv. Kosmy a Damiána), založené Břetislavem I. před polovinou 11. století (*Kosmas* II: *Bretholz 1923*). Jde o jeden z mála příkladů takto uceleně zachované stavby daného stáří ve střední Evropě. Její dispozice typově vychází z klasického bazilikálního trojlodí, v tomto případě doplněného kryptou (*Boháčová 2022a*). Současně byl potvrzen mladší původ raně středověkého kostela sv. Klimenta, vystavěného v její bezprostřední blízkosti s odstupem několika desetiletí. Datace této stavby byla dlouho předmětem diskusí, neboť část odborné veřejnosti (*Špaček 2012*) dosud hledá souvislost mezi tímto kostelem se starobylým patrociniem (respektive jeho nedoloženým předchůdcem) a kostelem sv. Kosmy a Damiána, u jehož dveří došlo k vraždě knížete Václava. Výzkum doložil, že k prvé zásadní proměně půdorysu baziliky dochází právě v souvislosti s výstavbou kostela sv. Klimenta, která je kladena předběžně do průběhu 1. poloviny 12. století. Rozsáhlými úpravami neprošla tehdy jen bazilika, u níž byla kromě nové krypty snesena jižní kaple, ale i okolí obou kostelů.

Archeologické výzkumy dokumentují postupné a v mladší fázi i poměrně rychlé proměny Staré Boleslavi od závěru středohradištního období do počátku vrcholného středověku. Zřejmě již počátkem 13. století se nárůst kulturních terénů zastavil. Vrcholně středověké období je zatím v nálezových situacích zastoupeno zcela výjimečně (*Boháčová – Špaček 2001*). Razantní změnou prochází Stará Boleslav po založení kapituly před polovinou 11. století, kdy se evidentně proměňuje funkce prostoru zejména v centrální části. Na ploše, původně vyhrazené běžným sídlištním aktivitám, postupně vyrůstají sakrální stavby, do jejichž blízkosti se z extravilánu přesouvá pohřbívání. Velká část volných prostranství, páteřní i dílčí lokální komunikace v blízkosti kostelů, jsou zpevněny kamenným posypem z lámané opuky či pískovcovými bloky. Širší okolí kapitulní baziliky je postupně v průběhu dalších desetiletí členěno do dílčích areálů, jejichž funkce, dispozice a případná další zástavba nejsou dosud detailněji poznány.

Nové prameny k ověření archeologické chronologie vývoje lokality – záchranný výzkum při kostele sv. Klimenta a jeho metodika

V roce 2005 si pokračující rekonstrukce areálu vyžádala položení sondy v souvislosti s budováním odvodnění sakrálních staveb (*Obr. 2*). Sonda č. 16 o rozměrech 900 × 180 cm byla položena bezprostředně při severní zdi kostela sv. Klimenta. Tento prostor byl téměř v celé ploše v roce 2003 zasažen neohlášeným snížením terénů o ca 70–80 cm, přičemž došlo k odstranění svrchní části raně středověkého souvrství. Pro dokumentaci a následný výzkum se podařilo zachránit pouze nevelký blok situací při severní zdi kostela.

Po odstranění horních, zčásti novověkých a místy i recentních vrstev, byla sondou 16 odkryta svrchní část hřbitovního horizontu, který tvořila homogenizovaná písčitohlinitá vrstva, v jejímž rámci, a především v její svrchní části, nebyly hrany hrobových jam nacházející se v početných superpozicích rozlišitelné. Dokumentována byla jejich až deseti-



Obr. 2. Stará Boleslav. Umístění sond záchranných výzkumů (1927, 1997, 2003 a 2005) v historickém jádru lokality (čárkovaně vyznačeny hrany sond/výkopů, čerchovaně linie řezů, podle *Boháčová 2005*, doplněno o sondu 16/2005).

násobná superpozice. Při severní hraně sondy byla, překvapivě ve značné vzdálenosti od zdiva kostela sv. Klimenta, zachycena na kótě ca 172,30–40 m n. m.[1] nepravidelná hrana vkopu pro jeho založení (14619 – viz níže *Obr. 3–5*; v západní části sondy zaujímal vkop celou její šíři). Většina hrobů byla zahloubena do výplně vkopu. Nejstarší hroby byly v rámci vkopu ukládány přibližně do úrovně povrchu původního podloží, tj. na kótu kolem 171,50 m n. m. Pod hroby tvořily výplň základového vkopu, který dosahoval na své bázi úrovně kolem 170,50 m n. m., vrstvy s vyšším obsahem stavebního odpadu, zejména maltoviny. Pod nepravidelně zvlněnou stěnou vkopu bylo zachyceno několik hrobů, které jeho hrana částečně porušovala (*Obr. 6*). Některé z nich zasahovaly již do podložního písku. Severní stěna sondy proťala recentní výkop pro inženýrské sítě (14621). Historické terény tak zůstaly místy zachovány jen mezi hrobovými jamami při dně sondy, kam výkop již nezasahoval. Byly tvořeny hlinitopísčitými vrstvami, v nichž bylo možné odlišit tři polohy (*Obr. 4*: 14008A, B, C), a hlinitou vrstvou půdního typu, nasedající na písčité podloží (14009) s ojedinělými zlomky starší mladohradištní a středohradištní keramiky. Tato vrstva, stejně jako písčité podloží, byla při západní hraně sondy proťata vkopem pro výstavbu jižní apsidy baziliky sv. Václava. V místě nejbližšího kontaktu obou staveb

[1] Do roku 2001 byly výškové údaje záchranného archeologického výzkumu udávány tradičně v systému Jadran, veškeré údaje v této práci jsou vztahovány k systému Balt po vyrovnání.

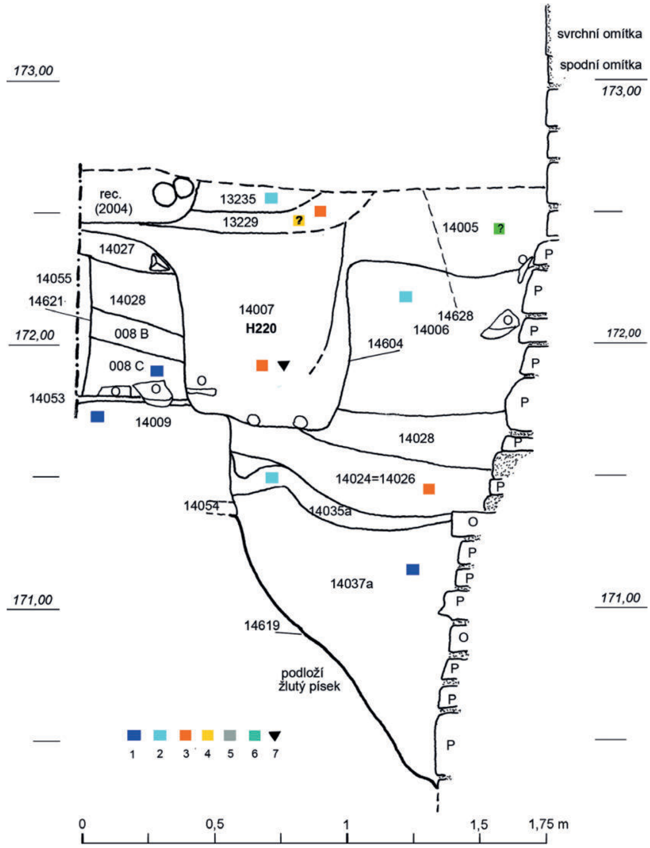
Obr. 3. Stará Boleslav 2005. Sonda 16 v pohledu od východu. Postup výzkumu v sektoru C a D. Vlevo základové zdivo kostela sv. Klimenta (foto autoři výzkumu).

byl dokumentován vztah jejich základových vkopů (*Obr. 5*: bazilika – 14626, kostel sv. Klimenta – 14619; *Obr. 7*).

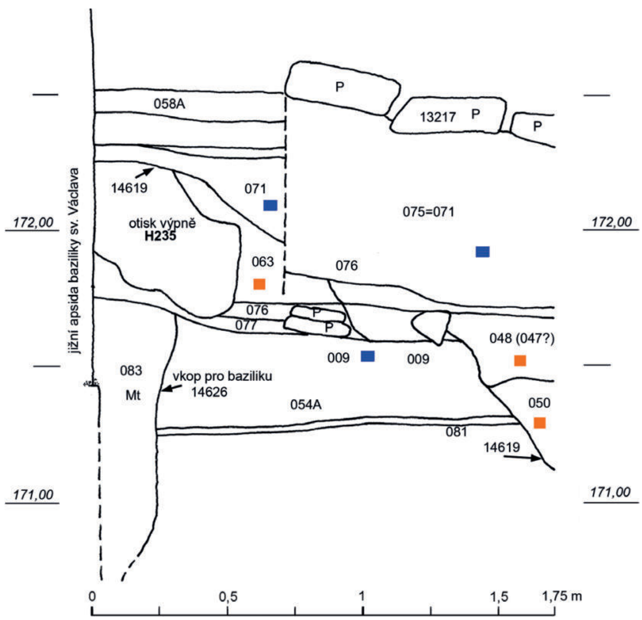
Výsledky a interpretace

Terénní výzkum

Výzkum zachytil v západní části sondy postupný vývoj v místě nejbližšího kontaktu obou raně středověkých sakrálních staveb. Počátky lokality, alespoň dle inventáře nejstarších vrstev, spadají do období nástupu nejmladší středohradištní keramiky, který je kladen přibližně k roku 900 (*Boháčová 2011a*; *2022b*). Výzkum potvrdil, že po nejstarší sídelní etapě, jejíž stopy jsou dochovány vzhledem k intenzívnímu pohřbívání v prostoru sondy jen zcela sporadicky, následovalo založení baziliky. V její bezprostřední blízkosti byly postupně zakládány hroby. Vzhledem k tomu, že dosud nebyl zjištěn žádný hrob porušený základy baziliky, bylo předpokládáno, že do nejstarší fáze pohřbívání náleží trojitá superpozice hrobů ve východní části sondy (H227–H229) a dva dětské hroby při apsidě baziliky



Obr. 4. Stará Boleslav. Řez 3 v sondě 16 dokumentující západní stěnu sektoru B jako jediný zachycuje nárůst historických terénů v místě jejich minimálního poškození intenzivním pohřbíváním. Vrstvy 14008B a C jsou jediným pozůstatkem souvrství, starším než nejstarší pohřby. Vkop kostela sv. Klimenta (14619) je v horní části porušen pouze hrobem H220, celé souvrství pak recentním výkopem pro vedení inženýrských sítí (14621). Datace dle keramických nálezů: 1 – RS4.1; 2 – RS3–4 bez rozlišení; 3 – RS4.2; 4 – VS1; 5 – VS2; 6 – N; 7 – železná kování. O – opuka, P – pískovec.



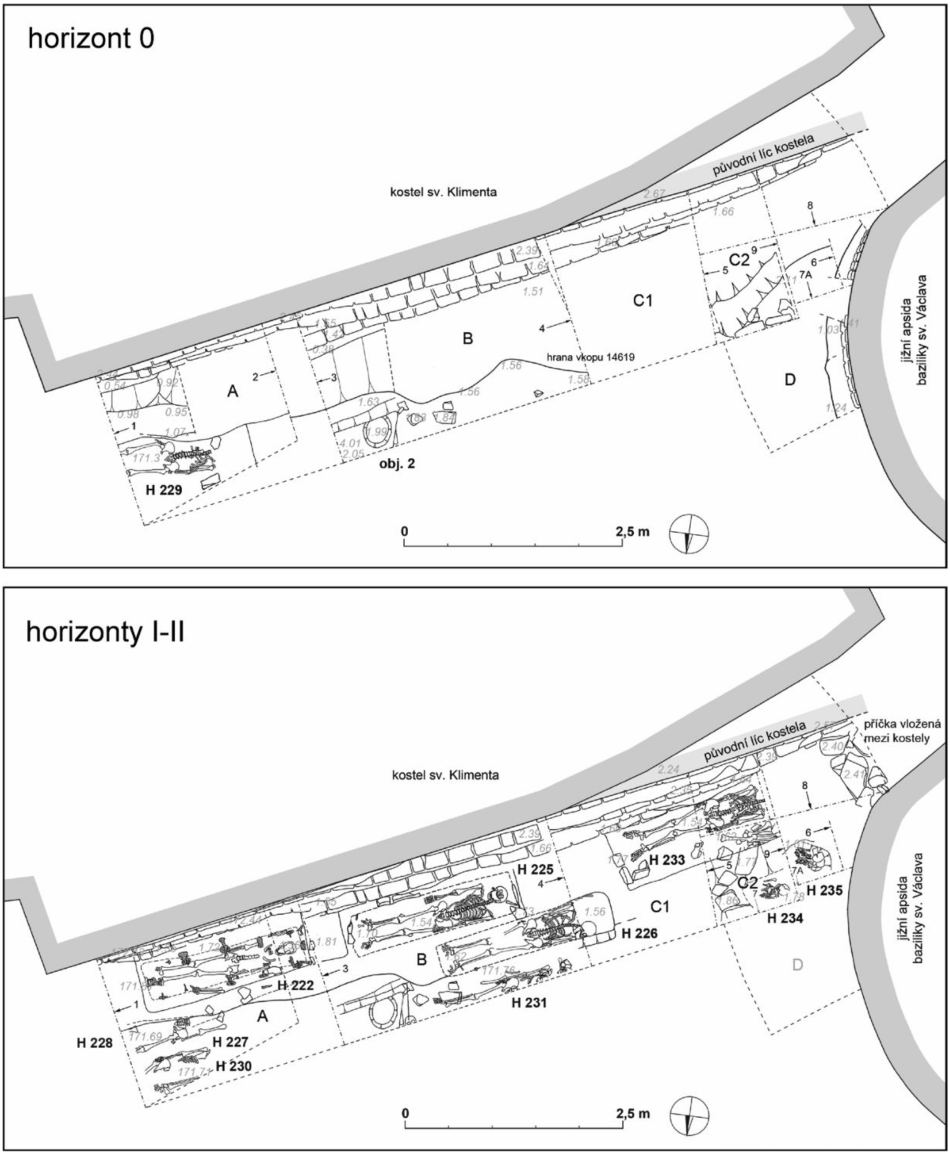
Obr. 5. Stará Boleslav. Řez 7, 7A v západní části severní stěny sondy 16/2005 zachycuje vztah základového vkopu kostela sv. Klimenta ke zdivu apsidy baziliky a jako jediný dokumentuje nárůst raně středověkých souvrství v místech mimo trasu výkopu pro inženýrské sítě. Legenda viz *Obr. 4*.

Obr. 6. Stará Boleslav. Sonda 16/2005 v pohledu od východu. Hrob H235 je uložený do základového vkopu baziliky. Její základový vkop i hrob jsou porušeny základovým vkopem pro kostel sv. Klimenta, jehož písčitá heterogenní výplň (vlevo) zasahuje až ke zdivu jižní apsidy baziliky (vpravo nahoře) (foto autoři výzkumu).

Obr. 7. Stará Boleslav. Sonda 16/2005 v pohledu od východu. 1 – povrch vrstvy půdního typu; 2 – spodní část výplně základového vkopu pro jižní apsidu baziliky; 3 – výplň hrobové jámy H235; 4 – zdivo jižní apsidy; 5 – výplň základového vkopu pro kostel sv. Klimenta (foto autoři výzkumu).

v její západní části (H234 a H235). S určitým časovým odstupem byl v prostoru pohřebiště založen kostel sv. Klimenta. Jeho základový vkop poškodil nejstarší hroby i základový vkop pro jižní apsidu baziliky. Mezi úrovní povrchu, z něhož byly hloubeny základy baziliky sv. Václava (dle rozhraní základového a nadzemního zdiva – viz *Boháčová 2003b*, 184) a úrovní, do níž byl založen kostel sv. Klimenta, došlo k nárůstu hřbitovního horizontu ca o 50–55 cm (*Obr. 5*). V zásypových vrstvách základového vkopu kostela sv. Klimenta se vyskytuje vedle starších nálezů výhradně keramika nejmladší fáze mladohradištního období. Krom toho vrstvy obsahují četné doklady stavební činnosti, včetně zlomku hlavice sloupu, k níž nacházíme přímou analogii v patce sloupu v mladší západní části krypty.

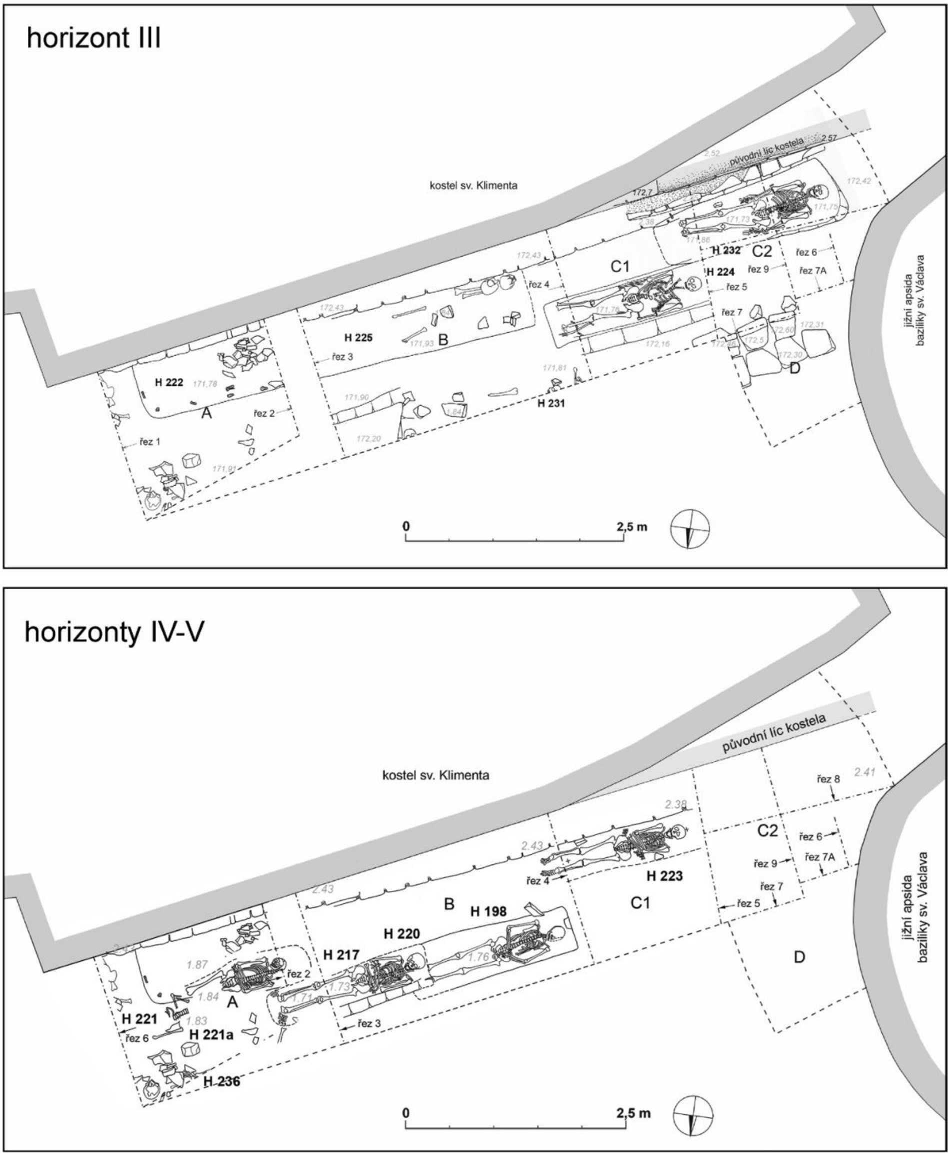
Založení kostela sv. Klimenta je předpokládáno v průběhu 1. poloviny 12. století, a to dle stavebně historického výzkumu i vzhledem k vysoce kvalitní freskové výzdobě dochované v jeho interiéru. Její vznik je kladen do průběhu 3. čtvrtiny, resp. 60. let 12. století (*Stránská – Všetečková 2011*, 288–289; naposled *Dientsbier et al. 2023*, 120–122) a není spojována s prvotní úpravou stěn stavby. Archeologické poznatky vycházející ze stratigrafie a chronologie keramické sekvence (naposledy *Boháčová 2022b*) podporují hypotézu, dle níž je třeba počítat se založením kostela sv. Klimenta nejdříve po roce 1100. Na základě vertikální i horizontální stratigrafie bylo vyčleněno sedm základních horizontů



Obr. 8. Stará Boleslav. Hřbitovní horizonty 0 a I–II v sondě 16/2005 (grafická úprava L. Raslová).

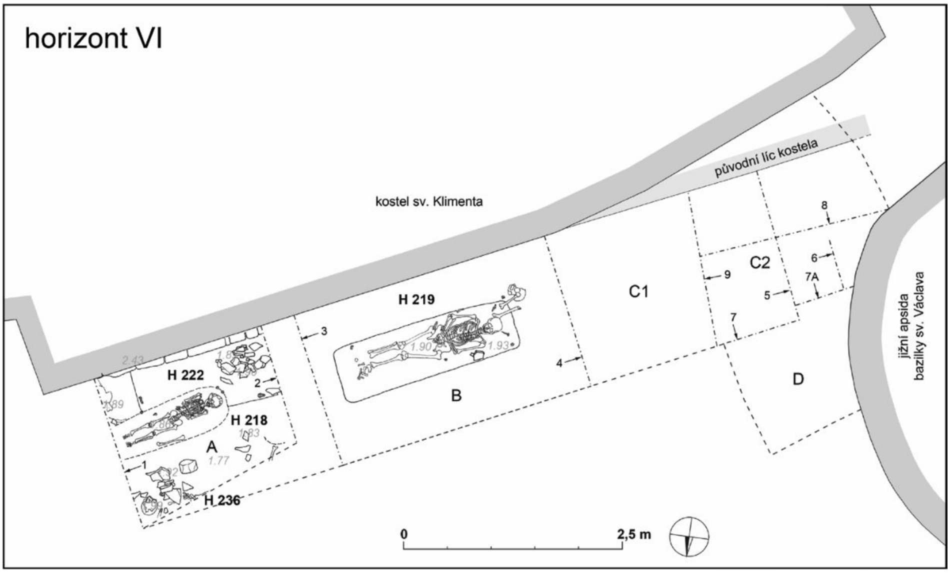
pohřbívání (0–VI; *Obr. 8–10*): dva pro etapu předcházející založení kostela sv. Klimenta (5 hrobů) a pět horizontů pro následné pohřbívání při něm (14 bezpečně identifikovaných hrobů). Samostatný horizont nebyl vyčleněn v případě, pokud se v superpozici s ostatními hroby daného horizontu nacházel pouze hrob jediný. Jeden z odkrytých hrobů (H231) nelze ke konkrétní fázi pohřbívání přiřadit.

Do závěrečné fáze pohřbívání v areálu při bazilice spadají již jen ojedinělé hroby, doloženo je i jejich nestandardní uložení. Vzhledem k tomu, že hřbitovní horizont obsahoval



Obr. 9. Stará Boleslav. Hřbitovní horizonty III a IV–V v sondě 16/2005 (grafická úprava L. Raslová).

značné množství sekundárně přemístěných kosterních pozůstatků (ať již jako jednotlivé kosti v rámci vrstev hřbitovního horizontu či záměrně uložených do hloubených hrobových jam), lze předpokládat, že značná část hrobů není dochována *in situ* a počet vzájemně se narušujících hrobů byl ve skutečnosti ještě vyšší. Nasvědčuje tomu i skutečnost, že v některých případech ležely kosterní pozůstatky těsně nad sebou, někdy i v mnohačetné superpozici, případně mladší hrob, obdobně situovaný, nasedal bezprostředně na ostatky pohřbu staršího, jehož část porušil.



Obr. 10. Stará Boleslav. Hřbitovní horizont VI v sondě 16/2005 (grafická úprava L. Raslová).

Celkem bylo na ploše sondy 16 identifikováno 20 pohřbů *in situ*, další dva jsou označeny jako nejisté (H221a a H236). V mnohých případech bylo obtížné vztah hrobových jam jednoznačně stanovit, neboť jejich hrany nebyly dobře čitelné. Týká se to především H221, v jehož rámci byly odkryty ještě další kosterní pozůstatky, u nichž nebylo ani zřejmé, zda náleží totožnému jedinci, nebo zda jde o další narušený pohřeb (H221a). Přiřazení k vymezeným hřbitovním horizontům je nutné vnímat jako hypotézu, která měla umožnit alespoň základní interpretaci vývoje pohřbívání v dotčeném prostoru.

Lze konstatovat, že na zkoumané ploše byl zachycen nejen intenzivní, ale i poměrně rychlý vývoj v historickém jádru lokality. Nejvýznamnější proměny se chronologicky řadí do mladší fáze mladohradištního období, na jejímž počátku byla založena staroboleslavská kolegiátní kapitula sv. Kosmy a Damiána a proběhly související změny, které archeologie pozoruje jako proměnu charakteru kulturních vrstev. Toto období můžeme charakterizovat jen nevýraznými proměnami keramické produkce. To ztěžuje dataci kontextů na základě keramiky, nehledě na to, že celý komplex vrstev hřbitovního horizontu je charakteristický opakovaným narušováním starších situací.

Sonda 16 je jedním z mála zkoumaných míst, kde je možné jednoznačně oddělit starší a mladší fázi raně středověkého pohřbívání při obou sakrálních stavbách. Tyto fáze lze s větší či menší mírou přesnosti datovat na základě výpovědi 1) stratigrafické sekvence, 2) keramického inventáře a 3) historických dat. Vzhledem k tomu, že disponujeme historickými, resp. stavebně historickými či uměnovědnými údaji o stojících sakrálních stavbách a podle dřívějších zjištění žádný z hrobů nebyl porušen stavbou baziliky sv. Václava, bylo možné předpokládat, že počátky starší fáze pohřbívání spadají do období po výstavbě baziliky, tedy nejdříve těsně před polovinu 11. století. Počátky mladší fáze pohřbívání pak byly kladeny do průběhu 1. poloviny 12. století po dokončení kostela sv. Klimenta.

Radiouhlíková analýza

Radiouhlíkové datování bylo realizováno ve dvou fázích v letech 2014 až 2015 a v roce 2023 v České radiouhlíkové laboratoři (CRL). Část vzorků z roku 2014 byla zpracována ještě konvenční metodou na nízkopozaďovém kapalinovém scintilačním spektrometru Quantulus 1220. Ostatní vzorky byly již zpracovány za použití metody AMS. Měření grafitizovaných vzorků bylo v první fázi provedeno na urychlovači MICADAS na pracovišti HEKAL ATOMKI HAS v Debrecenu. Vzorky z roku 2023 byly měřeny přímo v České radiouhlíkové laboratoři na urychlovači MILEA.[2] Pro kalibraci výsledků a zpracování souboru byl použit program OxCal 4.4 spolu s kalibrační křivkou IntCal20 (*Bronk Ramsey 2009*; *Reimer et al. 2020*). Při vyhodnocení byla využita 95% hladina pravděpodobnosti (sigma 2).

Vzorky pro analýzu byly vybrány ze sekvence pohřbů v rámci desetinásobné superpozice hrobů, a to ve vazbě na výše zmíněná historická data. Prvé analýzy byly zaměřeny především na ověření datace počáteční fáze pohřbívání při kostele sv. Klimenta s důrazem na dataci H222, o jehož mimořádnosti svědčí mohutná sbíjená dubová rakev opatřená nejméně jedenácti železnými úchyty (*Boháčová – Hošek 2014*). Ve druhé fázi byla dosavadní data doplněna především o vzorky z hrobů ze starší fáze pohřbívání, tj. před založením kostela sv. Klimenta. Radiouhlíková data měla potvrdit rozdělení vývoje pohřbívání do sedmi horizontů (horizont 0–VI), stanovených na základě vertikální i horizontální stratigrafie a nálezů keramiky ze zásypů hrobových jam. K analýze bylo předáno celkem 10 vzorků ze sondy 16, u nichž bylo provedeno 12 měření (vzhledem k nedostatečnému množství získaného kolagenu u dvou vzorků bylo provedeno opakované datování H227 a H221). Získané výsledky jsou statisticky konzistentní (*Tab. 1*).

Komparace výpovědi archeologických dat a radiouhlíkové analýzy

Archeologické prameny

Plochu sondy 16 vyplnil z větší části výkop pro základy kostela sv. Klimenta, jehož severní obvodové zdivo tvořilo jižní hranu sondy. Vzhledem k tomu, že protilehlá severní hrana sondy byla zničena recentním výkopem, nemáme k dispozici podélný řez, který by postihnul veškeré stratigrafické vztahy mezi vrstvami a objekty. Sestaven byl alespoň dílčí vývojový diagram zobrazující základní předěly ve vývoji v dané ploše ve vztahu k vývoji hřbitovního horizontu (*Obr. 15*). Souhrnně prezentuje výsledky analýzy stratigrafie, keramického inventáře a radiouhlíkových dat získaných z kosterních pozůstatků z deseti hrobů etážového pohřebiště.

Výpověď keramických nálezů naznačuje (*Obr. 11–14*, souhrnně *Obr. 15*), že větší část pohřbů, konkrétně prvé čtyři zachycené úrovně pohřbívání, nejspíše náleží období raného středověku (horizonty 0, I s dvěma úrovněmi pohřbů a II). U čtvrté úrovně pohřbů (horizont II) můžeme pouze konstatovat, že tyto hroby jsou hloubeny ještě do terénů raně středověkého stáří. Mladší příměs nebyla rozpoznána u tří hrobů uložených v horizontu II

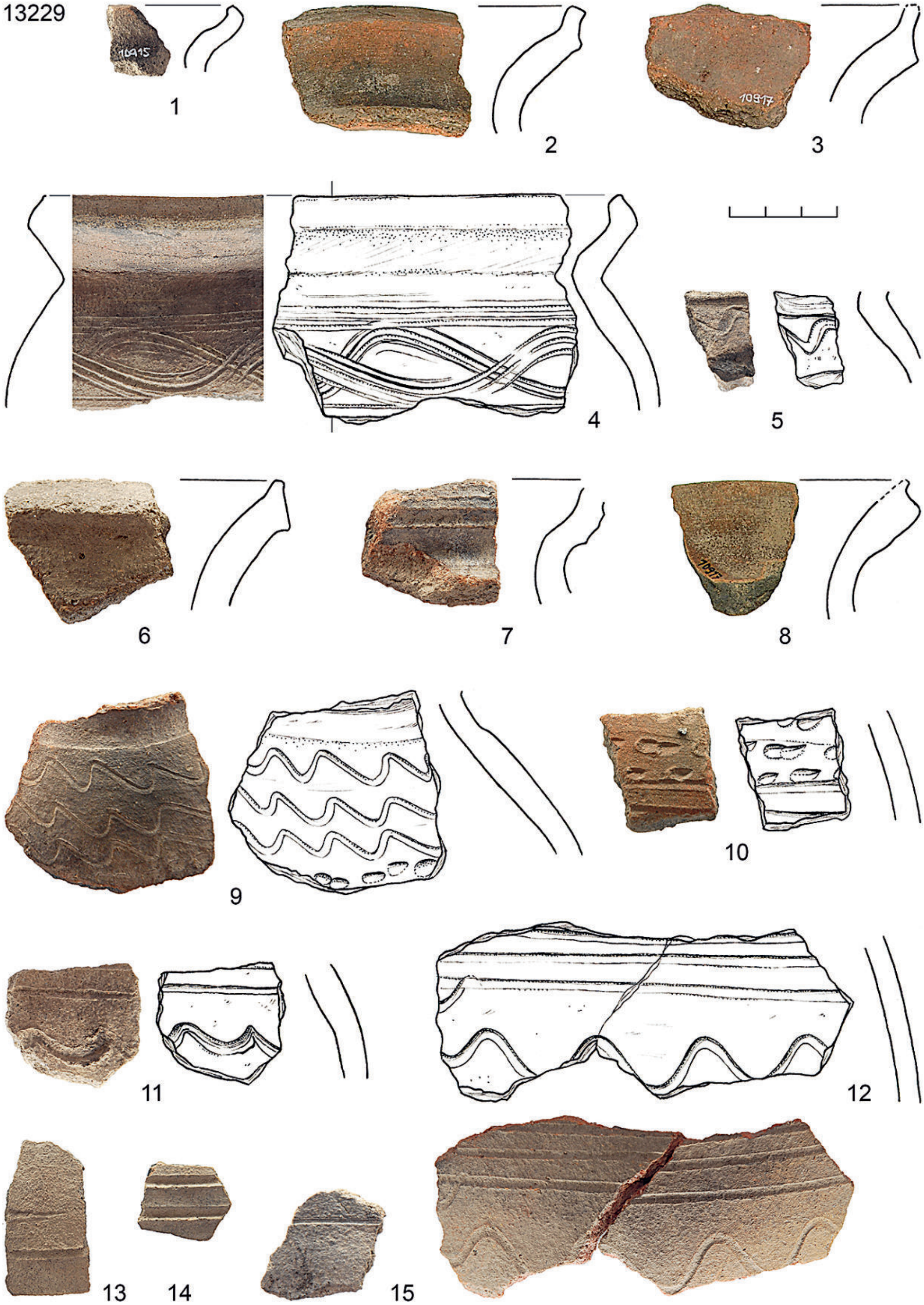
[2] Protokoly z radiouhlíkových analýz budou součástí závěrečné zprávy projektu GAČR a budou dostupné v archivu ARÚ Praha.

stanovený stratigrafický horizont	hrob	kód vzorku	konvenční radiouhlíkové stáří	kalibrované stáří 95,4% pravděpodob.	koncentrace kolagenu mg/g	kvalita kosti	věk jedince	odběr pro C^{14}
H VI	**H218**	CRL-14004	566±95	1263–1508 (94.1%); 1594–1618 (1.3%)	76	*neuvedeno*	6–9	kost
H V	**H220**	CRL-14005	744±78	1053–1075 (1.6%); 1156–1400 (93.8%)	88	*neuvedeno*	19–22	kost
H V	**H217**	CRL-15001	643±90	1224–1436 (95.4%)	74	*neuvedeno*	19–23	kost
H IV	**H221**	CRL-14007	625±33	1292–1400 (95.4%)	61	4	20–35	kost
H IV	**H221**	CRL-15428	597±34	1300–1410 (95.4%)	28	4–5		
H II	**H226**	CRL-230889	893±18	1048–1082 (21.3%); 1151–1218 (74.2%)	102	4,5	nad 50	žebro
H II	**H222**	CRL-14008	978±89	888–1230 (94.6%); 1244–1256 (0.9%)	210	*neuvedeno*	35–50	kost
základový vkop pro kostel sv. Klimenta								
H I	**H234**	CRL-230892	973±18	1024–1050 (29.1%); 1080–1154 (66.4%)	50	5	1–1,5	žebra, obratel
H I	**H228**	CRL-230890	963±18	1027–1054 (22.2%); 1076–1156 (73.2%)	97	4,5	40–55	žebra, prstový čl. ruky
H I	**H227**	CRL-14006	991±87	778–782 (0.2%); 880–1229 (94.7%); 1245–1255 (0.5%)	132	*neuvedeno*	35–45	kost
H I	**H227**	CRL-14261	1018±82	776–786 (0.7%); 832–850 (1.1%); 876–1218 (93.7%)	134	*neuvedeno*		
H 0	**H229**	CRL-230891	1020±19	992–1034 (95.4%)	83	5	35–50	žebra, obratel

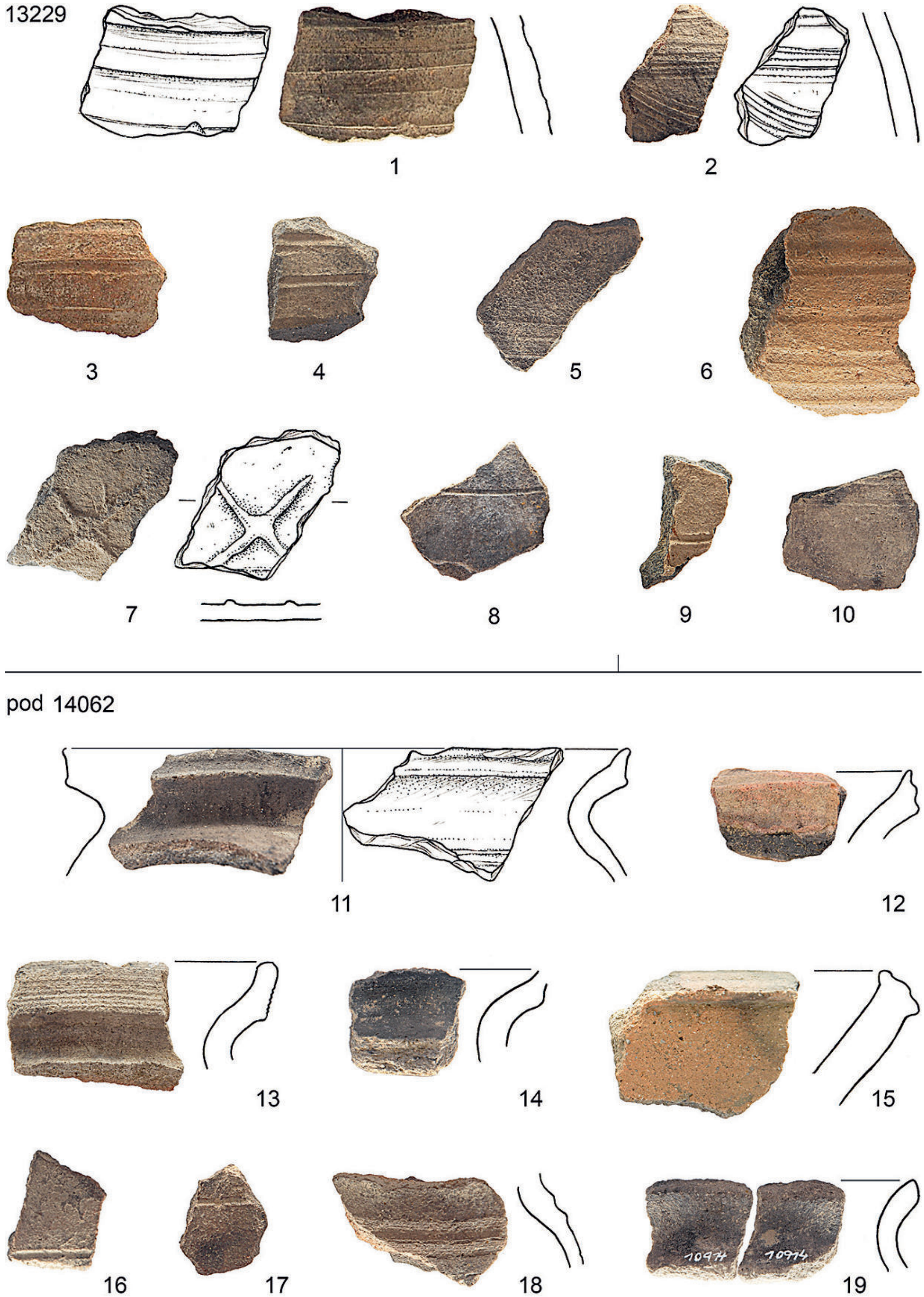
Tab. 1. Přehled vzorků a výsledky radiouhlíkové analýzy. Hodnocení jakosti vzorku kosti: 1 – nejvyšší kvalita, 6 – nevyhovující.

(H222, H226 a H230), u dalších dvou ale nelze její přítomnost vyloučit (H225 a H233), neboť se zde vyskytují ojedinělé keramické zlomky nesoucí nevýrazné rysy vyspělejší produkce. Keramické nálezy ze starší fáze vývoje pohřbívání (horizont 0 a I) tedy nevybočují z rámce starší fáze keramiky mladohradištního období, odpovídající nejpozději polovině 11. století. K dataci pohřbů tyto poznatky tedy nepřispívají, neboť lze předpokládat, že hroby byly zakládány do starších sídelních vrstev a soudobá keramika se v jejich zásypech nevyskytuje. Keramika mladší fáze mladohradištního období se objevuje až v zásypech hrobů horizontu II a hrobů horizontů následných a zcela dominuje v celé mocnosti nadloží. Svědčí to o opakovaném přemísťování zeminy s obsahem zlomků starších období. Vzhledem k nápadnému množství sídlištní keramiky ve vrstvách lze uvažovat i o větších terénních úpravách, k nimž by mohlo dojít v souvislosti s rozsáhlou stavební činností v celém areálu a jeho blízkém okolí někdy v průběhu 12. století.

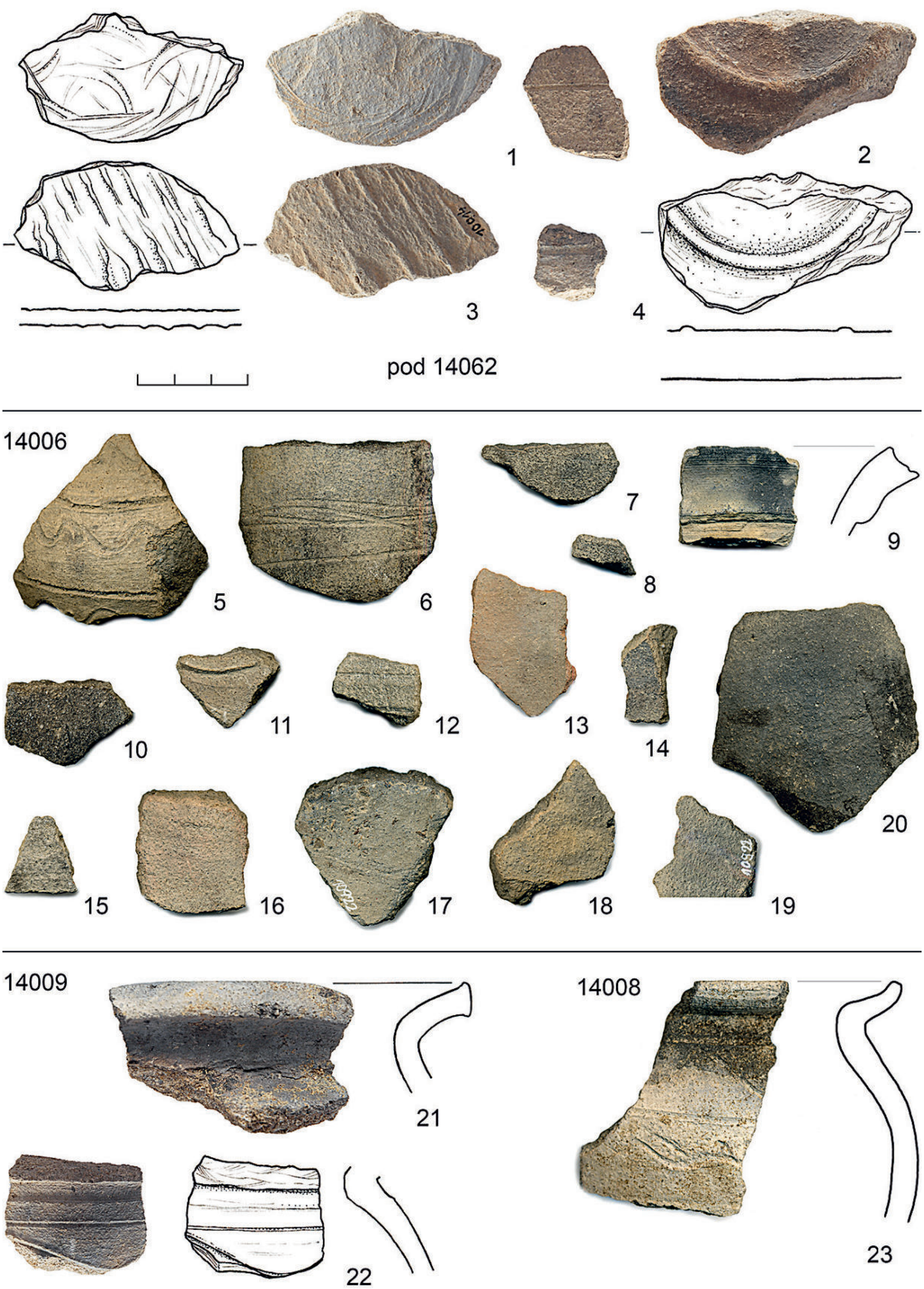
V hrobech mladších (poprvé v horizontu III – H224, H232 a v následných horizontech IV–VI) se již nástup keramiky starší fáze vrcholného středověku projevuje zřetelněji. Novověká keramika se v zásypech hrobů nevyskytuje, i v nejmladších situacích zcela převažuje pro boleslavskou sekvenci zcela typická keramika mladohradištního období (*Obr. 11–14*). Pokud se objeví mladší zlomky (stáří je vyvozováno pouze podle vyspělejších technologických znaků), je jejich výskyt zcela ojedinělý a nemůžeme vyloučit, že jde jen o kontaminaci plynoucí z porušení převážné části souvrství novodobými zásahy, zejména výkopem



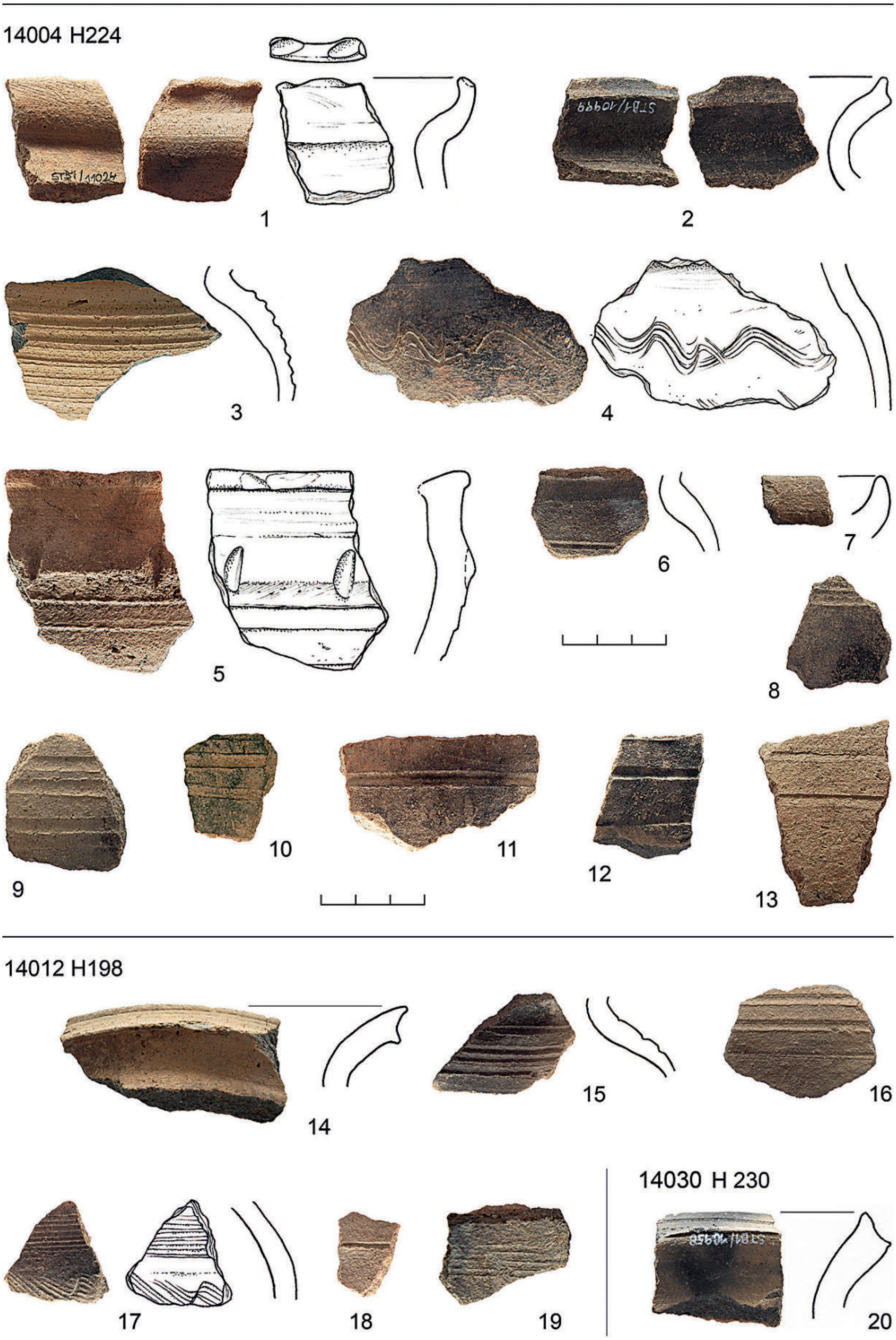
Obr. 11. Keramika z vrstvy nasedající na hřbitovní horizont (13229). Dataci ztěžuje skutečnost, že hrany hrobových jam nebyly často v rámci homogenizovaného hřbitovního horizontu rozlišitelné. Současně nelze vyloučit kontaminaci vrstev, jejichž hrany jsou v dokumentaci vyznačeny jako nečitelné, materiálem z recentních výkopů (kresba L. Raslová, foto K. Almassy).



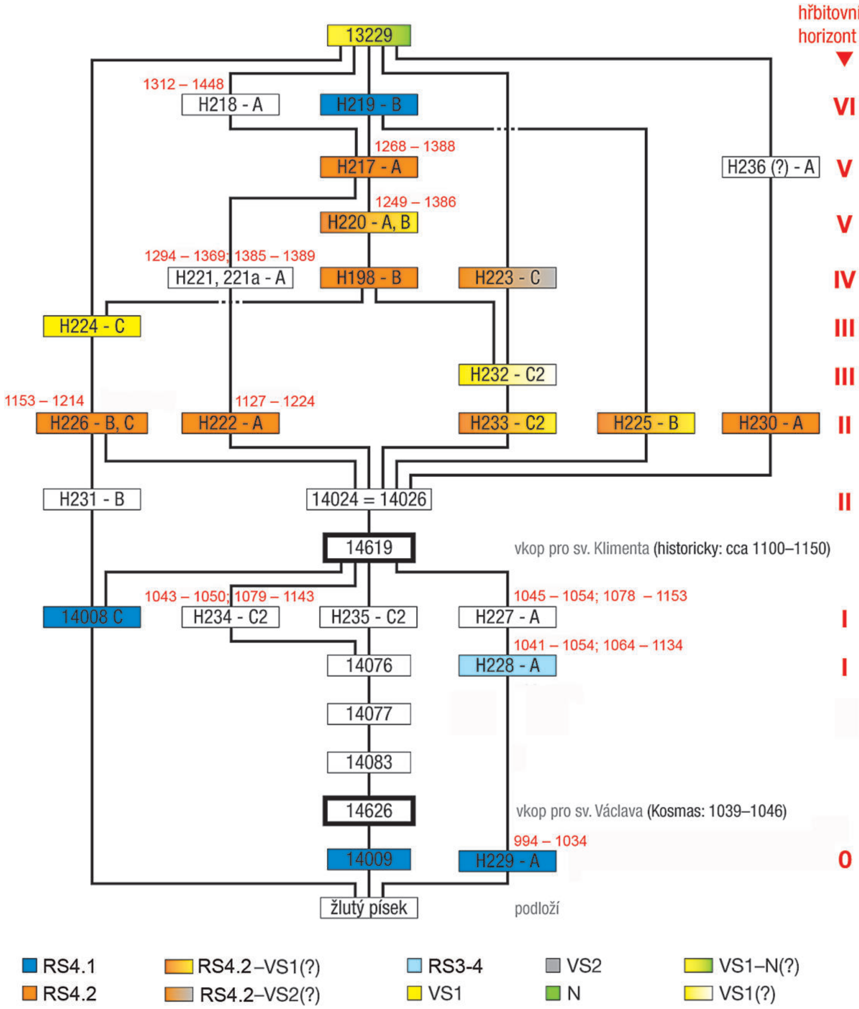
Obr. 12. Keramika z vrstvy nasedající na hřbitovní horizont (13229) a keramika z polohy (pod 14062) uzavírající výplň vkopu pro stavbu kostela sv. Klimenta (kresba L. Raslová, foto K. Almassy).



Obr. 13. Keramika z polohy (pod 14062) uzavírající výplň vkopu pro stavbu kostela sv. Klimenta. 14006: keramika z vrstvy, do níž byly postupně zakládány hroby mladší fáze pohřbívání po výstavby kostela sv. Klimenta. 14008 a 14009: keramika z nejstarších vrstev zachovaných nad písčitým podložím mezi hrobovými jamami (kresba L. Raslová, foto K. Almassy).



Obr. 14. Keramika reprezentující nálezy z hrobů mladší fáze pohřbívání (kresba L. Raslová, foto K. Almassy).



Obr. 15. Stará Boleslav. Dílčí vývojový diagram zachycující vývoj pohřbívání vzhledem ke klíčovým předělům ve stratigrafii sondy 16. Vyznačeny jsou vymezené hřbitovní horizonty 0–VI, známá historická data a modelované intervaly radiouhlíkových dat (viz *Tab. 2*) na hladině pravděpodobnosti 2 sigma (červeně). Doplněno výsledky analýzy keramického inventáře. RS4.1 – starší fáze mladohradištního období (pol. 10. – ca pol. 11. století); RS4.2 – mladší fáze mladohradištního období (ca pol. 11. století – 1200); RS3–4 – středohradištní až mladohradištní fáze bez rozlišení; VS1 – starší fáze vrcholného středověku (13. století); mladší fáze vrcholného středověku (14.–15. století); N – novověk; barevné přechody značí nejistotu určení; bílá – bez hodnotitelných nálezů (grafická úprava S. Babušková).

pro inženýrské sítě. V zachycené stratigrafii vrstev zastupují keramiku středohradištního či staršího mladohradištního období pouze nepočetné zlomky z torzovitě zachovaných situací z báze souvrství (*Obr. 13*: 14008 a 14009).

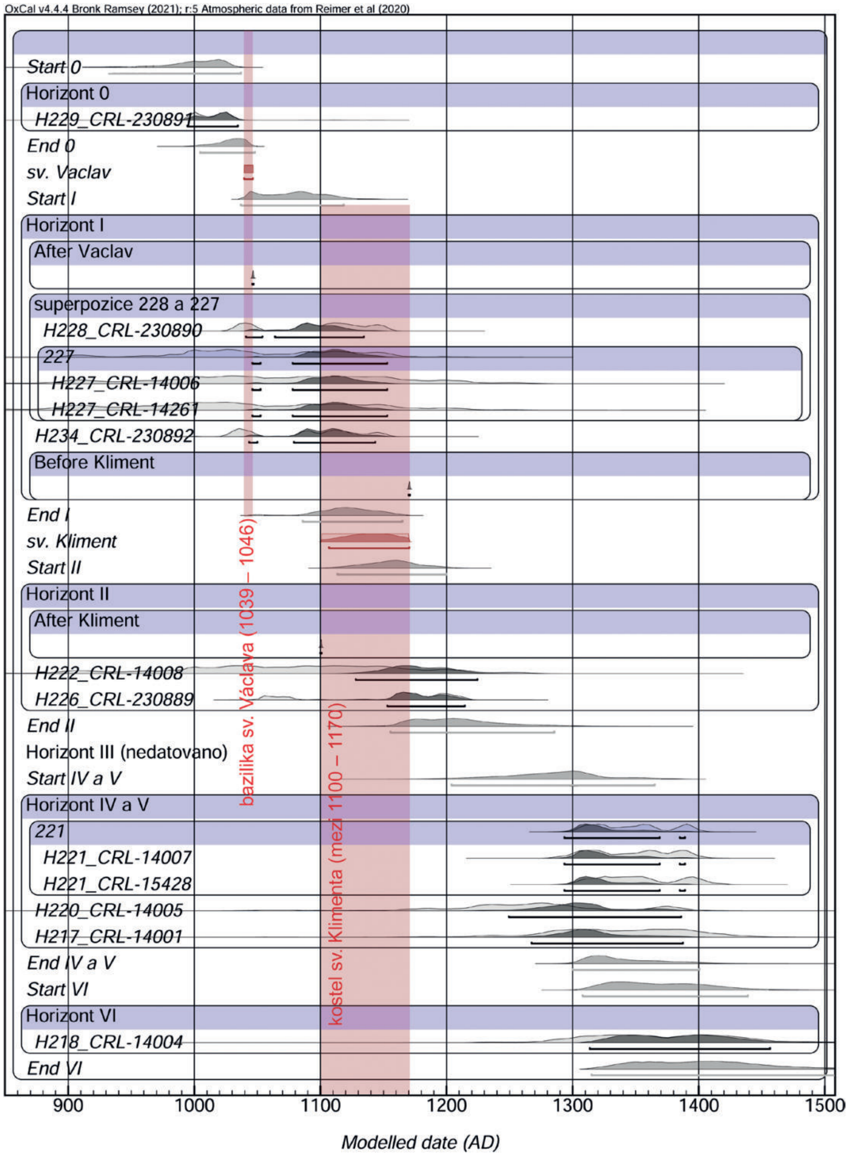
Výsledky analýzy keramiky z raně středověkých horizontů (0, I, případně II) tedy neodporují historickým údajům, jimiž disponujeme. Potvrzují však, že pokud je v zásypech hrobů keramika stáří shodného s dobou pohřbívání, jde o výskyt spíše výjimečný. Datování hrobů a terénů opakovaně porušovaných pohřbíváním a dalšími zásahy je tak na základě keramického inventáře neprůkazné. Nápadnou indicií vývoje ve stratigrafii je však proměna pohřebních zvyklostí, jež se projevuje od horizontu IV změnou v uložení horních končetin. Ty již nejsou srovnány podél těla, ale uloženy na břiše nebo v klíně. Nástup tohoto jevu je obecně nacházen v počátcích vrcholného středověku (např. *Boháčová 2012*, 185–187). V našem případě je provázen i výskytem železných hřebů obklopujících kostru (*Obr. 10*) a dalších artefaktů, indikujících výskyt kovaných rakví (blíže *Hrušková v tisku*). Rakve spojované hřeby se v českém prostředí objevují nejdříve ve 12.–13. století a jistě až v novověku (*Tomková 2005*, 169–170). Výjimečné postavení v českém kontextu mají hroby s rakvemi opatřenými úhlovými pásovými kováními z pohřebiště na akropoli Libice nad Cidlinou, které není možné datovat později, než do první poloviny 11. století (*Turek 1976*, 302; *1981*, 37–38; *Koštová 2014*, 48–50). Pásová kování v Čechách jsou zaznamenávána ojediněle, vesměs u hrobů spojených s elitním prostředím a s ne vždy jasnou chronologií (Praha – Pražský hrad, Anežský klášter; *Boháčová – Hošek 2014*, 251).

V hrobech předcházejících výstavbě kostela sv. Klimenta nebyl výskyt železných kování či jiných kovových prvků prokázán. Nejstarším pohřbem, uloženým do sbíjené dubové rakve s kruhovými úchyty, je zde výše zmíněný výjimečný hrob H222. Ze spodní části zásypu základového vkopu pro kostel sv. Klimenta byly ale vyzdviženy zlomky snad pásového kování a drobné silně zkorodované amorfní artefakty, ne však kované hřeby, typické pro mladší část pohřebiště. Výskyt pásových kování v pohřebním areálu při bazilice sv. Václava je doložen hrobem 36, odkrytým na bázi sondy 1/97 v rámci mnohačetné superpozice hrobů uložených bezprostředně na sobě. Z hrobu muže se zachovala pouze spodní část dolních končetin, jeho hrob však porušoval nejméně dva starší hroby. Nálezová situace v této části pohřebiště až na několik výjimek neumožňuje stanovit chronologii pohřbívání.

Radiouhlíková analýza

Při vyhodnocení radiouhlíkových dat můžeme využít dvou výše uvedených výrazných předělů ve vývoji lokality, pro které navíc známe rámcové historické datování. Jde o založení dvou církevních staveb – baziliky sv. Václava a kostela sv. Klimenta. Podle stratigrafického pozorování v terénu bylo možné odlišit hroby uložené před výstavbou kostela sv. Klimenta a ty, které byly vyhloubeny do zásypu základového vkopu tohoto svatostánku. Při modelování vývoje pohřbívání proto můžeme v těchto situacích pracovat s datováním *post* a *ante quem* (příkazy After a Before v kódovacím jazyce CLQ2), vztažené vždy k jednotlivým fázím pohřbívání a zakládání kostelních staveb, pro které známe rámcová kalendářní data (C_Date). Malá plocha sondy a velká kumulace hrobů navíc nabízí možnost využít k interpretaci dat i přímé superpozice dvou a více hrobů. Při modelování chronologické situace vycházíme z toho, že jednotlivé horizonty na sebe navazují, ale zároveň mezi vznikem jednotlivých kontextů mohla být i jistá časová prodleva. Radiouhlíkovou analýzou nebyly datovány hroby horizontu III. Celkový vícefázový model vznikl kombinací dat radiouhlíkových a kalendářních.

Z výsledků radiouhlíkové analýzy (*Tab. 2*; *Obr. 16*) vyplývá, že ostatky z nejstaršího hrobu starší fáze pohřbívání (H229, horizont 0) byly uloženy v intervalu krátce před rokem 1000 a nejpozději první třetinou 11. století, tedy v období předcházejícím založení baziliky sv. Václava (mezi lety 1039–1046). Radiouhlíková data pro hroby horizontu I,



Obr. 16. Modelovaná situace radiouhlíkových dat z hrobů v sondě 16 (A_{model}=115,2).

které byly vyhloubeny ještě před stavbou kostela sv. Klimenta, ale zároveň již u stojící baziliky sv. Václava, ukazují na poslední třetinu 11. nebo první polovinu 12. století. Je v nich patrný jistý odstup mezi vysvěcením baziliky (spojovaný obvykle s koncem její výstavby), k němuž mělo dojít krátce před polovinou 11. století, a datováním prvních hrobů, a to i kdybychom předpokládali, že byly uloženy v nejstarším možném úseku intervalu kalibrovaného stáří. Nabízí se otázka, zda stavba kostela sv. Václava nemohla trvat delší dobu, než se předpokládá, tj. ještě po vysvěcení kostela (1046). Datované pohřby nicméně nemusí patřit

stratigrafický horizont	hrob	kód vzorku	kalibrované stáří hrobu po modelaci, 95,4% pravděpodob.	Start horizontu, cal AD 95,4% pravděpodob.	End horizontu, cal AD 95,4% pravděpodob.
H 0	**H229**	CRL-230891	*994–1034*	*931–1037*	*1004–1048*
Sv. Václav				výstavba 1039–1046	
H I	**H227 Combine**	CRL-14261, CRL-14006	*1045–1054 (2.1%); 1078–1153 (93.3%)*	*1037–1118*	*1086–1165*
	H228	CRL-230890	*1041–1054 (6.1%); 1064–1134 (89.3%)*		
	H234	CRL-230892	*1043–1050 (3.1%); 1079–1143 (92.3%)*		
Sv. Kliment				výstavba 1. polovina 12. století	
H II	**H226**	CRL-230889	*1153–1214*	*1113–1199*	*1155–1285*
	H222	CRL-14008	*1127–1224*		
H III	*neodebráno*			?	?
H IV a H V	**H217**	CRL-15001	*1268–1388*	*1204–1365*	*1300–1401*
	H221 Combine	CRL-14007, CRL-15428	*1294–1369 (94.4%); 1385–1389 (1,1%)*		
	H220	CRL-14005	*1249–1386*		
H VI	**H218**	CRL-14004	*1312–1448*	*1307–1440*	*1314–1509*

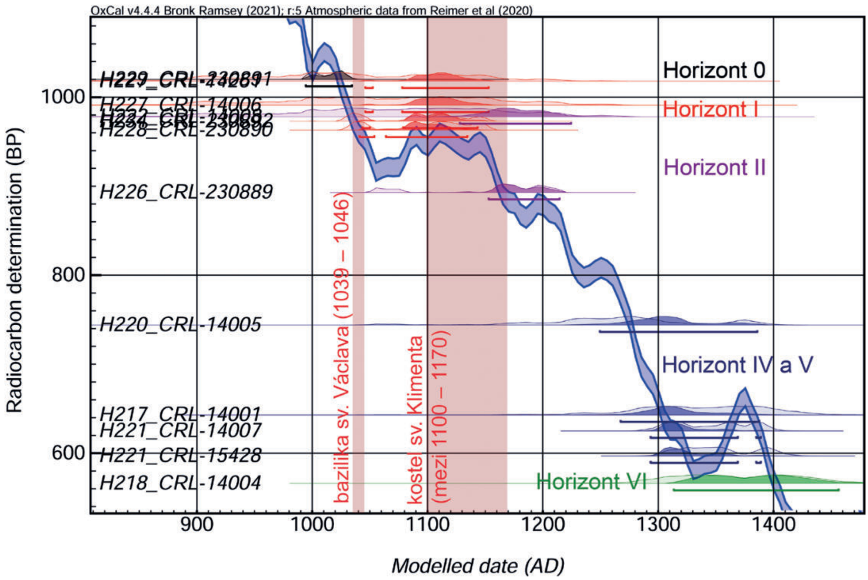
Tab. 2. Výsledky radiouhlíkové analýzy po modelaci.

mezi první uložené kolem nové baziliky a mohou reprezentovat dobu postupného zaplňování prostoru hřbitova. Detailní chronologii vývoje pohřbívání v okolí baziliky nedokážeme určit.

První pohřby horizontu II z počátku mladší fáze hřbitova byly ukládány již do zasypaného základového vkopu pro kostel sv. Klimenta. Dobu stavby určujeme pouze rámcově, nicméně dokončena by měla být nejspíše před 60. lety 12. století, kam je uměleckohistoricky datovaná vnitřní výzdoba, která ovšem není první úpravou interiéru. Z této nejednoznačnosti musíme vycházet i při modelování chronologické situace. Předpokládejme, že hroby horizontu I nemohly být uloženy později než v 60. letech 12. století a zároveň hroby horizontu II nemohou být starší než počátek 12. století. Mezi radiouhlíkovými daty obou zmíněných horizontů je patrný rozdíl. Zatímco horní možná datace horizontu I prakticky nepřekračuje polovinu 12. století, nejstarší možné datování horizontu II vychází do doby kolem poloviny tohoto století. Horní hranice datování horizontu II spadá do první třetiny 13. století (viz *Tab. 2*) a odpovídá slabým indiciím, které poskytuje keramický inventář ze zásypu hrobů.

Další radiouhlíková data, kterými disponujeme, se vztahují až k pohřebním horizontům IV a V. Stratigrafická situace těchto dvou horizontů byla v terénu velice špatně čitelná a nemůžeme vyloučit, že všechny analyzované hroby (H217, H220 a H221) patří ve skutečnosti do stejného horizontu. Z toho důvodu na horizonty IV a V pohlížíme při vyhodnocení radiouhlíkových dat souhrnně; hroby byly ukládané postupně v rozmezí druhé poloviny 13. a celého 14. století. Zdánlivě vyšší stáří celku H220 oproti datům hrobů H217 a H221 může být dáno spíše rozdílnými metodami měření (AMS oproti konvenčnímu).

Závěr pohřbívání v sondě 16 reprezentuje hrob H218 uložený během posledních tří čtvrtin 14. až v prvních dvou třetinách 15. století (viz *Tab. 2*). Vzhledem k tomu že překryv dat jednotlivých horizontů je velký, zdá se pravděpodobnější, že k uložení tohoto pohřbu



Obr. 17. Kalibrovaná radiouhlíková data vynesená na kalibrační křivku IntCal20.

došlo spíše ve starším až středním úseku kalibrovaného intervalu než v maximálním nejmladším možném rozmezí. Mezi hroby horizontů V a VI tak spíše nebyl výrazný časový předěl. Podobné úvahy však limituje malé množství vzorků pro jednotlivé fáze a také rozměry sondy, která v rámci celého hřbitova zaujímá pouze malou plochu. Vývoj ukládání hrobů se mohl na různých částech hřbitova lišit.

Data zpracovaná ještě konvenční metodou při kalibraci omezené na jednotlivé vzorky vykazují velmi široké intervaly kalibrovaného stáří. Z výsledků modelované situace vývoje pohřbívání však vidíme, že i tato data mohou přinést zajímavé výsledky a zpřesnit výslednou situaci. Tvar výsledných intervalů kalibrovaného stáří udává průchod kalibrační křivky a je na ní přímo závislý (*Obr. 17*). Z této vlastnosti vychází tvar výsledného intervalu, který se jen výjimečně soustředí do jednoho výrazného úseku. Naopak častěji dosahuje hustota pravděpodobnosti dvou nebo i tří vrcholů, někdy od sebe poměrně vzdálených.

Vzhledem k tomu, že se Stará Boleslav stala po založení kolegiátní kapituly sv. Kosmy a Damiána významným církevním centrem, které se navíc nacházelo v těsné blízkosti toku řeky Labe, byla zvažována možnost zkreslení výsledků radiouhlíkové datace možným vyšším podílem konzumace ryb. Ten bylo možné předpokládat nejen u osob přímo spojených s fungováním kapituly, ale díky silnému vlivu christianizačního procesu také u běžných obyvatel této významné církevní lokality. V důsledku vyššího zastoupení ryb ve stravě může dojít k tzv. sladkovodnímu rezervoárovému efektu (fresh water reservoir effect, FRE), který radiouhlíková data zdánlivě posunuje hlouběji do minulosti (např. *Bíšková et al. 2023*, 48; *Fernandes et al. 2012*). U hrobů analyzovaných v roce 2023 byla z tohoto důvodu provedena také analýza stabilních izotopů ^{13}C a ^{15}N, která odráží stravu daného jedince a může toto ovlivnění odhalit (*Fernandes et al. 2014a*; *2014b*). Z dosavadních výsledků vyplývá, že k možnému ovlivnění mohlo dojít v případě H226, tj. že tento jedinec konzumoval vyšší množství ryb (průměr $\delta^{15}N = 11{,}5 \pm 0{,}2$ ‰; průměrná hodnota modelu FRUITS pro sladkovodní ryby 4 ± 4 %). U hrobů ze starší fáze pohřbívání před založením kostela sv. Klimenta je podíl ryb v jídelníčku nižší (průměr $\delta^{15}N$ = 10,6 ± 1,2 ‰; průměrná hodnota modelu FRUITS pro sladkovodní ryby 2 ± 2 %).[3]

Zaměříme se proto na hrob H226. Pohřeb náležející do horizontu II byl situován nad základovým vkopem pro kostel sv. Klimenta. Vyvozujeme z toho, že v žádném případě nemohl být uložen dříve než v první polovině 12. století, zohledníme-li nejranější možné datování stavby. Zmíněný pohřeb se dále nacházel v přímé superpozici pod hroby H224 (horizont III) a H198 (horizont IV). Posledně jmenovaný leží pod radiouhlíkově datovaným H220. Výsledkem radiouhlíkového modelování celku H226 je interval *1153–1214 cal AD*, tedy doba bezprostředně navazující na dnešní představu o dataci kostela sv. Klimenta a odpovídající předpokládanému stáří horizontu II. Pokud by radiouhlíkové datum bylo ovlivněno FRE, jevilo by se starší než ve skutečnosti. Po odstranění tohoto vlivu bychom tedy měli získat výrazně mladší dataci. Celková nálezová situace a uložení v superpozici pod několika hroby nicméně z archeologického pohledu výrazně mladší datování neumožnuje. Z uvedeného vyplývá, že pokud je vliv FRE přítomen, nemá zásadní dopad na výsledky radiouhlíkové analýzy.

Příklad H229, jehož datace i zde spadá do období staršího, než jsou historicky známá data pro založení baziliky nám v rovině hypotézy umožnuje předpokládat, že v jádru akropole mohou existovat hroby, uložené před vznikem tohoto chrámu. S takovou alternativou je třeba počítat nejen vzhledem k původnímu uložení ostatků knížete Václava před translací do Prahy, ale i vzhledem k starším náhodným nálezům hrobů se středohradištními nádobami, lokalizovatelných do širšího prostoru jihovýchodně od baziliky sv. Václava (*Sláma 1977*, 153, tab. 40: 1, 6). Středohradištní či starší mladohradištní hroby v intravilánech sídlišť bývají v Čechách ojedinělé a jsou spojovány s elitním prostředím. V centrálních lokalitách prvního řádu se objevují rovněž prvá kostelní pohřebiště i hroby příslušníků nejvyšších společenských vrstev přímo v kostelích. K přesunu pohřebních areálů z extravilánů do jader sídel dochází někdy od poloviny 11. století, často právě v souvislosti se zakládáním dalších sakrálních staveb (*Boháčová 2011b*, 5; *Havrda – Tryml 2021*, 316–317). Otázka pohřbívání v historickém jádru Staré Boleslavi již ve středohradištním a ve starší fázi mladohradištního období a zejména jeho intenzita zůstává tedy nevyjasněná a měla by jí být věnována pozornost i v budoucnosti. Výsledky radiouhlíkové analýzy existenci hrobů tohoto stáří i v historickém jádru Staré Boleslavi podporují.

Radiouhlíková data nám neumožnují zpřesnit datování výstavby kostela sv. Klimenta, ke které podle současného stavu poznání došlo nejspíše v první polovině 12. století, nejpozději v 60. letech tohoto věku. Přiřazení konkrétních hrobů horizontu I a II vychází ze statigrafického pozorování. Bez znalosti základového vkopu pro kostel sv. Klimenta bychom situaci pouze na základě radiouhlíkových dat nebyli schopni správně interpretovat. Modelovaná radiouhlíková data nicméně dovolují hledat nejpravděpodobnější datování předělu mezi horizonty I a II v polovině 12. století. Nelze vyloučit, že k výstavbě kostela sv. Klimenta došlo záhy po roce 1100, ale spíše se tak stalo až někdy před polovinou nebo kolem poloviny 12. století. Situaci neulehčuje ani samotná kalibrační křivka, na níž se ve sledované době objevuje drobné plató, které deformuje výsledky datování (*Obr. 16*).

[3] Za provedenou analýzu děkujeme S. Drtikolové Kaupové z Národního muzea v Praze.

Získaná data pohřbu H218, který je řazený do nejmladšího horizontu, navozují další a dříve neřešenou otázku, zda závěr intenzivního pohřbívání při bazilice a při kostele sv. Klimenta nespadá již do 15. století a nesouvisí se zpustošením baziliky během husitských válek (k roku 1421). Jednoznačně novověké hroby jsou v prostoru kapitulního areálu zatím archeologicky prokázány jen výjimečně (*Špaček 2012*). Novověký hřbitov je naopak doložen při stojícím kostele Nanebevzetí P. Marie. Kostel zasvěcený P. Marii je zmiňován na předhradí před rokem 1541 (*Paprocký z Hlohol 1602*).

Závěr

Plošně omezený výzkum v historickém jádru přemyslovského hradu se dotkl klíčové polohy ve východní části kapitulního areálu, vzniklého těsně před polovinou 11. století. Sondou při severní zdi románského kostela sv. Klimenta a jižní apsidě baziliky sv. Václava zachytil 20 hrobů etážového pohřebiště, jehož vývoj byl na základě stratigrafických pozorování rozčleněn do sedmi hřbitovních horizontů, z nichž dva předcházejí výstavbě kostela sv. Klimenta. Vzhledem k jedinečnosti nálezové situace, zachycující v relativně krátkém období vývoj lokality v nejmladší fázi raného středověku a ve vazbě na dostupná historická data, byly ostatky z deseti hrobů využity pro radiouhlíkovou analýzu. Komparace vyhodnocení archeologické situace a historických údajů s pravděpodobnostním modelováním radiouhlíkových dat ukázala, že základní interpretace vývoje pohřebního areálu byla správná, některé otázky však nebylo možné na základě terénního výzkumu vyřešit: nezachytil počátky pohřbívání a jeho výsledky neumožnily přesněji stanovit ani závěr pohřbívání; výpověď archeologických pramenů neupřesnila interval, do něhož je kladen vznik kostela sv. Klimenta. Poznatky získané archeologickým výzkumem sondy 16 jednoznačně potvrdily předpokládaný vývoj lokality a jeho chronologii, prokázaly následnost dvou významných raně středověkých sakrálních staveb a umožnily definovat detailní vývoj pohřbívání v jejich okolí. Využití členité stratigrafie s významnými historicky datovanými předěly pro radiouhlíkovou analýzu však tyto poznatky dále upřesnilo a přineslo i nové podstatné závěry, které nejen přispívají k poznání vývoje Staré Boleslavi, ale v širším kontextu jsou významné pro řešení nejen chronologických, ale i obecně historických otázek z období raného i vrcholného středověku.

Přestože radiouhlíková analýza nebyla použita pro hroby horizontu III, disponujeme téměř kompletní absolutně datovanou stratigrafickou situací. Základní poznatky vyplývající z modelování radiouhlíkových dat a jejich komparace s výsledky studia historických oborů lze shrnout do několika tezí.

1) Radiouhlíková data naznačují, že nejstarší pohřby byly v daném prostoru ukládány ještě před založením baziliky sv. Václava. Kromě historicky doloženého dočasného uložení ostatků knížete Václava před translací do Prahy, by mohlo jít především o elitní hroby v historickém jádru lokality a v blízkosti historicky známého kostela sv. Kosmy a Damiána, jehož poloha není známa. Tento kostel bývá předpokládán ve východní části kapitulní baziliky.

2) Datace hrobů horizontu I uložených před výstavbou kostela sv. Klimenta spadá do intervalu mezi historicky datovaným vznikem baziliky s kapitulou a předpokládanou dobou vzniku kostela sv. Klimenta, která je především odvozována od interiérových úprav a z uměleckohistorického rozboru jeho freskové výzdoby, respektive tuto mez jen málo

překračuje. Archeologické prameny nepřinášejí k této otázce žádné relevantní informace. Modelovaná sekvence radiouhlíkových dat umožňuje hledat nejpravděpodobnější předěl mezi horizonty I a II rámcově v polovině 12. století. Závěru, že ke vzniku kostela sv. Klimenta dochází spíše v mladším období, než na počátku 12. století, nasvědčuje i datace pohřebního horizontu II. Horní hranice časového intervalu pohřbů tohoto horizontu se pohybuje v rozpětí 2. poloviny 12. až 1. třetiny 13. století. Vzhledem k tomu, že rozlišení stavebních a technologických fází úprav interiéru kostela sv. Klimenta a intervalů mezi nimi nemůže být jednoznačné, datování vzniku kostela blíže k polovině 12. století se jeví jako pravděpodobné a odpovídá existenci neupřesněného a zřejmě nevelkého intervalu mezi prvotní úpravou interiéru a jeho následnou výmalbou ve třetí čtvrtině 12. století, respektive v jeho 60. letech.

V bezprostředním okolí baziliky došlo v období před založením kostela sv. Klimenta, nejspíše během první poloviny 12. století, k nárůstu terénů o několik desítek centimetrů. Takový rychlý vývoj by mohl souviset s doloženou stavební aktivitou a nejspíše s rozsáhlejším přemisťováním zeminy.

3) Chronologie pohřbívání, naznačená radiouhlíkovým modelem, koresponduje s poznatky z terénního výzkumu, který dokládá změny v pohřebním ritu nastupující v závěru raného středověku a v průběhu 13. století. Markantní je proměna polohy horních končetin zemřelých. Oproti staršímu zvyku ukládáni rukou podél těla, jsou nyní uloženy v různých pozicích na trupu. Křížení rukou na hrudi zde doloženo není. Změna polohy rukou může souviset s ukládáním těl do rakví, pro jejichž přítomnost svědčí nejdříve výskyt zlomků pásových kování, posléze zejména kované hřeby provázející mladší část hřbitovního horizontu. Výjimečným je pohřeb v mohutné dubové rakvi, vybavené kruhovými závěsy, který patří ve zkoumané ploše k nejstarším pohřbům při kostele sv. Klimenta a jehož uložení může spadat ještě do 2. poloviny 12. století.

4) Pohřbívání je ve sledovaném prostoru radiouhlíkovou datací kosterních pozůstatků doloženo pro celý vrcholný středověk, naznačeno je i nečetným keramickým inventářem vrcholného středověku v zásypech hrobů. Otázkou zůstává jeho útlum, k němuž mohlo dojít v souvislosti s historicky známou devastací lokality včetně baziliky v průběhu husitských válek na počátku 20. let 15. století. Radiouhlíkové datování tuto variantu umožnuje.

Získaná data potvrdila správnost archeologické interpretace vývoje zkoumaného prostoru a jeho chronologie včetně nástupu změn v pohřebním ritu s počátkem vrcholného středověku. Zároveň také naznačila možnost založení kostela sv. Klimenta v poněkud mladším období a nastolila témata, kterým bude potřeba věnovat pozornost v budoucnosti. Mezi ně patří především otázka pohřbívání v historickém jádru lokality před vznikem kapituly, kontext vzniku kostela sv. Klimenta a rovněž datace vyznívání intenzivní fáze pohřbívání v širších historických souvislostech. Současně výsledky analýzy potvrzují, že interpretace radiouhlíkových dat je komplikovanou otázkou a jejich využití je vhodné především v kontextu výpovědi dalších pramenů.

Příspěvek je výstupem projektu GAČR 2307198S Raně středověké centrum – topografie, funkce, proměny: přemyslovská Boleslav a její transformace v sídlo kolegiátní kapituly (900–1200). Detailní vyhodnocení dat radiouhlíkové analýzy N. Koštovou bylo vypracováno na základě podpory z OP JAK MŠMT, v rámci projektu Připraveni na budoucnost: porozumění dlouhodobé odolnosti lidské kultury (RES HUM), Reg. č. CZ.02.01.01/00/22_008/0004593.

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The development of the early medieval centre of Stará Boleslav revealed by radiocarbon dating of the multi-level cemetery at the Basilica of St Wenceslas and the Church of St Clement

The excavation limited to the historical centre of the Přemyslid castle was targeted at a key location in the eastern part of the chapter area built just before the middle of the 11th century. The test pit at the northern wall of the Romanesque Church of St Wenceslas captured 20 graves from the multi-level cemetery, the development of which was divided based on stratigraphic observations into seven basic cemetery horizons (0–VI), two of which precede the construction of the Church of St Clement (horizon 0 and 1). Due to the uniqueness of the find situation capturing in a relatively short period the development of the site in the latest phase of the Early Middle Ages and in relation to absolute dates based on available historical sources, the remains from ten of the graves were used in two phases (2014–2015, 2023) for a radiocarbon dating analysis in order to verify the interpretation of the uncovered terrain situation and its dating based on historical and archaeological sources. A comparison of the evaluation of the archaeological interpretations with the results of the radiocarbon analysis confirmed these interpretations and also made it possible to significantly refine the chronology of local burials.

The basic knowledge from the detailed analysis of the obtained radiocarbon dates and their comparison with the results of the study of historical disciplines can be summarised in several theses (*Fig. 15*; *Fig. 16*).

1) The earliest burials were made at the given location before the founding of the Basilica of St Wenceslas (horizon 0). These could primarily be elite graves in the historical core of the site and near the historically well-known Church of St Cosmas and Damien, whose location is not yet verified (but is assumed to be in the eastern part of the basilica). However, the overall extent and intensity of this burial is not known.

2) The dating of horizon I graves buried before the construction of the Church of St Clement falls in the interval between the historically dated construction of the Basilica of St Wenceslas with the chapter and the estimated time of the construction of the Church of St Clement, which is mainly derived from the interior and the art-historical analysis of its fresco decoration (or it only slightly exceeds this dating). Archaeological sources do not provide any relevant information on this question. The modelled sequence of radiocarbon dates makes it possible to search for the most probable dating of the divide between horizon I and II in the middle of the 12th century. We can consider that the founding of this church took place around the middle of the 12th century rather than at its beginning.

The conclusion that the Church of St Clement occurred later than the beginning of the 12th century is also supported by the dating of the graves of horizon II, whose upper limit of burial ranges from the second half of the 12th to the first third of the 13th century. Given that the distinction between the construction and technological phases of the interior of the Church of St Clement and the intervals between them cannot be unequivocal, the dating of the creation of the church closer to the middle of the 12th century seems likely and corresponds to the existence of an unspecified – and perhaps small – interval between the initial treatment of the interior and its subsequent painting in the third quarter, or in the 1160s.

3) The chronology of burials indicated by radiocarbon analysis corresponds to findings from field research, which demonstrates changes in the burial rite that occurred at the end of the Early Middle Ages and during the 13th century. The change in the position of the upper limbs of the deceased is striking: in contrast to the older practise of placing the arms along the body, they are folded across the chest, or the hands are clasped on the abdomen. Arms crossed on the chest are not documented directly in this area. The change in the position of the arms may be related to the deposition of bodies in coffins, the presence of which is first evidenced by the rare appearance of coffin band fittings, and later by the appearance of forged nails that line the remains of the deceased. A burial in a massive oak coffin fitted with circular hinges is exceptional and belongs to the oldest burials near the Church of St Clement and whose deposition may still date back to the second half of the 12th century.

4) Intensive burial in the studied area is documented by the radiocarbon dating of skeletal remains for the entire High Middle Ages and is also indicated by the large high medieval ceramic inventory in the backfills of the graves. Remaining unanswered is the question of the decline in burial, which, as radiocarbon dates suggest, could have occurred in connection with the historically known devastation of the site, including the basilica, during the Hussite Wars in the early 1420s.

The obtained dates confirmed the correctness of the archaeological interpretation concerning the development of the investigated area and its chronology, indicated the possibility of moving the founding date of the Church of St Clement to a somewhat later period, confirmed the onset of changes in funeral rites with the emergence of the High Middle Ages and also raised some topics that will need attention in the future. These include, above all, the question of burial in the historical core of the site before the creation of the chapter, as well as the question of dating the end of the intensive phase of burial. At the same time, the results of the analysis confirm that the interpretation of radiocarbon dates is a complicated issue and their use is especially appropriate in the context of the testimony of other sources. Of key importance in the case of the presented sample of dates is the fact these are not isolated dates, but rather a set of ten stratified samples from a fragmented burial horizon.

IVANA BOHÁČOVÁ, Archeologický ústav AV ČR, Praha, Letenská 4, CZ-118 00 Praha 1, Czech Republic
bohacova@arup.cas.cz
NIKOLA KOŠTOVÁ, Archeologický ústav AV ČR, Praha, Letenská 4, CZ-118 00 Praha 1, Czech Republic; Ústav jaderné fyziky AV ČR, Hlavní 130, 250 68 Husinec, CZ-260 68 Řež, Czech Republic; kostova@arup.cas.cz

BOOK REVIEW – RECENZE

Françoise Bostyn – Jacek Lech – Alan Saville – Dagmara H. Werra (eds.): Prehistoric Flint Mines in Europe. Archaeopress Publishing, *Oxford 2023*, ISBN 978-1-80327-222-1. 530 stran, 418 obrázků, 22 tabulek.

Koncem loňského roku spatřila světlo světa dlouho očekávaná publikace evropských revírů hloubkové těžby silicitů. Sborník, který se začal sestavovat už před dobrou desítkou let, zdržely nejprve problémy se srozumitelností překladů do angličtiny, poté úmrtí hlavního výkonného editora A. Savilla a posléze neochota oslovených institucí převzít finanční náklady na vydání tak objemného díla. Zdá se, že nakonec byl výběr zastoupených lokalit a autorů veden snahou po zdůraznění názoru, že pravěká těžba silicitů byla motivována hlavně obstaráváním surovin na nástroje. To je jaksi automaticky předpokládáno již v úvodní souhrnné kapitole *About the beginnings of prehistoric archaeology, studies of stone artifacts and ancient flint mines* (s. 1–15) z pera editorů kromě zesnulého A. Savilla. Přináší sice cenný přehled historie objevování a publikování silicitových dolů, avšak téměř nic o jejich účelu či vůbec smyslu.

V následující části jsou vybrané dobývky rozdělené do dvou úseků, totiž na ty významnější, resp. více zkoumané („key sites") a na ty ostatní. Klíčové lokality mají být jen čtyři: Defensola v Itálii, Rijckholt-St. Geertruid v Nizozemsku, Spiennes v Belgii (kde podle první kapitoly celé zkoumání pravěké těžby roku 1867 začalo) a Grime's Graves v Anglii. S výjimkou prvé lokality na nich těžba z křídových sedimentů vždy vrcholila ve starším a středním eneolitu (tj. v mladším neolitu dle používaného západoevropského schématu), a dobýval se na nich pazourek výtečné kvality, čímž zapadají do navyklého obrazu počátků evropského hornictví. Zmíněnou výjimku představují dobývky u Defensoly na poloostrově Gargano, protože ty fungovaly již v době nejstarší neolitické kultury s impresso keramikou. Jejich nejstarší fáze jsou tedy současné s ještě mezolitickými počátky těžby v Krumlovském lese. Pojednává o nich stať *The Early Neolithic mine of Defensola and the Gargano Promontory (Italy)* od A. Galiberti a M. Tarantini (s. 19–57). Technika těžby prostřednictvím rozsáhlé sítě štol s komorami, časem zaplňovanými odvalem, je vzhledem k časnému datování značně pokročilá. Štoly se šířily horizontálně do vápencových lavic s rohovci na ploše snad 4 km^2, a vlastní rohovce, v přerušovaných polohách ca 10–15 cm mocných, se vylamovaly buď ze stropu nebo ze schůdku u dna štoly. V celém prozkoumaném systému chodbiček se nachází jen jedna svislá přístupová šachta A3 a pod ní leží jediná koncentrace výrobního odpadu a polotovarů, tedy tzv. dílna. Tu a tam se na podlaze najde celá nádoba, podobná těm z jeskyně Copa Navigata, na stěnách lze pozorovat nepravidelné porýhování nebo i dělený obdélník a našla se i jedna lampa, tj. kus vápence s důlkem. Ojedinělá těžba z konce eneolitu je pak daleko jednodušší a nahodilejší.

Ostatní klíčové lokality si představíme jen heslovitě: *The mining complex at Rijckholt-St. Geertruid (Eiisden-Margraten, Limburg, The Netherlands)* z pera M. E. Th. de Grooth, J. Deeben, J. W. de Kort, a J. Schreurs, (s. 59–102) popisuje síť minimálně 75 šachet rozšířených u dna do komor nebo směřujících do chodbičkovitých systémů na ploše 2500 m^2, datovaných hlavně do mladší fáze kultury michelsberské, lidské pozůstatky jsou vesměs mladší; vyráběny dlouhé čepele a sekyry s širokou distribucí. *The Neolithic flint mines of Spiennes (Belgium)* od H. Collet a P. Collin (s. 103–130) představuje dobývání sestávající z více šachet s rozšířením do vyšších komor, až do hloubky 15 m, a méně propojených systémů než na předchozí lokalitě, datování (kulturní příslušnost) a produkce podobná, šíření méně rozpoznatelné. Kapitola *Grime's Graves (Norfolk, England)* od F. Healy, P. Topping a G. Varndell (s. 131–164) popisuje odlesněné pole se stovkami pinek, jež představují mohutné zasypané šachty s komorami na bázi, hloubka do 12 m, datované do 3. tisíciletí BC (kultura Grooved Ware), produkovány sekery a „diskovité nože" s částečnou plošnou retuší, produkce mladší fáze (pohárové kultury a doba bronzová, těžba z jednodušších šachet) není známa, distribuce produktů nejasná.

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V nejobjemnější druhé části knihy, nazvané *Some other European Flint Mines* (s. 165–485) se seznámíme s dobývkami od Španělska po Polsko. Jiné země z východní části střední Evropy a z východní Evropy tu již zastoupeny nejsou. Pojednány jsou lokality Casa Montero (Španělsko, stovky šachet do hl. 9 m ze staršího neolitu, čepelová jádra), Tomaszów I (těžba čokoládového silicitu z jednoduchých šachet do hl. 3 m ve Svatokřižských horách, starší neolit s možnými počátky v mezolitu až doba bronzová, čepele), Sąspów (krakovsko-čenstochowská jura, neolitická těžba z prostých šachet do hl. 4 m, čepele, rozsáhlá dílenská výroba a distribuce v mladší LnK), Ash-Borgerhau ve Švábské Albě (neolitické a eneolitické jámy ve vápenci do hl. 2 m, čepele do 10 cm délky), Lousberg u Cách (středoeneolitická terasová těžba rohovce, hojné parohové a rohovcové těžební nářadí se středním zúžením, export polotovarů seker na stovky km hlavně SV směrem), a Nagytevel poblíž Balatonu v Maďarsku (mělká těžba limnosilicitů, radiolaritů a rohovců, čepelová jádra, doklady distribuce suroviny jižním směrem ovšem nemusejí souviset s dolováním). Další vzájemně vzdálené body spojuje jen jejich narůstající vzdálenost od středoevropského prostoru: Södra Sallerup ve Švédsku (staroeneolitická těžba senonského pazourku z jednoduchých šachet až 5 m hlubokých, čepele, šipky a sekery, jimž podobné byly rozšířené v celé jižní Skandinávii, v polozaplněné šachtě hrob ženy), Cissbury v Anglii (mohutné šachty do křídy se sály a ohništi u dna, pohřby, eneolitická výroba polotovarů seker), Jablines v SV Francii (pole s tisícovkou dokumentovaných šachet, hlubokých až 2,5 m, u báze rozšiřovaných do chodbiček a komor, jež však netvoří souvislé koridory, vrcholí v michelsberské, případně chaséenské kultuře, distribuce polotovarů seker severním směrem ke Spiennes), Ri-Ronai v SZ Francii (lokalita v mnoha směrech podobná předchozí, parohové kopáče, dílny), Plancher-les-Mines a dvě jiná těžní pole v SV Francii (husté a rozsáhlé koncentrace šachet ze staršího eneolitu).

Dvěma polským koeditorům jistě vděčíme za zařazení posledních dvou lokalit, protože dokládají rozsáhlé hlubinné dolování ještě v době bronzové a železné. Prvou z nich je Borownia ve Svatokřižských horách, kde se ve starší době bronzové (asi mierzanowické kultuře) těžil z mělkých jam týž páskovaný silicit jako v Krzemionkách a vyráběly se z něj hlavně polotovary seker. Těžba páskovaného silicitu se ovšem provozovala i v Korycizně, a přežívala i v samotných Krzemionkách, činných hlavně v kultuře kulovitých amfor. Také na lokalitách Ożarów, Polany II, Polany – Kolonie II a Tomaszów spadá vrchol těžební činnosti do starší doby bronzové. Poslední zastoupenou lokalitou pravěké těžby je Wierzbica-Zele, kde se z mnoha hlubokých šachet, při bázi někdy jen lehce rozšířených, těžil kvalitní čokoládový silicit a od starší doby bronzové až do konce doby popelnicových polí se z něj odrážely úštěpy z diskovitých jader, vyráběly úpadkové polotovary seker a později nože typu Zele se strmým hřbetem. Vyskytují se tu i jádra („*paracores*“), z nichž nelze odrazit nic užitečného, takže se autoři (J. Lech a D. H. Werra) domnívají, že práce měla i rituální důvody, spojené s kultem předků jako v Krumlovském lese (s. 475).

Tento názor a celý podobný diskurz je tu však výjimkou, což souvisí s výběrem lokalit, které takové otázky nutně nevyvolávají, tj. spadají do období, kdy byl o kamenné nástroje ještě zájem, protože se s nimi pracovalo (tzn. do doby kamenné), a kde se těžil výtečný silex, šířený na značné vzdálenosti. To je ovšem doložitelné jen tam, kde se těžený silicit něčím odlišuje od ostatních, např. u některých dolů v Anglii a v Rijckholtu. Některým autorům naplnění shora vyjmenovaných kritérií stačí, jiní však přesto o praktických účelech těžby i v těchto „jasných“ případech pochybují (s. 154–155). V případě Grime's Graves poukazují třeba na ponechané nádoby a figurálně opracované (falické?) kusy křídy, jinde o rituálních dimenzích těžby svědčí získávání variet pazourku, které z funkčního hlediska zaostávaly za těmi, které bylo možno nabýt snadněji (Cissbury, s. 353). Zcela se opomíjí skutečnost, že většina vytěženého kvalitního pazourku sice posloužila k výrobě sekerových polotovarů, později i broušených, nebo dlouhých čepelí, jejichž role byla ovšem socio-rituální a teprve druhotně pracovní. Nejde tedy ani tak o charakter lokalit, ale o přemýšlivost jednotlivých autorů, jak dokazuje třeba názor, že činnost v pazourkovém dole u Södra-Sallerup ve Švédsku (který všechna funkcionalistická kriteria splňuje) a pravěká těžba silicitů obecně musela odrážet společenské poměry a symbolické projevy tehdejší společnosti (s. 335–336).

Zatímco lokality v prvé části sborníku jsou opravdu klíčové (a postrádáme mezi nimi velmi známé Krzemionki), ve druhé části jsou vedle těch důležitých i takové, které mnoho nevypovídají – příkladem je třeba povrchová těžba rohovců v Ash-Borgerhau a různých silicitů u Blatenského jezera, jakých by se našlo jistě mnoho.

Rozpory s technicky utilitárním výkladem pravěkého dolování silicitů vyvstávají nejvíce v těch případech, kdy se těžila podřadná surovina, k výrobě prestižních či rituálních předmětů nevyužitelná, a dobývala se mohutně, dlouho a dokonce hlavně v době, kdy o vytěžený kámen nebyl prakticky ani společensky motivovaný zájem. Typický příklad takových revírů leží v Krumlovském lese na jižní Moravě, kde se poměrně nekvalitní rohovec těžil od mezolitu až do starší doby železné s vrcholem v době kultury únětické. Krajina s markantními pozůstatky těžby (pinky, terasy, odvaly, kvanta štípané industrie, sedátka pro štípače, upravené skalní výchozy) byla zpočátku využívána jako těžební (ať už byla její motivace jakákoli) a posléze jako ritualizovaná země předků s krajinnými antecedenty. Ve starší době bronzové se tu těžilo ze stovek mohutných šachet a vršky protěžovaných hřbítků se snížily, aby se nakonec opět restituovaly, přičemž štípání rohovců stále sílilo. Za tímto zvláštním, ale dostatečně dokumentovaným procesem je spatřována proměna vztahu k předkům, kteří tuto činnost určovali (*Oliva 2019*; *2022*). Je to jistě případ krajní, na jiných dobývkách jej doložit nelze, ale byla by škoda jej nebrat v úvahu.

Z tohoto hlediska je nový sborník o nejvýznačnějších místech pravěké těžby silicitů promarněnou šancí. Bylo by totiž možné ukázat původní názor, dlouho považovaný za jediný možný, že šlo o získávání suroviny na pracovní nástroje, jako pochybný a téměř vždy nepravděpodobný. Je nadále zatěžko chtít po specialistech na keramický pravěk, aby v pravěkém dolování hledali společenské a symbolické dimenze, když je tam nehledají ani sami badatelé zabývající se těžbou. Snad je to tím, že ti původně ani archeology nebyli a měli blíže k inženýrské montanistice, a proto není divu, že archeology a zájemce o pravěk vidina takové technicistní četby, jakou publikace o pravěkých dolech slibují, nikdy příliš nelákala.

I v novém reprezentačním sborníku se ovšem čtenář dozví mnoho nových skutečností, ale jen o vybraných lokalitách. I z tohoto faktografického hlediska zůstává dílo poměrně kusé oproti daleko kompletnějším přehledům v objemném katalogu z Bochumi (*Weisgerber et al. 1981*) a článcích v ročníku č. 33(1995) časopisu *Archaeologia Polona*.

Martin Oliva

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