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CONTENT – OBSAH

EDITORIAL

We live in an immensely interconnected world. Digital information and data, being immaterial, can travel across the globe in seconds. Modern technology also enables the rapid movement of people. If one wishes, it is possible to have breakfast in London, dinner in Tokyo, and continue on to New York the following day. Nevertheless, bearing in mind the ontological turn that archaeology has experienced in the last decade or two, we must also recognise that the same mobility was also bestowed on non-human things. In fact, things may now be more mobile than people. Although I cannot support this with precise statistics, it is difficult to ignore that there are more machines in orbit than astronauts, cargo ships outnumber cruise liners on the seas, and parcel lockers have quietly taken over our streets and parking lots, distributing vast quantities of goods each day.

Things have become largely trans-local. It is not uncommon that a single, relatively simple object may consist of components produced in far-flung regions of the world. Unfortunately, with such mobility of things also comes greater dependency; the comfort of the modern world proves to be fragile. A few years ago, the COVID pandemic exposed the weaknesses of complex global supply chains on a full scale, only to be continued today by trade wars and the use of critical resources as weapons of international politics.

But is interconnectedness and the long-distance transport of objects a uniquely modern phenomenon? Archaeological evidence suggests otherwise. Although they likely did not bind people in such dependency, extensive networks can be traced deep into prehistory. This issue's first paper provides an interesting example. Milan Salaš and colleagues tracked the origin of a Late Bronze Age casting mould found in South Moravia back to the Carpathian Basin. Petrographic analysis shows that the mould was made of rhyolite tuff available in adequate quantities in northern Hungary. The type of spearhead it produced was also common in the northern Carpathian Basin. What remains beyond the reach of current methodology is whether inhabitants of South Moravia realised the origin of the mould they were (most probably) using for smelting.

Although prehistoric connections are widely acknowledged, the nature of exchange differed significantly from today's systems. In his classic 1924 study, Marcel Mauss described the exchange of things in traditional societies as governed by complex social and symbolic obligations. Rather than a system shaped by supply, demand, and profit, it functioned through a hard-to-escape framework of gift-giving and obligations. Nonetheless, it allowed objects to migrate from one owner to another and reach distant sites. When and how then did our modern commercial system commence? In his paper, Maciej Miścicki examines an interesting aspect linked to the Hanseatic League, a medieval organisation that laid the ground for the modern capitalist economy. Miścicki analysed 112 fragments of medieval wooden barrels with carved or branded marks found in several Baltic towns. The results show that at least some types of marks can be related to mercantile contexts, either as ownership or content labels. In some ways, they can be considered similar to the modern EAN 13 bar code system. These inconspicuous, yet likely the world's most widespread marks can provide information about the state of origin, which can be inferred simply from the first three digits of the code, no scanners needed. Most people are completely unaware of this, even though they are surrounded by EAN 13 codes every day.

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Were barrel marks so mundane but also encrypted for inhabitants of Baltic towns in the 14th to 16th century?

Trade did not occur randomly, but was organised in specific places and times – the markets. These gatherings, bringing together people, goods, and materials from diverse backgrounds, have always attracted the attention of anthropologists and archaeologists. Jakub Sawicki and Jan Hasil contribute to this line of research through their spatial analysis of a modern flea market in Cieplice, Poland. Their study is a fresh contribution to Central European archaeology, where garbological approaches are still relatively rare. As many scholars engaged in analysing spatial patterns and taphonomy know, spatial data from archaeological sites can be frustratingly ambiguous. Despite this, Sawicki and Hasil were able to identify several behavioural patterns in the material record of the flea market. Indeed, their task was eased by their familiarity with the social and functional contexts of the objects they studied, which is a luxury that prehistorians usually do not enjoy. Still, their results bring an important grain of hope that spatial analysis can help us to interpret medieval marketplaces and other periodically used sites frequented by large numbers of people.

The triad of high-medieval papers in this issue is concluded by Martin Miňo and colleagues, who present a multidisciplinary analysis of material excavated at the site of the medieval town hall in Bánská Bystrica, Slovakia. Dealing with material retrieved during rescue excavation, the authors were faced with difficulties due to insufficient documentation. They used 3D-based modelling aided by artificial intelligence. I believe this approach can inspire many other researchers dealing with a similar situation. The study by Martin Miňo and colleagues provides insight into the economy of the town, which was oriented toward livestock. Herding influenced the surrounding landscape and helped to preserve open niches of meadows and pastures. The authors thus demonstrate that intra-mural archaeological research is also valid for addressing broader ecological questions.

Václav Vondrovský

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

A unique stone mould for casting a spearhead from Morkůvky in South Moravia as an example of long-distance import in the Urnfield Period, and its technological contribution

Unikátní kamenný kadlub na hrot kopí z Morkůvek na jižní Moravě jako příklad dálkového importu v době popelnicových polí a jeho technologický přínos

Milan Salaš – Antonín Přichystal – Jan Petřík – Karel Slavíček – Dalibor Všianský – Vojtěch Nosek

The paper provides a comprehensive analysis of a well-preserved half of a stone mould, accidentally found in the village of Morkůvky (Břeclav District). Although it is a stray find, it is characterised by above-standard informative value from the point of view of both typology and technology, as well as in terms of raw material provenance. According to macroscopic traces and XRF–XRD analyses, bronze was poured into vertically erected halves of the mould, which were tightened with copper wire. The negative reveals that the mould was used to cast a socketed lanceolate spearhead, in which each of the flanking blade wings and the midrib carried a longitudinal rib. This spearhead type is commonly found in the Carpathian Basin and is mostly dated to the Late Bronze Age. The area of its most frequent occurrence thus indicates the Carpathian origin of the mould, which was verified by petrographic analysis. According to its results, the casting mould is made of rhyolite tuff, i.e. a rock that occurs in adequate quantities in northern Hungary. The casting mould from Morkůvky is thus demonstrably the result of long-distance import and further evidence of Carpathian influences in the Middle Danube Urnfield Culture.

South Moravia – Late Bronze Age – spearhead – XRF/XRD analyses – petrography – material provenance – Carpathian imports

Příspěvek přináší komplexní analýzu unikátně dochované poloviny kamenného kadlubu, náhodně nalezeného v obci Morkůvky (okr. Břeclav). I když je to ojedinělý nález, vyznačuje se nadstandardní vypovídací hodnotou, a to z hlediska jak typologického a technologického, tak surovinově provenienčního. Podle makroskopických stop a XRF–XRD analýz byl do svisle postavených a měděným drátem stažených polovin kadlubu vléván cínový bronz. Dobře dochovaný negativ prozrazuje, že v kadlubu byl odléván hrot kopí s hruškovitě tvarovanou čepelí, žebírky profilovaným listem i žebírkem v listové části tulejky. Tento typ kopí je na Moravě přitom vzácný, běžně se vyskytuje v karpatské oblasti a většinou je datovaný do mladší doby bronzové (stupně B D-Ha A). Těžiště jeho územního výskytu proto také indikuje karpatský původ samotného kadlubu, což verifikovala petrografická analýza. Podle ní je odlévací forma vyrobena z ryolitového tufu, tedy horniny, která se v adekvátním množství vykytuje nejblíže v severním Maďarsku. Kadlub z Morkůvek je tak prokazatelně výsledkem dálkového importu a dalším dokladem karpatských vlivů v prostředí kultury středodunajských popelnicových polí.

jižní Morava – mladší doba bronzová – hrot kopí – XRF/XRD analýzy – petrografie – provenience suroviny – karpatské importy

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Introduction

Casting moulds which provide evidence of metallurgical or metal-founding production are still relatively rare among the Bronze Age finds, and their number does not correspond to the enormous volume of bronze artefacts and bronze casts found. However, this disproportion is only apparent, distorted by the nature of the sources, the very material essence of the casting moulds, and the foundry technology. Solid, permanent moulds, mostly made of stone, rarely of bronze, were used repeatedly and allowed mass production. The otherwise certainly numerous, but mostly single-use clay moulds as well as moulds for the lost-wax casting are more difficult to identify in the pool of finds, and the technique of sand-moulded casting falls within the archaeology of the unfound (cf. e.g. *Merta 1978*; *Goldmann 1981*; *Weidmann 1982*; *Trommer – Bader 2013*, 313–314; *Lochner 2004*; *Jantzen 2008*; *Nessel 2019*).

The reliable identification of moulds is often negatively affected by their considerable fragmentation, both intentional technological and non-intentional post-depositional. This fragmentation can also complicate the typological determination of the cast artefact, which also applies to fragments of stone moulds. Another handicap of this type of finds is the state of their analysis and evaluation – for Bohemia and Moravia, we still lack a compendium that would catalogue and assess all the casting moulds known so far. Hundred pieces of casting moulds collected in north-western Bohemia were processed and evaluated in this way, and the authors indicatively recorded 186 moulds from all over Bohemia (*Blažek et al. 1998*). In recent years, at least indicative inventories of casting moulds, albeit without their typological determination, have appeared for some areas of Bohemia in studies by *Augustýnová* (*2016a*; *2016b*; *2017*; *2018*).

In Moravia, the finds of Bronze Age casting moulds are even less mapped. Some moulds from several sites interpreted as metallurgical centres (*Podborský 1974*) were indicatively recorded, but only the finds from Hradisko in Brno-Obřany (*Adámek 1961*, 120; *Kosarová 2009*, 79–81) and from Cezavy near Blučina (*Salaš 1985*; *1995*; *Salaš et al. 2023*, 344) have been listed in more detail or assessed. Several sickle and axe moulds were recorded in the relevant volumes of the Prähistorische Bronzefunde series (*Říhovský 1989*; *1992*). The only attempt at a comprehensive assessment of Moravian moulds from the Urnfield Period remains the master's thesis of *Kosarová* (*2009*), in which 51 stone and lost moulds from 22 sites were collected, but only those related to the Middle Danube Urnfield Culture. However, the inventory certainly did not capture all the previously known finds. Also, the mould from the Brno-Špilberk site (*Kosarová 2009*, 82–83 after *Salaš 1995*, 570) was recently reconsidered as medieval object (*Kostrhun et al. 2024*, 164–166, obr. 10). The current assemblage of the casting moulds from the Urnfield Period for the whole of Moravia can be estimated to be about three times as large as the cited list, according to published finds.

Most finds of casting moulds generally come from settlements, both fortified and open (*Salaš 1995*, 570–572; *Kosarová 2009*, 83, tab. 2). Much more rarely, moulds are found among grave goods (e.g. *Jockenhövel 2018*). It can be documented in Moravia by only two funerary assemblages – a pin mould in grave no. 177 in Určice (*Gottwald 1924*, 60; *1931*, 82) and two moulds for tanged sickles at the burial ground in Moravičany, which were, however, used as part of the stone lining of a group of graves (*Nekvasil 1962*, 58; *1982*, 431, tab. 357: 1, 2; *Jockenhövel 2018*, 259–261, Abb. 24). Relatively large numbers of

moulds occur in hoards, especially those with homogeneous contents, i.e. consisting only of casting moulds (e.g. *Nessel 2019*, 349–358). Nevertheless, in the case of older finds, lacking adequate documentation of the context, these might not be hoards *sensu stricto*, but rather unrecognised inventories of metallurgical workshops. An example is the Tetín 1 hoard, where the clay moulds (two cores and a hammer mould) were not part of the hoard itself, but were found together with fragments of daub in the ashy backfill of a pit, most likely used for workshop production (*Axamit 1924*, 19; cf. *Kytlicová 2007*, 248–249, 310, Taf. 141: 47–49; *Nessel 2019*, 355, 357, 732). Similarly, the set of 21 stone moulds from Zvoleněves belonged to contents of a settlement feature, probably used for production purposes (*Ernée – Smejtek 1997*). Among Moravian sites, Hradisko near Kroměříž, one of the sites with a higher concentration of finds of casting moulds (*Podborský 1974*, 70), can serve as a similar example. According to the manuscript by I. L. Červinka, '*in one pit, there were several sandstone moulds for a dagger, sickles, a ribbed bracelet, a pin, a star, and fragments of others*' (*Červinka 1939*, 39), which indicates a workshop feature or production waste rather than a hoard.

If some finds of moulds are reported as stray and isolated finds (e.g. *Blažek et al. 1998*; *Nessel 2019*), then a closer examination of the settlement and topographic context would most likely prove their settlement origin, or a spatial relationship to a nearby settlement. This is also the case with the find of the mould from Morkůvky (Břeclav District) in South Moravia, to which this article is dedicated. It deals not only with standard typo-chronological or chorological analysis of the cast artefact, but also with some aspects of foundry technology, thanks to the exceptionally high-quality preservation of the mould with traces of intensive use. The unusual stone raw material, the petrographic analysis of which may indicate the provenance of the casting mould itself, also deserves special attention.

Circumstances of discovery, location and description of the find

The casting mould was found by J. Tomanec in 2007 during earthworks in the garden (plot no. 37/1) of his house no. 241 on the north-eastern edge of Morkůvky (*Fig. 1*). Here, it is said to have protruded with one corner to the current surface, but already in a tertiary position, because it was originally intended to be used secondarily in the stone foundations of a barn, standing in the north-eastern corner of the garden. The mould was most likely redeposited in modern times from an Urnfield Period site in the vicinity (*Fig. 1*; more details in the chapter Settlement and spatial context of the find). In 2019, the find was provided to the Moravian Museum by Z. Omelka from Hrušovany nad Jevišovkou for expert processing and in November 2024, it was transferred to the museum's archaeological collection (inv. no. 215 933). Geomorphologically, the findspot of the mould is located on a gentle north-western slope at an elevation of 205 m above sea level on the right-bank terrace of the Haraska Stream on the eastern edge of the Diváky Highland district and the Boleradice Highland subunit, belonging to the Ždánice Forest from the subsystem of the Central Moravian Carpathians (*Bína – Demek 2012*, 277–278).

The find is represented by one half (valve) of a massive tabular casting mould made of rhyolite tuff, slightly trapezoidal in outline, with perpendicular circumferential lateral sides. The dividing plane is ideally flat, the opposite outer (dorsal) surface is slightly and irregularly arched with unevenly spaced transverse grooves 3–4 mm wide and red-coloured

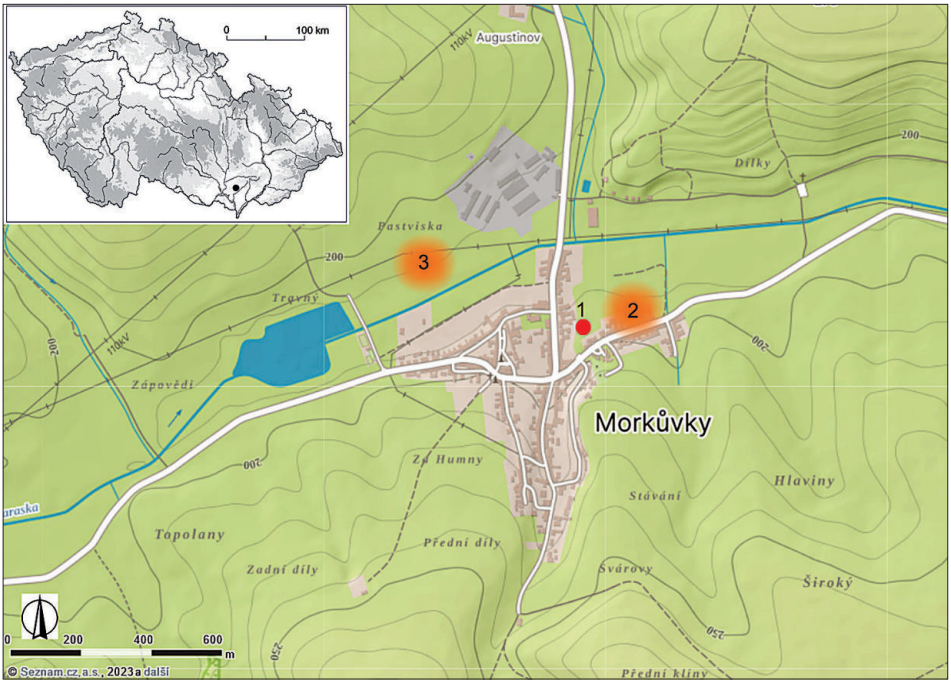

Fig. 1. Location of the find of a casting mould (no. 1) and Late Bronze Age sites (nos. 2, 3) in the cadastre of Morkůvky (Břeclav District).

inside. In the dividing plane, almost the entire negative of a socketed lanceolate spearhead has been preserved with longitudinal ribs on each of the flanking blade wings and on the midrib section of the socket. A groove for fixing the core with a rod chaplet runs across the free part of the socket and the entire width of the mould. One of the corners at the narrower end of the mould was broken off ages ago, and a sample for petrographic analysis was cut off the lower left corner at the wider end of the mould. Distinct traces of red, grey to black scorch or overburning are visible especially in the dividing plane. Inside the negative itself there are numerous transverse small cracks from overburning, on the corner of the outer side of the mould to the right of the socket and on the adjacent edge, the rock has been changed to glassy bubbly slag by overburning. The maximum length of the mould is 227 mm, the width ranges from 90 to 112 mm and the height from 28 to 40 mm. The preserved weight of the object is 1093 g (*Figs. 2–6*).

Morpho-typological and chrono-chorological analysis of the spearhead

Despite the evident signs of repeated and intensive use, the negative of the cast object is very well preserved and typologically easy to classify. The mould has been used for casting a socketed lanceolate spearhead with longitudinal ribs on the blade wings and a sharp rib on the midrib section of the socket (*Fig. 2*; *Fig. 3*). The same typological classification was

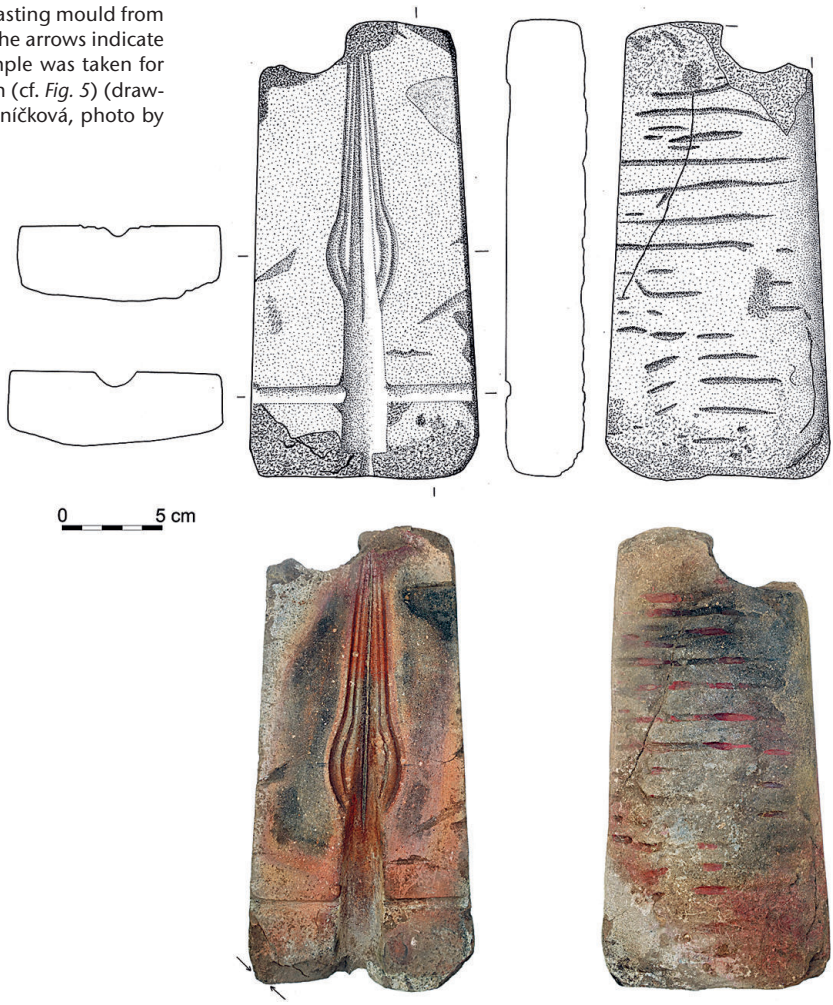

Fig. 2. The casting mould from Morkůvky. The arrows indicate where a sample was taken for a thin section (cf. *Fig. 5*) (drawing by A. Vaníčková, photo by M. Salaš).

also verified by a virtual cast (*Fig. 4*). In Moravia, this rare type of spearhead is represented so far by only two fragmentary specimens, namely a blade fragment in the Drslavice 2 hoard (*Říhovský 1996*, 86–87, Taf. 19: 188; *Salaš 2005*, 72, tab. 163: 254) and an analogous fragment in the hoard from Polešovice (*Salaš 1997*, 33, Taf. 21: 527). The two assemblages of finds have in common both the dating to the Drslavice – Ořechov hoarding horizon, corresponding roughly to the later part of Reinecke's B D stage (*Salaš 1997*; *2005*), and the spatial location in south-eastern Moravia, more precisely in the south-eastern part of the Zlín Region. The casting mould from Morkůvky with this type of spearhead is located a little further west, 36 km as the crow flies from Polešovice, but it is still the eastern half of the South Moravian Region. Morpho-typologically similar, but spatially somewhat different, is one of the spearheads in the Šebetov 5 hoard in Malá Haná region, which has a profiled blade and two small ribs on the midrib section of the socket (*Jarůšková 2023*, 241, obr. 25: 5). Except this hoard, the spatial location of the other Moravian specimens

Fig. 3. 3D scan of the mould from Morkůvky (SfM – Agisoft Metashape). Rendered in Blender 4.2. For more details, see *Online Supplementary Material 1* (created by V. Nosek).

is not accidental. It is related to the territorial distribution of the mapped type of spearhead, especially in the northern part of the Carpathian Basin, where spearheads with one or more ribs on the blade and the socket, including the midrib section, are relatively common (e.g. *Hampel 1887*, Taf. 114: 11; *1892*, táb. CXLIV: 34, 39; *Miske 1908*, Taf. XXX: 13; *Foltiny 1955*, Taf. 50: 9; 51: 6; *Kemenczei 1965*, XX. tábla: 3; *Novotná 1970*, Taf. 50: A6, 7; *Mozsolics 1973*, Taf. 51: 3; *Petrescu-Dîmboviţa 1978*, Taf. 197: 980, 990; *Mozsolics 1985*, Taf. 3: 9; 4: 8, 9; 177: 8; *Říhovský 1996*, 63, 67; *Kobaľ 2000*, Taf. 31: A8; 34: B8, 10; 36: 27, 29; 48: 50, 51; 63: 22, 24; 89: 13; *Leshtakov 2015*, tab. 25: 5; 26: 1; 62: 7). However, an objective assessment of their occurrence is complicated by the fact that the ribs are difficult to identify in photos and sometimes even drawings, and without a profile drawing, they cannot always be distinguished from a rhomboid-sectioned socket (cf. e.g. *Mozsolics 1985*, Taf. 4; 5).

Morpho-typologically related are spearheads with a smooth blade and a socket profiled with one or more ribs. In Moravia, they are more numerous than the previous type of spearheads, but to the ten specimens registered already in 1994 (*Říhovský 1996*, 62–69), only three spearheads from the Polešovice hoard (*Salaš 1997*, 33, Taf. 20: 517; 21: 518, 519) and a spearhead from the Míchov 6 hoard in Malá Haná were added.[1] The share of this type

[1] For information about the as yet unpublished contents of the Míchov 6 hoard, we thank Mgr. Z. Jarůšková from the Museum of the Boskovice Region in Boskovice, where this hoard has been stored.

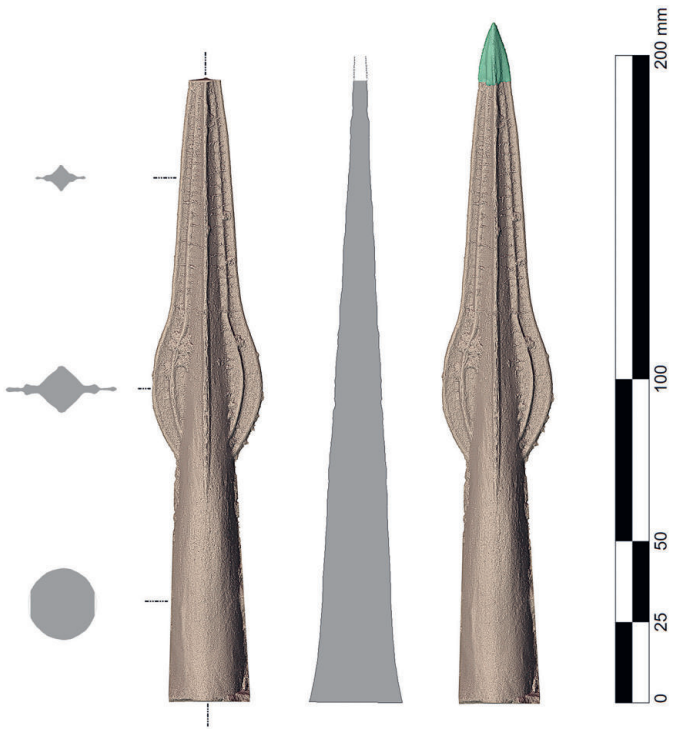

Fig. 4. Virtual cast of a spearhead from the mould from Morkůvky (yellow), supplemented by a missing fragment according to a scan of a spearhead of a similar shape (green) from Nemšová (Trenčín District, Slovakia). Rendered in Blender 4.2. For more details, see *Online Supplementary Material 2* (created by V. Nosek).

of spearhead in the total number of finds in Moravia is still around six per cent (cf. *Říhovský 1996*, 62). Also, in this type of spearhead, the centre of its distribution is located in the northern part of the Carpathian Basin, especially in the north-eastern part of Hungary and the adjacent areas of south-eastern Slovakia, Transylvania, and Transcarpathia, from where it sporadically spreads in the northern, western, and south-western directions (e.g. *Miske 1908*, Taf. XXXII: 7; *Kemenczei 1965*, XX. tábla: 4; *Mozsolics 1973*, Taf. 51: 4; *1985*, Taf. 177: 7; *Vinski-Gasparini 1973*, tab. 77: 24; 97: 11; *Petrescu-Dîmboviţa 1978*, Taf. 40: 2; 43: A4; 49: C14; 79: B15; 81: B12; 89: 26, 28; 102: 35, 37, 40, 41; 151: 403; 197: 984; 221: E7; 222: B2; 251: A20; *Chiodioşan – Soroceanu 1995*, 183, Abb. 1: 14, 15, 17; *Enăchiuc 1995*, 297, Abb. 2: 9, 11; *Říhovský 1996*, 63, 67, 86–87; *Kobaľ 2000*, Taf. 17: H4; 28B: 2, 3; 34B: 9, 11–12; 36: 26, 28; 38: B5; 39: 1, 2; 48: 49, 52–54; 51: 19–20; 81: 19, 20; 56: A19; 63: 23, 25; 65: A2; 87: C3; 96: 26–30; *König 2004*, Taf. 1: 6; *Gedl 2009*, 69–71; *Bader 2015*, 384–387; *Leshtakov 2015* with many examples).

The presence of spearheads with one or more ribs on the midrib section of the socket in Moravia can thus be considered the result of eastern to south-eastern, Carpathian, influences. For the dating of these forms, it is important that in all areas of their occurrence they are fixed by the find complexes mainly to the early phase of the Urnfield cultures, i.e. to stages B D–Ha A1, while spearheads with a smooth blade and a profiled socket are even rarely found in the Ha A2–Ha B1 stages (*Bader 2015*, 384–387; *Říhovský 1996*, 63, 65–67, 86–87). As regards the finds from Moravia, in the case of spearheads with both blade and socket profiled, and thus also in the case of the casting mould from Morkůvky, this is well confirmed by the above-mentioned hoards of Drslavice 2 and Polešovice.

Fig. 5. Casting mould from Morkůvky. Detail of the surface on the basal lateral side of the mould around the mouth of the socket, on the left is the cutting surface for a thin section (photo by J. Cága).

Fig. 6. Casting mould from Morkůvky. Detail of the terminal lateral side with incisions (photo by J. Cága).

Spearhead moulds in Moravia, Bohemia, and neighbouring countries

Finds of spearhead moulds are relatively rare, much rarer than, for example, axe or sickle moulds. In Central Europe, this may be distorted mainly by hard-to-identify fragmented clay casting moulds, documented in more western areas (*Weidmann 1982*). Therefore, from the territory of Moravia and Bohemia, only a few pieces of stone casting moulds for spearheads are known to this day. In Moravia, two moulds of this type have been reliably documented so far. The first comes from a storage pit of the Lusatian Urnfield Culture in Bořitov. In its dividing plane, a part of the negative of a spearhead and a bracelet with longitudinal ribs has been preserved (*Fig. 7*: 1; *Čižmář et al. 2000*, 37, 129–130; *Štrof 2000*, 37; *Kosarová 2009*, 81, tab. V: 2). The second stone mould for spearheads is mentioned as a surface find from the 'Příčníky' site near Býkovice, also from a settlement of the Lusatian Urnfield Culture in the Boskovice Furrow (*Kosarová 2009*, 81; *Štrof 2014*, 167). The third stone mould could be represented by a fragment, which was in 1915 probably found among grave goods in Královopolské Vážany, today a part of the town of Rousínov (*Procházka 1921*, 28; in other literature erroneously as Vážany nad Litavou: *Kosarová 2009*, 82, tab. VI: 1; *Podborský 1974*, 71, tab. XII: 2), but the typological classification of its negative is not entirely reliable due to its fragmentation (*Fig. 7*: 2). Even less reliable and traceable is the casting mould from a settlement pit at the 'Mezicestí' site near Malenovice, which is supposed to have contained a negative of either an arrowhead or a short spearhead (*Červinka 1939*, 41). Thus, the spearhead from Morkůvky is only the third reliable and at the same time the best-preserved specimen of its kind in Moravia.

Judging by the published collections, the quantity of spearhead mould finds is not much better in most of the surrounding areas either. For example, in the entire original collection

Fig. 7. Stone spearhead moulds from Moravia. 1 – Bořitov (Blansko District, photo by Z. Jarůšková); 2 – Královopolské Vážany (Vyškov District, photo by J. Cága).

of casting moulds from north-western Bohemia, only two spearhead moulds are mentioned – from Třískolupy and Soběsuky (*Blažek et al. 1998*, 53, 152–154, Taf. 12: 60; 14: 65). Similarly, only two spearhead moulds were recorded from Lower Austria, namely an entire half of a mould from the Thunau am Kamp hillfort (*Lochner 2004*, 109, Abb. 2: 1) and both halves of a mould from another Urnfield Period hillfort near Stillfried (*Hellerschmid – Penz 2004*, 171, Abb. 9: 7; *Penz 2006*, 349, Taf. 18/3). In Slovakia, the find of an incomplete half of a casting mould from a strategically located settlement near Pobedim (*Studeníková – Paulík 1983*, 70, 139–140, 246, tab. XXXIV: 5) is geographically and culturally closest to Moravia. No other spearhead mould from the Urnfield Period is mentioned in the literature for Slovakia (*Pančíková 2008*); the moulds from Nižná Myšľa are chronologically older, from the beginning of the Middle Bronze Age (*Olexa et al. 2021*, 224–226, 236). These numbers of spearhead moulds for the countries under review are certainly underestimated, distorted by the state of research and processing of excavated assemblages. This can be demonstrated on significantly more numerous finds from, for example, Hungary (*Ilon 2006*; *2022*) or Poland, where spearhead moulds are also found among grave goods (*Gedl 2009*, 79–80, Taf. 28–29; *Jockenhövel 2018*, 297).

Technology insights

The casting mould from Morkůvky is part of a classic and solid casting assembly for socketed metal artefacts (in addition to spearheads, also arrowheads, axes, or socketed chisels). These assemblies were usually three-part: two mirror-identical halves of the casting mould were complemented by a metal or clay casting core to create a socket. To fix the core, a needle or rod made of metal or organic material was used, which passed horizontally through the dividing plane of a vertically placed mould, crossing the free part of the socket

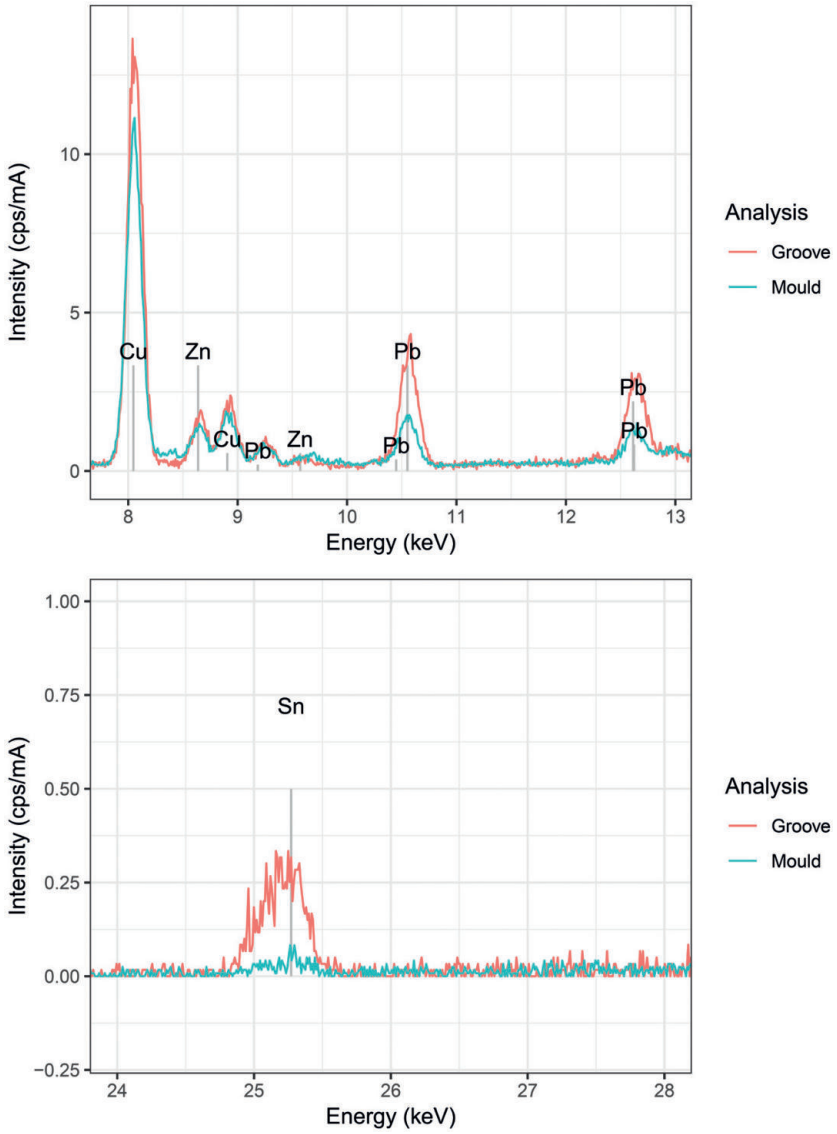

Fig. 8. Sections of the spectral record from XRF analysis documenting the enrichment with Cu, Sn, and Pb at the place of the inlet channel. Top – K-lines of Cu and L-lines of Pb (analysed with the secondary Mo target); bottom – Kα1-line of Sn (secondary Al target).

(cf. *Tylecote 1962*, 116; *Hänsel 1990*, 60–61, Abb. 3; 4: 1; 5: 5–6; 9: 1, 2, 5; *Trommer – Bader 2013*, 314–315; *Nessel 2019*, 167–169 and others). In the case of Morkůvky, it is well documented by the transverse groove for inserting a rod chaplet (*Fig. 2*; *Fig. 3*). The same grooves for fixing the core are common in other casting moulds as well (e.g. *Blažek et al. 1998*, 53, 152–154, Taf. 12: 60; 14: 65; *Lochner 2004*, 109, Abb. 2: 1; *Leshtakov 2015*, tab. 37: 6; 42: 11; 45: 9; 53: 1, 2; 76: A; 80: 5; 87: 4; 154: 2; *Jockenhövel 2018*, 256–257,

Tab. 1. Chemical composition of slaggy surface in the inlet channel of the mould. Analysis performed with a benchtop XRF spectrometer on powder samples (concentrations of the major oxides are given in wt.%, trace elements in ppm).

	Rock	Inlet channel
SiO_2	77.6	69.9
Al_2O_3	12.0	19.0
K_2O	5.4	5.7
Fe_2O_3	3.1	2.7
CaO	1.4	2.4
P	217	1634
S	594	694
Ti	1127	1017
Cr	61	462
Mn	429	432
Ni	74	22
Cu	411	590
As	13	16
Rb	91	74
Sr	58	68
Sn	-	78
Pb	32	99

Abb. 21: 5; 22A: 7–8; Taf. 19: 29; 20: 31; 21: 32; *Overbeck 2018*, 121, Taf. 20: 31; 21: 32; 22: 33). By transverse fixation of the casting core, holes were created in the wall of the socket, which were later used to better fix the spearhead to the wooden shaft (*Trommer – Bader 2013*, 316).

The casting hole of spearhead moulds could be placed both on the side of the socket mouth and on the side of the tip of the spearhead (*Tylecote 1962*, 116, Fig. 25). It can usually be located in the mouth of the socket, and this is also the case with the mould from Morkůvky, where it is evidenced by the heavily burned, blistered or even slagged surface in the immediate vicinity of the socket mouth, as well as by the partially preserved groove of the sprue channel opening into the socket (*Fig. 2*; *3*; *5*). Here, slag-like crusts are preserved on the surface, the composition of which was examined on a benchtop ED-XRF spectrometer (Rigaku NEX-CG). Both the surface of the mould and the powder scraped off the surface of the sprue channel at the socket mouth with a scalpel were analysed. By comparing the content of silica, iron, and other components (K, Ca) between the rock itself and the surface of the channel, it was possible to prove local enrichment with non-ferrous metals in the inlet part of the mould. The measurements confirmed an increased proportion of copper (Cu) in the sprue channel and also detected tin (Sn) and lead (Pb), which indicate the presence of bronze (*Fig. 8*; *Tab. 1*). In the stone mass of the mould, these elements are found only in trace amounts. In accordance with macroscopic traces of overburning, XRF analyses clearly evidenced the repeated use of the mould for the production of tin bronze casts.

In the case of the moulds from Tříškolupy and Soběsuky, bronze was also poured into the mould through the socket mouth (*Blažek et al. 1998*, 53, Taf. 12: 60; 14: 65) and similar inlet grooves in the socket also feature the moulds e.g. from Stillfried (*Penz 2006*, 349, Taf. 18/3), Legnica, Głubczyce (*Gedl 2009*, Taf. 28: 377, 382; 29: 383; *Jockenhövel 2018*, Abb. 21: 5; 22A: 7–8; Taf. 20: 31), or from other sites in Germany (*Overbeck 2018*, 121).

	Groove filling	Groove filling	Groove filling	Mould surface	Mould surface
S	0.4259	0.4841	0.4173	0.396	0.3535
K	5.6531	5.9836	5.3131	5.6659	5.4124
Ca	1.9883	2.0254	5.076	1.9401	2.2556
Ti	0.0791	0.0818	0.083	0.0956	0.0911
Mn	0.0343	0.0355	0.0837	0.0315	0.0373
Fe	1.085	1.1483	4.0277	1.1082	1.1913
Co	0.0083	0.0096	0.0199	0.0089	0.0112
Ni	0.0024	0.0085	0.0065	<LOD	<LOD
Cu	0.1942	0.4431	0.292	0.013	0.066
Zn	0.0036	0.0034	0.0945	0.0041	0.0034
As	<LOD	0.0022	<LOD	0.001	0.0017
Rb	0.0154	0.0154	0.0132	0.0143	0.0177
Sr	0.0083	0.008	0.0088	0.0087	0.0079
Zr	0.0127	0.0116	0.0099	0.0102	0.0105
Sn	0.0078	0.0129	0.1591	0.004	0.0068
Ba	0.0215	0.0226	0.0284	0.0205	0.0232
Pb	0.0142	0.0148	0.1729	0.0139	0.0113

Tab. 2. Chemical composition of the red-coloured substance in the grooves on the dorsal surface of the mould. Analysis performed with a handheld XRF spectrometer. Elements that were below the limit of detection or quantification were omitted from the table (the values are in wt.%; <LOD indicates values below the limit of detection).

On the other hand, the casting hole opening into the tip of the spearhead is documented by a mould from the Slovak site of Pobedim (*Studeníková – Paulík 1983*, 140, 246, tab. XXXIV: 5), and in Moravia by a mould from Josefov, which is, however, chronologically older, dated to the Věteřov Group (*Šráčková 1963*).

The local blistering or even slagging of the surface as well as various shades of red, grey or black overburning testify to high thermal stress associated with repeated and intensive use. This is also reflected in the small transverse cracks inside the negative itself, which are the result of sharp temperature fluctuations. Up to dozens of spearheads could have been cast in the mould, and it is even assumed that up to a hundred possible casts could have been made from a single stone mould (*Jantzen 2008*, 161; *Jockenhövel 2018*, 284).

Relatively rarely, incisions are preserved on the outer surfaces of solid moulds, mostly on their lateral sides, which are usually interpreted as traces of fixation, or tightening the parts of the mould, most likely with a wire (e.g. *Šráčková 1963*, 506; *Blažek et al. 1998*, 53, 119, Taf. 14: 65; 15: 81; *Leshtakov 2015*, 162; tab. 54 :4). Leather straps or plant fibres are also considered, but they would still have to be covered with a clay sheath (*Drescher 1957*, 59; *Jantzen 2008*, 161, note 128; *Overbeck 2018*, 204–205). In the case of the mould from Morkůvky, two distinct vertical incisions have been preserved on the otherwise mostly broken-off terminal side in front of the tip area (*Fig. 3*; *Fig. 6*). However, they are very sharp and narrow, so it is not possible to reliably assess whether they may be related to wiring or whether they are rather splicing marks (cf. *Ernée – Smejtek 1997*, 194; *Novotná 1957*, 317), especially since there are no holes for splicing pins on the dividing plane. Incisions were used as splicing marks on multi-part moulds in the production of not only spearheads, but also other types of bronze artefacts, e.g. socketed axes (*Wanzek 1989*, 40–44).

The irregularly spaced transverse, 2–4 mm wide, and locally distinctly red-coloured grooves on the dorsal side of the mould are a conspicuous and very probably a technological feature (*Fig. 2*). Both the grooves and their colouring are so specific or even unprecedented that it was desirable to subject them to a separate analysis. A combination of several analytical procedures was used to identify the material that fills the distinctive red-coloured grooves and to determine the chemical composition of the stone mould. In the first phase, indicative measurements were made, for 20 seconds each, at various points of the mould using a handheld XRF spectrometer set in the 'soil mode'. This was done to determine, in particular, the occurrence of elements heavier than silicon. To obtain more accurate data on the stone body of the mould itself, a small sample (powder) was drilled off the central part in the place where a cutting sample for a thin section analysis had already been taken earlier. A small amount of powder for X-ray diffraction analysis (XRD) was also taken from the selected spot in the red filling of the grooves on the dorsal side of the mould. Analysis of the red coating from these grooves showed that it was predominantly an amorphous material with a noticeable proportion of copper and a trace amount of tin (*Tab. 2*). Especially compared to the surface of the mould, increased concentrations of Cu and Sn were proved, which corresponds well with the results of X-ray fluorescence. The results of these analyses, primary data and the script for creating the graph are stored in an external repository (*Slavíček et al. 2025*).

Petrographic analysis of raw material and its provenance

The magnetic susceptibility of the mould rock measured by the portable KT-6 magnetic susceptibility meter is not homogeneous, it probably changes with the nature of the affliction of the mould during firing. At the tip of the spearhead, it reaches only about 0.5×10^{-3} SI units on the dorsal surface and $1.5 – 1.7 \times 10^{-3}$ SI units on the ventral surface. On the lower side of the socket part, the values are higher (up to 2.8×10^{-3} SI units). It is probably related to higher temperatures and slagging.

Under a stereomicroscope, the original colour of the rock appears as light grey or originally reddish, and its crystalloclastic structure is clearly visible. Larger, sharp-edged fragments of whitish feldspars reach up to 1.5 mm, somewhat smaller are shards of quartz (about 0.5 mm), followed by flakes of black mica–biotite. The rock does not react with 5% HCl, and it is scratched by a steel needle.

A petrographic thin section was made from a rock fragment and studied under an Olympus BX-51 polarising microscope (*Fig. 9*; *Fig. 10*). The crystallo-vitroclastic structure is visible at first glance, with a predominance of fragments of clear glass measuring 0.1–0.2 mm, which appears isotropic (black) under crossed polars. Furthermore, distinctly shard-like fragments of feldspars are present, e.g. plagioclases with polysynthetic twinning, probably also alkali feldspars, and quartz crystals. Biotites have undergone baueritisation, which means that they have retained their characteristic cleavage, but they lack pleochroism. In some places, there are irregular accumulations of opaque mineral, which shine through brown at the edges. It is very likely a mixture of iron oxides and hydroxides referred to as limonite. Occasionally, round, larger fragments of bubbly or fluidic glass have been observed. The rock can be assigned to volcaniclastic (pyroclastic) sediments and classified as a sandy crystal-vitric tuff with biotite (see the classification in *Petránek et al. 1961*;

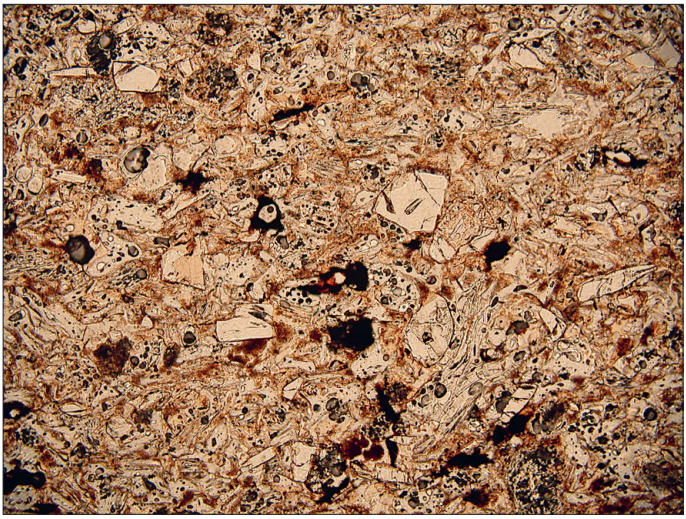

Fig. 9. Thin section of the raw material of the casting mould examined under a polarising microscope, plane-polarised light (image length 1.5 mm, photo by A. Přichystal).

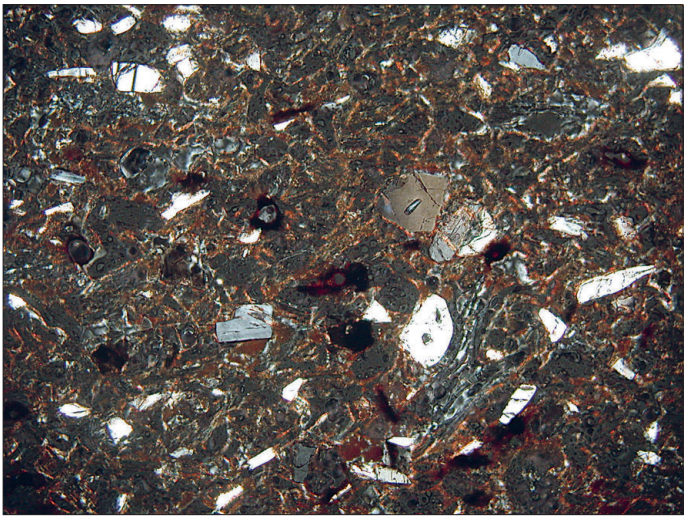

Fig. 10. Thin section of the raw material of the casting mould examined under a polarising microscope, crossed polars. The same part of the thin section as in *Fig. 9* (photo by A. Přichystal).

Kukal 1985). The parent rock was undoubtedly acidic volcanite with a composition that corresponded to rhyolite or dacite.

X-ray fluorescence analysis was applied both to the red substance filling the grooves on the dorsal side and to the surface of the mould. Considering the elements important for classification, the content of potassium, which is 2.5–3 times higher than that of calcium (*Tab. 2*), indicates that the parent rock of the tuff was rhyolite. This is also largely confirmed by X-ray diffraction phase analysis (*Slavíček et al. 2025*), which, in addition to plagioclase, detected significantly represented potassium feldspar and mica minerals. Given the small transformation of the analysed rock, it is clear that it must be a rhyolite tuff of Tertiary age. We do not know the sources of such volcanism in Moravia, Silesia, Bohemia, or Poland; its closest occurrences are as far as the Western Carpathians in Slovakia and Hungary.

Acid tuffs of Miocene age form large areas in north-eastern Hungary with an overlap into southern Slovakia, so with the current state of knowledge, we are unable to determine the specific place of origin of the raw material of the casting mould. Preliminarily, it seems likely that it might be the so-called Gyulakeszi Rhyolite Tuff from northern Hungary (with its outcrops mainly near the town of Salgótarján or in the south-eastern vicinity of the Bükk Mountains), which originated in the Late Tertiary at the Eggenburg/Ottnang boundary and is supposed to be 19.6 ± 1.4 million years old. Its thickness in the mentioned area reaches up to 100–200 m and it forms conspicuous formations called 'fairy chimneys' or 'beehive stones' (*Budai – Gyalog 2010*). Similar formations are known from Cappadocia in Turkey.

Settlement and spatial context of the find

The current location of the casting mould is almost certainly the result of repeated recent redeposition. This is evidenced not only by the original use of the mould in the stone foundation of the former barn, but also by the fact that no prehistoric finds are known from the given plot or from the immediately adjacent plots. However, at least two sites of the Urnfield Period are documented both directly from the inner built-up area of the village and from other parts of the cadastre. The closest to the findspot of the mould is a settlement from the Velatice phase of the Middle Danube Urnfield Culture, located on the eastern edge of the village on the right-bank terrace of Haraska stream (*Unger 1985*, 20–21). Fragments of settlement pottery were discovered here during construction of houses nos. 212 and 222 in the 1970s (*Fig. 11*: 1–4). A bronze pin was also allegedly found on the site of house no. 212 (*Unger 1985*, 21). Its stem probably passes into a ring-shaped head with a plano-convex cross-section, but only its lower arched segment (*Fig. 11*: 5) has been preserved. The ends of the segment are probably not fractured, but rather unfinished, so it could be a defective casting. Therefore, it is not possible to classify the pin with sufficient certainty as a ring-headed pin, which is dated to the Early Bronze Age (e.g. *Tihelka 1953*, 270; *Zich 1996*, 202–203, 647; *Bartelheim 1998*, 70–71, Taf. 46: T12; *Moucha 2005*, 52) and whose ring has a circular cross-section, unlike the specimen from Morkůvky. The pin, thus, cannot be reliably classified and used for chronological considerations. Moreover, its finding context is unclear as well as the relationship to the assemblage of Velatice pottery. The pin could be related, for example, to settlement finds of the Únětice Culture identified in the north-western part of the cadastral municipality of Morkůvky on the left-bank terrace of Haraska stream in the Pastviska site. Other sites of the Únětice Culture are known from the neighbouring cadastral municipalities of Boleradice and Brumovice (*Skutil 1939*, 18–19; *Unger 1984*; *Klanicová 1993*, 2; *Geisler 1996*, 91).[2]

The second settlement site of the Middle Danube Urnfield Culture was recorded in the above-mentioned Pastviska site (*Fig. 1*: 3). Here, a part of an amphora-shaped bowl, typical of the Velatice phase of Middle Danube Urnfield Culture, was accidentally found in 1978 (*Fig. 11*: 6). The distance of this site from the findspot of the casting mould is about 450 m,

[2] The mentioned finds from Morkůvky are stored in the Regional Museum in Mikulov. We thank Mgr. F. Trampota, Ph.D. for information about unpublished finds.

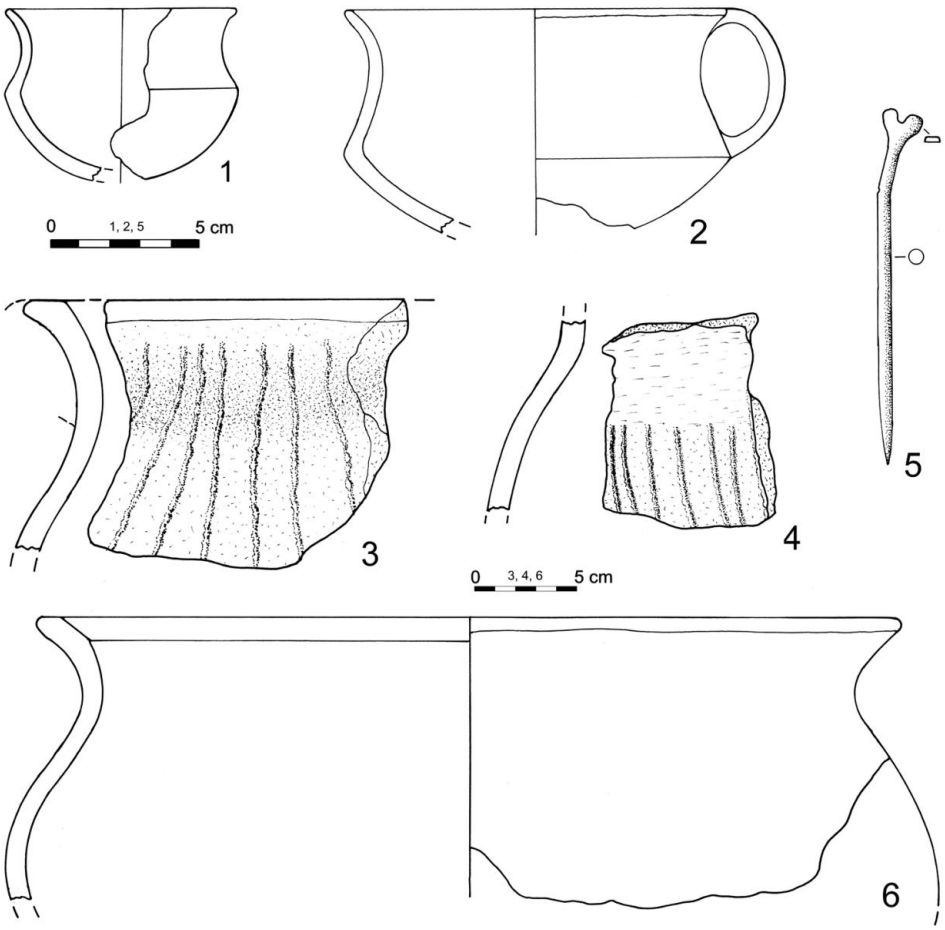

Fig. 11. Morkůvky. 1–4 – pottery of the Velatice phase of Middle Danube Urnfield Culture from a settlement in the eastern part of the inner built-up area of the village (no. 2 in *Fig. 1*); 5 – bronze pin from house plot no. 212 on the eastern edge of the village; 6 – settlement pottery from the 'Pastviska' site in the north-northwest part of the cadastre (no. 3 in *Fig. 1*) (collection of Regional Museum in Mikulov, drawing by A. Vaníčková).

while the distance to the nearest settlement finds of Middle Danube Urnfield Culture in the eastern part of the built-up area of the village, or the finds at house no. 222, is only about 115 m. Therefore, the spatial connection of the mould with this settlement is highly probable.

Discussion

Among the most remarkable technological attributes of the casting mould are the grooves on its dorsal surface and their red colouring. The connection between the grooves and the fixation and tightening of both valves of the mould is beyond all doubt. Nevertheless, the

interpretation of the red coatings, for which no analogies have been found, is somewhat more problematic. At first, our considerations were directed towards the application of red dye as a ritual part of the casting process, but after the elemental composition analyses showed an increased copper content in the red coatings, we interpret them as traces of tightening the halves of the casting mould with copper wire.

In addition to technological knowledge, a remarkable aspect of the casting mould is its allochthonous provenance. The cast type of spearhead with ribs on the blade and on the midrib, as well as the rock used, which is classified as rhyolite tuff, testify to the Carpathian origin of this casting mould. The locally limited occurrence of rhyolite tuff allows us to search for the origin in the area of northern to north-eastern Hungary. In this northern part of the Carpathian Basin, tuff was quite commonly used for the production of casting moulds in the Bronze Age due to its advantageous properties. Petrographic analysis of 125 moulds showed that nine of them were made of tuff from Hungary (*Bálint 2004*). Another example may be the casting moulds from the eastern Slovak fortified site of Nižná Myšľa, where about half of the forty moulds found, including spearhead moulds, are made of local tuffs (*Olexa et al. 2021*, 224–225, 236). In the Czech lands, this is the first evidence of using such a stone raw material, moreover, an imported one, for a casting mould in the Bronze Age.

When locating the outcrops of the raw material used in the northern part of the Carpathian Basin, or roughly in the vicinity of Salgótarján, it is about 250 km as the crow flies to the findspot in Morkůvky. The travel distance would be at least 100 km longer. The casting mould from Morkůvky is thus another reliable and eloquent evidence that the long-distance transport of raw materials used for the production of stone moulds could reach tens to hundreds of kilometres (*Ernée – Smejtek 1997*, 197–198; *Jockenhövel 2018*, 280–282; *Overbeck 2018*, 200–201). Similarly, up to hundreds of kilograms of copper ingots, contained mainly in hoards of the Middle to Late Bronze Age, were transported to Moravia by long-distance transfer as another type of raw material. Illustrative and convincing evidence of the long-distance transport of final artefacts in the Urnfield Period can be the ceramic vessels with chip-carved decoration at Cezavy near Blučina, originating from as far as the Upper Danube region (*Salaš et al. 2023*, 256–257).

If distances of up to hundreds of kilometres are to be overcome, the mould would probably be transported as a final product rather than a rough piece of stone raw material (similarly, for example *Ernée – Smejtek 1997*, 197–198). The import of a finished mould is also indicated by the fact that the cast type of spearhead is not commonly found in Moravia; it is not autochthonous here. On the other hand, it is common in the Carpathian Basin and in regions where the given raw material naturally occurs. If a block of rock was imported, then in the new environment, in this case in South Moravia, it would most likely be used for the production of another, more autochthonous type of spearhead.

The casting mould testifies to direct or mediated contacts between the Middle Danube Urnfield Culture in South Moravia and the cultural complex of the South-Eastern Urnfields, most likely the Carpathian Piliny Culture or Suciu de Sus Culture. If we take into account other, relatively numerous manifestations of intra-Carpathian influence, particularly evident in the Drslavice 1–2 and Polešovice hoards (*Salaš 1997*; *2005*, 219), it is clear that in the early stage of the Urnfield Period (B D2–Ha 1) there was a cultural and probably partly migratory diffusion from the area of the Carpathian Basin westwards beyond the arc of the White Carpathians.

The casting mould shows indisputable macroscopic traces of repeated and intensive use. This raises several questions. First of all, to what extent the mould was used for the production of casts in the original, i.e. Carpathian, environment and whether and to what extent it was still used in practice in the environment of the Middle Danube Urnfield Culture in South Moravia. Of course, the latter cannot be completely ruled out, but if so, then the entire casting assembly, including both the mould and the core, would have to be imported. Importing only half of the mould would have no practical sense, except perhaps as an object of ritual practices or a rarity.

If the imported casting mould was used in practice in a new destination, the question would arise as to how to assess the cast spearhead from the point of view of cultural provenance. It would be an autochthonous, local product, so it would not be a direct Carpathian import, but even so, with regard to the spatial occurrence of the given spearhead type and the origin of the casting mould, it would still be the result of Carpathian influences.

Conclusion

Although the stone spearhead mould from Morkůvky is a recently redeposited object, torn out of the original settlement context, its informative value exceeds the standard of most similar artefacts. Despite minor and probably recent damage, it is one of the best-preserved halves of casting moulds of this kind in the Czech lands. It shows indisputable macroscopic traces of repeated and intensive use associated with thermal stress. Judging by the working traces that were examined using the X-ray fluorescence and X-ray diffraction analyses, tin bronze was poured into the vertically placed halves of the mould tightened with copper wire, through a sprue channel opening into the socket of the artefact. According to the perfectly preserved negative, the cast artefact can be reliably and accurately typologically classified as a socketed lanceolate spearhead with ribs on the blade and the midrib. In Moravia, this type has been evidenced only by one piece each in the Drslavice 2 and Polešovice hoards, which, together with other assemblages of finds outside the territory of Moravia, prove its dating and thus the dating of the mould itself to the early phase of the Urnfield cultures.

From a chorological point of view, it is significant that both hoards containing this type of spearhead are located in south-eastern Moravia near the arc of the White Carpathians. The centre of distribution of this type is the northern part of the Carpathian Basin, so their currently-known Moravian finds are located at the western periphery of this area. If these spearheads in Moravia are the result of Carpathian influences or directly Carpathian imports, then the origin of the casting mould can also be sought in the Carpathian Basin on the basis of its typological classification. This provenance is uniquely verified and refined by petrographic analysis of the raw material used for the casting mould. It is rhyolite tuff of Tertiary age, which does not occur in the Czech lands. The nearest suitable petrographically adequate outcrops of this raw material are found in northern Hungary, especially in the surroundings of Salgótarján or in the south-eastern vicinity of the Bükk Mountains. With regard to its typological classification and raw material provenance, the casting mould from Morkůvky is, alongside some types of bronze artefacts, especially in the Drslavice 1–2 and Polešovice hoards, another eloquent evidence of Carpathian diffusion into the western neighbourhoods.

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MILAN SALAŠ, Institute of Archaeology, Moravian Museum, Zelný trh 6, CZ-659 37 Brno; msalas@mzm.cz
ANTONÍN PŘICHYSTAL, Department of Geological Sciences, Faculty of Science, Masaryk University, Kotlářská 2, CZ-611 37 Brno; prichy@sci.muni.cz
JAN PETŘÍK, Department of Geological Sciences, Faculty of Science, Masaryk University, Kotlářská 2, CZ-611 37 Brno; petrik.j@sci.muni.cz
KAREL SLAVÍČEK, Department of Geological Sciences, Faculty of Science, Masaryk University, Kotlářská 2, CZ-611 37 Brno; slav.karel@sci.muni.cz
DALIBOR VŠIANSKÝ, Department of Geological Sciences, Faculty of Science, Masaryk University, Kotlářská 2, CZ-611 37 Brno; dalibor@sci.muni.cz
VOJTĚCH NOSEK, Department of Archaeology and Museology, Faculty of Arts, Masaryk University, Arne Nováka 1, CZ-602 00 Brno; vojtechnosekuam@gmail.com

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Marks on late medieval barrels from the southern Baltic coast: A contribution to classification based on visual features

Značky na pozdně středověkých sudech z jižního pobřeží Baltského moře: Příspěvek ke klasifikaci na základě vizuálních znaků

Maciej Miścicki

In late medieval trade, barrels were the most popular containers for transporting various commodities. They were often marked with various symbols, the meaning of which is difficult to interpret. The presented analysis included 112 fragments of barrels with carved or branded marks. All the specimens were dated between the 14th and 16th centuries AD and came from archaeological excavations in Elbląg, Gdańsk, and Puck. The investigated symbols are thought to have served different functions, including as merchants', craftsmen's, or ownership marks. The registered examples were divided into five groups: branded; compositions of multiple irregular lines; geometric figures; simple compact, often symmetrical symbols; and other that do not belong to any of the aforementioned categories. Analyses of the investigated artefacts and their comparisons with other published finds and written accounts revealed that simple compact marks were applied on barrels used in mercantile contexts. Determining the function of barrels based on marks of the other groups was proved to be ambiguous and requires further research.

archaeology – marks – barrels – Late Middle Ages – post-medieval period – Hanseatic League – Baltic towns

V pozdně středověkém obchodování byly sudy nejoblíbenějšími nádobami pro přepravu různých komodit. Často byly označeny různými symboly, jejichž význam je obtížné interpretovat. Předložená analýza zahrnovala 112 fragmentů sudů s vyrytými nebo vypálenými značkami. Všechny exempláře byly datovány do 14. až 16. století a pocházely z archeologických vykopávek v Elblągu, Gdaňsku a Pucku. Předpokládá se, že zkoumané symboly plnily různé funkce, například jako kupecké, řemeslnické nebo vlastnické značky. Zaznamenané příklady byly rozděleny do pěti skupin: vypálené; kompozice vícero nepravidelných linií; geometrické figury; jednoduché kompaktní, často symetrické symboly; a ostatní, které nepatří do žádné z výše uvedených kategorií. Analýzy zkoumaných artefaktů a jejich srovnání s dalšími publikovanými nálezy a písemnými zprávami ukázaly, že jednoduché kompaktní značky byly aplikovány na sudy používané v kupeckém prostředí. Určení funkce sudů na základě značek z ostatních skupin se ukázalo jako nejednoznačné a vyžaduje další výzkum.

archeologie – značky – sudy – pozdní středověk – postmedievální období – Hanzovní liga – baltská města

Introduction

The corpus of archaeological barrel fragments dated to the Late Middle Ages and Early Modern Period comprises a significant number of specimens with carved or, less often, branded marks. They usually take the form of single or multiple lines arranged with varying degrees of complexity. Sometimes, a geometrical or literal theme can be discerned in them, but many are random compositions with no visible pattern. Such multitude of marks and

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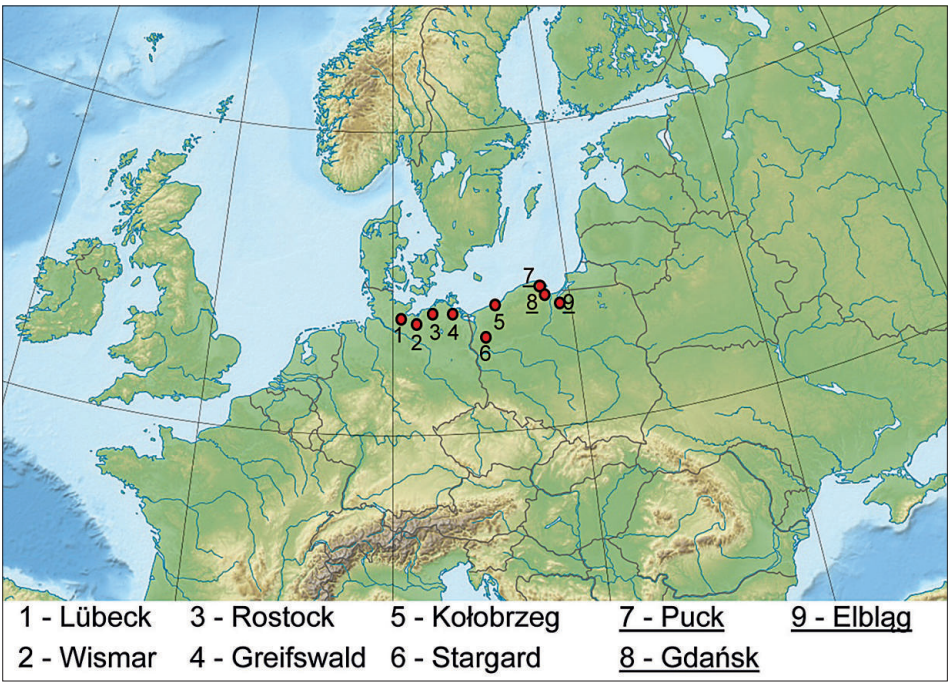

Fig. 1. Findspots of wooden vessels bearing marks mentioned in the paper with analysed assemblage underlined.

patterns requires systematisation and careful interpretation. The current state of research clearly indicates that this category of artefacts has been underrated as sources for the history of commercial exchange, trade relations, and cooperage as an important craft during the economic boom in late medieval towns. Previous scholarly works dealing with these artefacts have so far focused foremost on describing their morphological features and classifying particular specimens. The functions of these items, if determined at all, were usually simply correlated with their findspots and its context – which is not an error in itself but overlooks a number of interpretational possibilities related to their earlier exploitation. One should remember that barrels were reusable containers and thus often repaired, meaning that their lifespan could be quite long. In effect, research on the role of marks on barrels in the medieval economy is still wanting, especially regarding their place of origin and commercial use. In light of the already great and steadily increasing number of such finds, a revision of the current perspective on this category of artefacts seems necessary.

This, in turn, begs the question whether the visual features and complexity of a mark are indicative of a barrel's function or provenance: Did the mark indicate that a given barrel was a container or a commodity itself? Or perhaps it communicated the place of origin of the barrel or that of the goods transported in it? Were the symbols 'random', i.e. put on the vessel for reasons entirely unrelated to trade? To what extent can late medieval barrels with marks serve as supplementary sources in studies on commercial exchange and trade relations? The present paper addresses these questions based on late medieval and Early Modern archaeological finds from Pomerelia. During this period, the region saw significant

growth in long-distance trade, largely driven by the Hanseatic League, in which barrels played an essential role. These versatile containers were used for transporting goods such as beer, wine, grain, herring, nails, tar, and cloth, and also served as a unit of measure in both local and regional trade. This study examines finds from Elbląg, Gdańsk, and Puck to explore the similarities and differences in marking barrels between major urban centres and peripheries in a small, homogeneous area. They are considered in the context of the finds from other Hanseatic cities on the southern coast of the Baltic Sea (*Fig. 1*). In the broader geographical context, it may serve as a preliminary exploration of regionalisms and transregional universalisms in manufacturing and trade, shedding light on the involvement of investigated towns in urban culture and local commercial networks. Another aspect of the analysis is the previously underexplored circulation of barrels in domestic and long-distance exchange. By confronting archaeological data with written sources – namely guild regulations and town registers – the study provides a new perspective on the discussed questions, filling in important gaps in our understanding of late medieval economy and material culture. The findings are relevant not only for the investigated urban centres but also other parts of Europe with which they maintained trade relations. Due to the wide range of functions played by barrels and their connection to trade, other types of mark-bearing wooden vessels, typically used in household contexts, were not included in the analysis.

Background

Any consideration of the role of barrels and marks in trade and commerce in the late medieval towns of the southern Baltic coast must acknowledge the significant influence of the Hanseatic League on the whole region. A federation of merchants and towns, the League gained a dominant position between the 14th and 15th centuries AD. It was made up of the vast majority of important urban centres by the Baltic Sea and facilitated and controlled their mutual trade relations and exchange with other parts of Europe. The Baltic merchants traded grain, beer, forest products, wax, salt, herring, animal skins, textiles, as well as many other goods. The rise in sea transportation created a demand for barrels, the primary containers for most commodities, and provided a strong incentive for their mass production. Barrels themselves were even commonly traded as goods. In effect, this specialised craft saw rapid growth in many Hanseatic towns in the discussed period (*Dollinger 1997*, 129). The significance of cooperage is confirmed in written documents from Gdańsk, where the number of registered master coopers increased from 27 in the year 1416 to 100 in 1500. Moreover, the branch responded to demand by diversifying – Gdańsk registered not only master coopers but also barrel menders and hoop-makers (*Bogucka 1962*, 82–84, 91–95). In terms of trade volume, it is estimated that at the end of the 14th century, the import of salted herring from Scania to Vendic towns alone required 150,000 barrels (*Dollinger 1997*, 202). If we remember that herring were but one of the commonly transported goods, this example reveals the scale of barrel requirements in the investigated period, providing a crucial supplement to the scarce archaeological record.

In terms of percentages, wooden barrels with carved or branded marks still constitute a small fraction of all finds from this category, but the constantly growing source base has already rendered their study a worthwhile effort. Along the southern coast of the Baltic Sea, late medieval and post-medieval finds of vessels and barrels with marks are known, among

others, from Gdańsk (*Kasprzak 2007*, 9; *2010*, 173; *Ossowski 2014*, 260–261, 271–274; *Rembisz-Lubiejewska 2021*, 111; *Miścicki 2022*, 401, 408–409, 413), Puck (*Starski 2017*, 134, 137), Kołobrzeg (*Polak 1997*, 230; *Bobik 2016*, 148), Stargard (*Bobik 2012*, 186; *Bucka 2017*, 167), Lübeck (*Neugebauer 1975*, 117–137; *Falk 2002*, 422–434), Wismar (*Buchholz 1994*, 62–89), Rostock (*Schäfer – Patzelt 1992*, 48–49), and Greifswald (*Ansorge et al. 2003*, 133; *Robben 2008*, 77–86) (*Fig. 1*). They are usually mentioned in passing in publications and only sporadically addressed in detailed studies. This situation is certainly caused by the condition in which they are typically found, i.e. often fragmented, with the marks partly obliterated and surfaces heavily worn and barely legible. The marks consist primarily of variously arranged straight lines, so the number of possible reconstructions of incompletely preserved configurations is almost infinite. Typically stray and isolated finds, frequently retrieved from layers of waste or backfills of wells and cesspools, they are even more difficult to study because identical or similar marks are rarely registered within the same assemblage or archaeological site. Larger collections with recurring symbols are exceptions, but at the same time, they often come from well-defined, homogeneous archaeological contexts (such as shipwrecks), thus providing priceless data on the functions served by these marks (*Ossowski 2014*, 260–261, 271–274). However, when published, they are discussed as isolated cases, without direct analogies. Comparative analyses of the published assemblages rarely reveal similar symbols found at different sites, and even when they do, their accidental similarity is often difficult to rule out.

The research questions related to marks on wooden vessels are relevant to a broader group of artefacts. This observation has already been discussed multiple times in the literature. Researchers usually stress the difficulties in determining the exact functions of these marks, which could be the signatures of individual craftsmen, merchants, or owners. The research on the subject offers many interpretations, sometimes mutually exclusive (*Holl 1966*, 62; *Neugebauer 1975*, 129; *Śledź 1979*, 354; *Scholkmann 1982*, 128; *Schäfer 1992*, 60; *Buchholz 1994*, 64, 66; *Müller 1996*, 139–140; *Morris 2000*, 2260–2261; *Baran 2005*, 433–434; *Kostrouch 2009*, 493; *Nawrolska 2009*, 90; *Robben 2009*, 175; *Kasprzak 2010*, 173; *Haak – Russow* 2012, 162; *Szajt – Wieczorek-Kańczura* 2018, 327–328; *Szajt 2021*, 22, 74). Hence, to make the argument clearer, this paper focuses exclusively on barrels, leaving out the wide range of other medieval wooden vessels. This way, marks can be typologised for a single and, thus, precisely-defined category of artefacts – barrels – whose common use as containers in trade is well established. Marking vessels was crucial in mercantile contexts, resulting in barrels becoming the most frequently marked type of wooden items. Today, this makes it possible to not only typologise the symbols but also to interpret them more accurately.

The marks facilitate interpretation because one of the types most commonly discussed in the literature is believed to have served an explicitly trade-related function (*Śledź 1979*, 354; *Buchholz 1994*, 66; *Müller 1996*, 141; *Morris 2000*, 2260–2261; *Robben 2008*, 82–84; *Ossowski 2014*, 271–272). According to this interpretation, marks are usually understood as signatures of the owners of transported commodities (*Müller 1996*, 139; *Falk 2002*, 428; *Możejko 2014*, 67–68; *Ossowski 2014*, 273). Another possibility is that they indicated the intended recipient of a shipment (*Falk 2002*, 429; *Ossowski 2014*, 273). Marking containers was even more important in maritime trade, since a single ship could carry barrels filled with goods belonging to different merchants (*Możejko 2014*, 72). Hence, marks not only prevented mistakes, mishandling, or theft, but also facilitated inventorying the

cargo and controlling the payment of customs (*Falk 2002*, 428). The possibility to identify the owner of goods by their mark was especially helpful in retrieving assets lost in a maritime disaster (*Falk 2002*, 429; *Robben 2009*, 175; *Możejko 2014*, 65). One account of this very situation was presented by Stanisław Matysik based on historical sources detailing the dispute between Toruń merchants and a Danish magnate over the rights to the goods retrieved from a Gdańsk trader shipwrecked in 1377 (*Matysik 1949*, 18–19). Admittedly, the conflict continued for many years, but it was thanks to marks on the chests containing the cargo that the majority of goods were recovered. Moreover, legal documents for the commodities salvaged from the disaster included a detailed description of the marks, which made it possible to identify the owners of particular chests. Matysik mentions that the merchants could easily determine the contents of specific containers based on the marks (*Matysik 1949*, 24). A similar conclusion was proposed after an analysis of an inventory book from a ship which sank in the Meuse (*Robben 2009*, 176).

However, this does not explain the problematic cases of barrels bearing multiple different marks. Hypothetically, the additional marks may have indicated a partnership of several merchants or that a container was reused (*Robben 2008*, 84; *Możejko 2014*, 72). It has been pointed out, however, that this solution could easily have led to mistakes and frauds (*Falk 2002*, 429). Some scholars suggest that in such cases, the mark on the bottom of a barrel represented the owner of the vessel's content (*Kasprzak 2010*, 173), while the mark on the stave identified the addressee or both seller and buyer (*Falk 2002*, 429). Alternatively, the bottom mark could indicate the type of content (*Robben 2008*, 84; *Kasprzak 2010*, 173) or the maker of the barrel (*Holl 1966*, 62; *Scholkmann 1982*, 128; *Buchholz 1994*, 66; *Morris 2000*, 2260–2261; *Falk 2002*, 423; *Nawrolska 2009*, 90; *Rembisz-Lubiejewska 2021*, 111; *Szajt 2021*, 22). A carved symbol – usually placed in the middle of the bottom – was supposedly meant to enable identification of the workshop that produced the vessel and to certify its quality (*Falk 2002*, 423).

Marking wooden goods, especially within the cooperage craft, was also required by guild regulations. A barrel, which served simultaneously as a unit of volume, had to have precisely-defined dimensions in order to prevent fraud. Late medieval and post-medieval regulations of the coopers' guilds in Gdańsk and Toruń explicitly state that senior guild members were obliged to verify the quality of goods and mark all barrels coming from a specific workshop. Moreover, a cooper in Gdańsk would not be allowed to buy staves that had not been quality-checked by a checker (presumably attested by marking the positively-verified staves) (*Herbst 1933*, 227; *Bogucka 1962*, 101–102). Similar regulations are also known from Riga and Wismar, where master coopers had to put marks on their products (*Falk 2002*, 426, 428). There are written accounts documenting that staves would be marked by the makers and bottoms by the users, as they were replaced more frequently (*Robben 2009*, 175). Meanwhile, an agreement between Cologne and Dutch towns stated that bottoms were to be marked by the makers and staves by the urban authorities, to guarantee proper dimensions of the barrels (*Robben 2009*, 175). It remains possible, however, that several different marks could be used by the same person (*Homeyer 1870*, 268; *Śledź 1979*, 354–360; *Ossowski 2014*, 273).

Unfortunately, the appearance of a mark is not always specified in publications. In effect, it is difficult to determine whether a given mark is a trace of quality control by the guild or a personal signature of the maker, even though in Toruń and Lübeck an official municipal stamp was made specifically for making marks (*Herbst 1933*, 227; *Falk 2002*, 428).

As shown, there are multiple interpretative options, and each could potentially be true depending on the local circumstances, such as the internal regulations effective in a given town or region.

This underscores the need for a typology of marks found on barrels, as without it, their functions will be difficult to decipher precisely. At the current stage of research, comprehensive understanding and linking particular symbols to specific historical persons is nearly unimaginable. Nevertheless, even with such diversity (from simple marks composed of single lines to extremely sophisticated patterns), it should be addressed whether the complexity of a mark correlates with the function of a barrel or whether certain marks can be identified as related specifically to, e.g. trade (signifying a merchant, carrier, commodity, recipient, etc.), craftsmanship (makers or guild quality checkers), or other activities that remain as yet unidentified.

Description of the assemblage

The analysis was conducted on 112 mark-bearing barrel fragments from Elbląg, Gdańsk, and Puck, the majority of which have not been published to date. The main objective was to answer the questions listed above, taking into account parameters such as the number, density, and arrangement of lines. Multi-season archaeological investigations in the said urban centres yielded a very diverse collection of wooden vessels, with and without marks, dated between the mid-14th and mid-16th centuries. The three centres developed in similar cultural and political contexts, at first within the State of the Teutonic Order and later, from the mid-15th century, within the Kingdom of Poland (*Biskup 1967*; *Czaja 2000*). At the same time, being urban organisms of different stature and dynamics, they offer distinct perspectives – that of large economic hubs in Gdańsk and Elbląg, and of a small regional centre in the case of Puck. Likewise significant is that all three towns participated in Baltic trade under Hanseatic influence, because this feature facilitates comparisons with urban centres of the southern Baltic coast. It should also be noted that, although the forms and directions of commercial exchange were decided largely by the Hanseatic League, newer studies ascribe a more prominent cultural role to settlers from various parts of Germany, who arrived in the region as Elbląg, Gdańsk, and Puck were being chartered (*Suhonen 2001*; *Immonen 2007*; *Jahnke 2009*; *Müller 2014*; *Naum 2015*; *Pluskowski 2022*, 238–244; *Starski 2022*, 96). The factors mentioned above were consistent across all the towns discussed and pivotal to their economies and material cultures, which justifies the selection of sources for this analysis.

Elbląg

The history of Elbląg began in 1237, when the Teutonic Order built a stronghold at the mouth of the Elbląg River into the Vistula Lagoon. A settlement started to grow quickly around the stronghold and nine years later the Order granted the town a charter under the Lübeck Law (*Czaja – Nawrolski 1993*, 60–70). The favourable location enabled Elbląg to participate in long-distance trade connecting the Baltic region directly to Poland, Hungary, and Rus, and indirectly to many centres in Western and North-Western Europe. Under such circumstances, Elbląg thrived and developed rapidly from its chartering until the

mid-14th century. The town's economy faced a crisis at the turn of the 15th century due to strong competition from Gdańsk, which eventually dominated Elbląg and pushed it into a more peripheral position (*Czarciński 1993*, 147–152).

The largest collection, including 71 fragments of barrel bottoms and other stave-built vessels with marks, comes from the multi-season archaeological excavation in the Old Town of Elbląg, which started in 1979 and continued almost without interruption for the next 30 years (*Fonferek et al. 2012*, 16–19; *Nawrolska 2012*, 20–23; *2014*, 44–50). All the finds are held by the Muzeum Archeologiczno-Historyczne in Elbląg, together with an inventory and visual documentation compiled already when the excavations were still ongoing. Thanks to this effort, the assemblage can be meaningfully researched even many years after the work ceased. Furthermore, as the discussed finds have not yet been studied or published separately, the present overview itself constitutes a valuable contribution, significantly enhancing research on the marks found on barrels.

Gdańsk

The earliest settlement within today's Gdańsk is dated to the turn of the 11th century. The first charter under the Lübeck Law was granted by Świętopełk, Duke of Pomerania, in the 1220s or 1260s (*Maciakowska 2022*, 19). During the Teutonic Order's invasion of Pomerania in the first decades of the 14th century, Gdańsk was razed to the ground and then founded again, which was confirmed by a new charter issued by the Order in 1342, this time under the Kulm Law (*Spors 1982*, 64–71; *Paner 2004*, 15–33; *Długokęcki 2009*, 27–42; *Maciakowska 2009*, 16–26). During the 14th century, the town developed rapidly, becoming one of the most important regional trade centres alongside Elbląg and Toruń. It connected the Baltic region with the Teutonic Order's domain and the Kingdom of Poland, and through them with more distant parts of Europe (*Bogucka 1962*, 7–9; *Litwin 2014*, 19–29). In the 15th century, especially after the Thirteen Years' War (1454–1466), Gdańsk emerged as the dominant commercial power on the Baltic coast, playing a key role in the development of several smaller centres under its influence (*Gierszewski 1966*, 184).

The wooden vessels found in Gdańsk were analysed based on available publications (*Kasprzak 2010*, 173; *Miścicki 2022*, 401, 408–409, 413) and during a study visit to the Muzeum Archeologiczne in Gdańsk. The assemblage comprises 26 mark-bearing fragments of bottoms of barrels and other stave-built vessels. Since these finds come from excavations conducted over a long period in different parts of the city and by different teams, many of them could be dated only approximately. Moreover, the complexity of Gdańsk as a research site and the large number of archaeological excavations taking place in the city suggest that the presented assemblage is but a part of the potentially available source base. Therefore, it should be seen as a preliminary contribution and foundation for future studies rather than an authoritative representation (*Paner 2006*, 11–88).

Puck

Puck was first mentioned as a village at the turn of the 13th century, but by the following decades of that century, it was referred to as a trade settlement (*Śliwiński 1998*, 55–68). The archaeological finds analysed here are related to the town chartered in 1348 by the Teutonic Order under the Kulm Law (*Bruski 1998*, 73–77; *Kruppé – Milewska 2015*, 11).

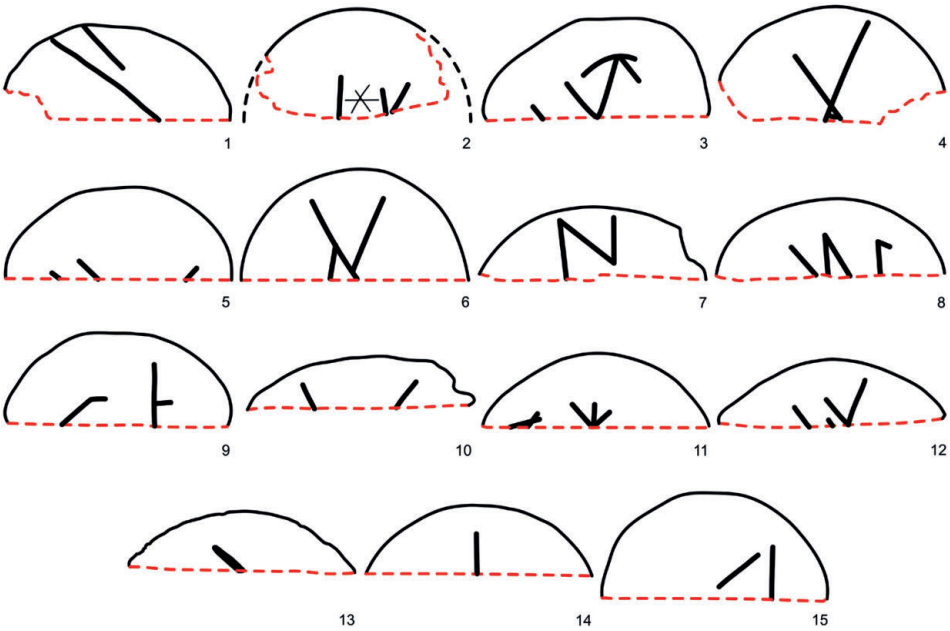

Fig. 2. Illegible marks from Elbląg (1, 3–5, 7–12, 14–15) and Puck (2, 6, 13). The finds are dated to the 14th century (1), late 14th–early 15th century (2), 14th–15th century (3–5), first half of the 14th century (6), and 15th century (7–15).

Throughout the discussed period, Puck remained a small settlement classified as a third-category town in the literature due to the occupational structure of its inhabitants – a local centre of craftsmanship, with part of the population engaged in farming (*Bogucka – Samsonowicz 1986*, 108). In regards to its participation in trade, Puck should be seen as economically dependent on the dominant Pomeranian power, Gdańsk. This relationship is also reflected in the archaeological record from the town (*Starski 2015*, 200–202). Simultaneously, it is worth emphasising that compared to other peripheral Pomeranian towns, Puck is described by a relatively rich array of written sources, including the Town Register (*Kardasz 2017*, 71).

The ongoing archaeological work in Puck, conducted systematically for more than 30 years, yielded 15 fragments of barrel bottoms with marks. Although the smallest of the analysed collections, the Puck assemblage is dated most precisely – predominantly to different parts of the 15th century. Moreover, it has been comprehensively elaborated and published, except for the excavation seasons after 2017 (*Starski 2017*, 134–137).

Preservation

The primary difficulty in studying this category of artefacts appears already during archaeological excavations. Wooden vessels are typically found fragmented, with no marks preserved in their entirety. Thus, the symbols, which were schematic by design, become completely illegible or so ambiguous that their meaning is impossible to infer with any precision. The staves and bottoms of barrels were often secondarily used to pad the yards

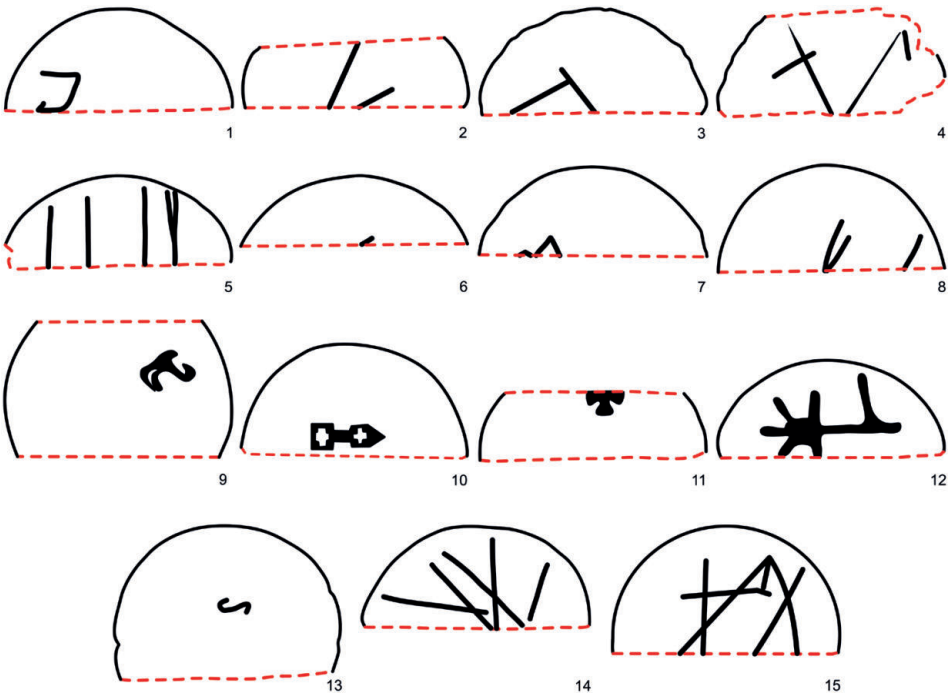

Fig. 3. Illegible marks (1–8), branded marks of group I (9–13), and marks composed of multiple irregular lines categorised as group II (14–15). Finds are from Elbląg (1–2, 5, 9–12, 14–15) and Gdańsk (3–4, 6–8, 13), dated to the 14th century (9), 14th–15th century (10, 14–15), 15th century (1–2, 11–12), 15th–16th century (3–5), and 14th–16th century (6–8, 13).

of urban plots or for casings of cesspools or drainages (*Polak 1996*, 332; *Bobik 2016*, 153; *Blusiewicz 2017*, 99, 115–116; *Starski 2017*, 134). As a result of such prolonged exploitation, marks on wood became blurred, which also complicates their proper identification. Moreover, soft wood heavily soaked with water deposited in compact and hard layers of manure can easily be damaged in the course of archaeological excavation. Immediately after removal from the ground, it is fairly easy to distinguish intentionally carved marks from random incisions left by archaeologists. These differences, however, become less evident over time and are no longer clear in post-excavation documentation. In addition, without proper chemical stabilisation wooden finds dry out quickly and uncontrollably, which leads to irreversible damage or deformation negatively affecting the legibility of the marks. To complicate things even more, conservation may be impossible due to a variety of reasons. Hence, the key to preservation of information on marks lies in their proper documentation – as much as practically possible, they should be documented already during excavation or shortly afterwards.

All the aforementioned finds are fragments, which usually means that the marks survived only partly, an effect particularly strong for barrels. Although their bottoms had originally consisted of at least two or three pieces, usually just one of them survived. On the best-preserved specimens, the mark on the surviving stave could be seen either in whole or in part sufficiently large to enable its plausible reconstruction. In the worst cases, only some

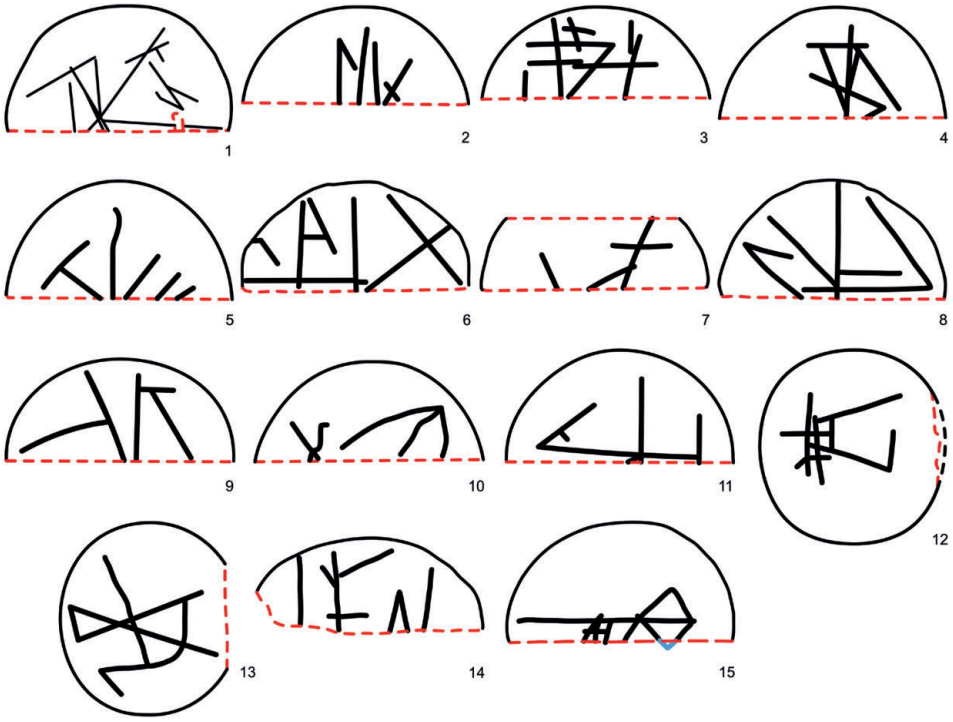

Fig. 4. Marks of group II composed of multiple irregular lines from Elbląg (1–12, 14–15) and Gdańsk (13). The finds were dated to the 14th–15th century (1–5), 15th century (6–12), second half of the 15th century (13), and 15th–16th century (14–15).

of the lines, single or measuring a few centimetres, could be seen (*Fig. 2*; *Fig. 3*: 1–8). Apart from the said 23 specimens, the rest are at least half-legible, thus allowing comparison and classification.

Categories of marks

Of all the categories of wooden vessels, barrel bottoms show the greatest diversity in the visual features of marks. Hence, five groups were distinguished within the discussed assemblage. The first (I) includes five branded symbols – four from Elbląg and one from Gdańsk (*Fig. 3*: 9–13). These marks are the least common in the archaeological record, as evidenced in relevant publications. It is unclear whether they were guild, craftsmen's, ownership, symbolic, or decorative symbols (*Scholkmann 1982*, 128; *Müller 1996*, 140–141; *Falk 2002*, 422–423; *Kostrouch 2009*, 493; *Szajt – Wieczorek-Kańczura 2018*, 327). These are usually not large marks and they occupy a small part of the barrel bottom.

The other three groups (II–IV), forming the vast majority of the assemblage, consist of stylistically diverse marks carved with a chisel or knife, with lines 0.5 to 1.0 cm in width. The most complex are composed of six to nine lines of various lengths arranged quite loosely and asymmetrically, not resembling any legible sign (II). The lines can be crossed, broken, or tangential, set at various angles. They can have a single discernible primary line

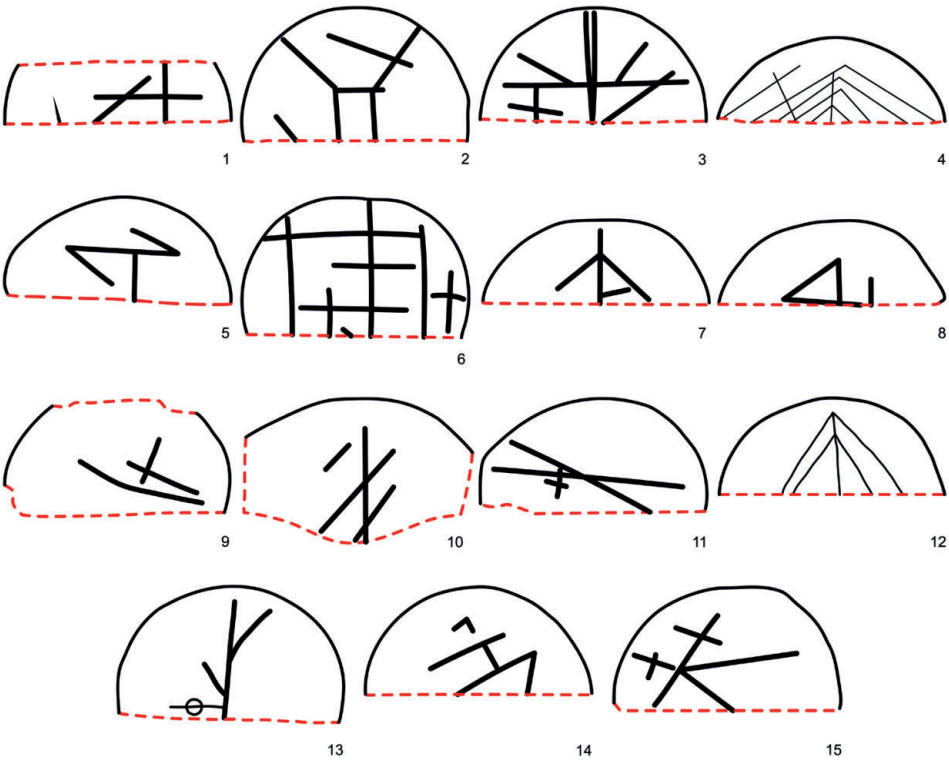

Fig. 5. Marks of group II composed of multiple irregular lines (1–3), and marks of group III composed of multiple regularly-arranged lines (4–15) from Gdańsk (1–4, 13), Elbląg (5–12, 15), and Puck (14). The finds were dated to the second half of the 14th century (4, 14), 14th–15th century (5–10, 15), 15th century (11–12), 15th–16th century (1), and 14th–16th century (2–3, 13).

or several long lines with shorter branches, as well as crossed or overlapping broken lines. The cut lines are usually straight, with only a few arched or rounded. The marks typically take up most of the space on the barrel bottoms, but they tend to concentrate in their central parts. A total of 20 such marks were found in the analysed assemblage (*Fig. 3*: 14–15; *Fig. 4*; *Fig. 5*: 1–3).

The third group (III) consists of marks featuring geometric figures, either standing on their own or in groups, which are sometimes connected or criss-crossed with single lines. The majority are roughly triangular or rectangular, with the addition of lines intersecting with or extending from them. The group also includes marks composed of multiple lines, not necessarily closed. Unlike the previous group, this category contains marks with less chaotic arrangements, making more frequent use of parallel and perpendicular lines, but also occupying most of the surface of the bottom of the barrel (*Fig. 5*: 4–15; *Fig. 6*; *Fig. 7*: 1–6). The assemblage of finds from Elbląg, Gdańsk, and Puck contains 33 such marks.

The next analysed group (IV), totalling 23 specimens, includes marks with a compact and legible composition most often placed in the central part of the bottom. They show greater regularity, better workmanship, and are more often symmetrically axial, resembling various kinds of arrows or closely-arranged lines – parallel, crossed, or broken with other

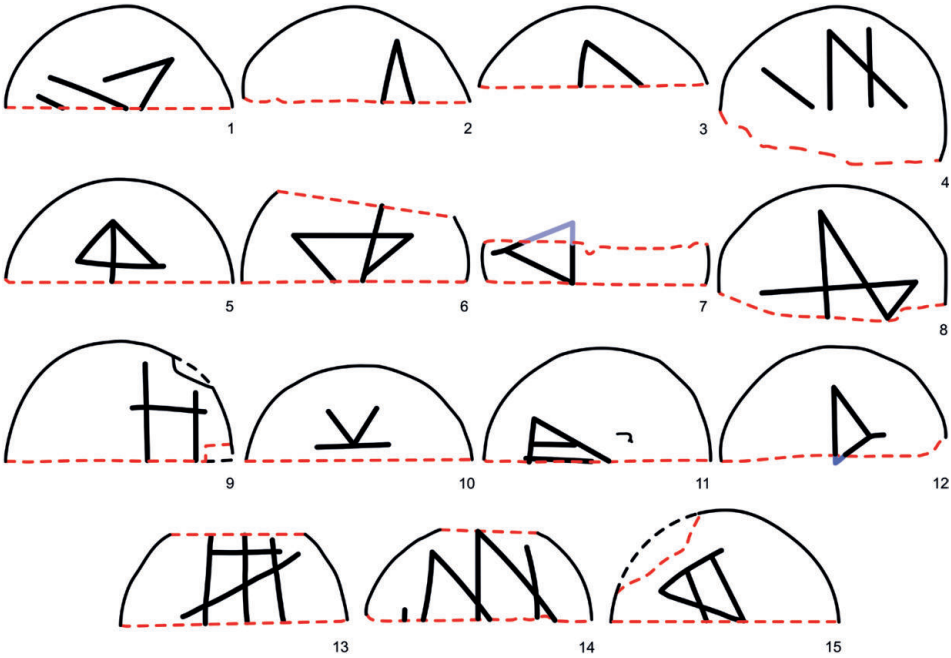

Fig. 6. Marks of group III composed of multiple regularly-arranged lines from Puck (1–4) and Elbląg (5–15). The finds were dated to the first half of the 15th century (1), the second half of the 15th century (2–4), and the 15th century (5–15).

lines or geometric figures (*Fig. 7*: 7–15; *Fig. 8*). Simple symbols predominate, although more complex examples are also present. Regardless of complexity, most of them make deliberate use of distinct patterns. It was only in this group that the same mark was used more than once (*Fig. 7*: 11–12).

The remaining eight marks are difficult to classify with certainty and were thus counted together as a single outlying group (V). Their forms resemble carved letters or Roman numerals, often combined with other symbols (*Fig. 9*). The most sophisticated in this regard is the mark from the barrel bottom found in Elbląg, where an uneven row of letters 'BBS' was carved together with lines – one parallel and one perpendicular – broken at the ends with two circles (*Fig. 9*: 5). Bottoms bearing only letters were also found in smaller stave vessels (buckets or pails) from Elbląg (*Fig. 9*: 1, 6). The crossed and straight lines recorded on barrel bottoms from Puck may look like Roman numbers, but such symbols are so intuitively simple and common that they may have had a different meaning (*Fig. 9*: 3–4, 7).

Results

The frequency distribution of mark-bearing finds in the discussed assemblage shows clear predominance of groups II–IV, with group III as the largest (*Fig. 10*). Some of the 23 incompletely-preserved and illegible marks might be tentatively connected to groups III or IV, but at the current stage of research labelling them as 'unidentified' seems more reasonable.

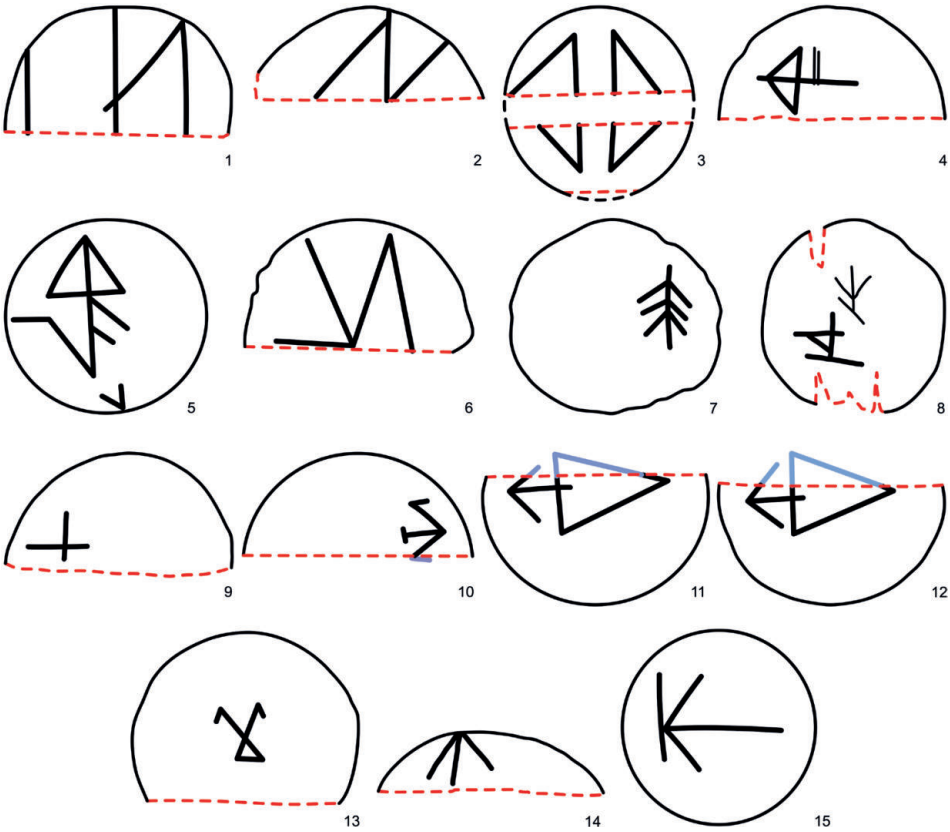

Fig. 7. Marks of group III composed of multiple regularly-arranged lines (1–6) and marks of group IV with compact composition (7–15) from Elbląg (1, 9–12), Puck (2, 15), and Gdańsk (3–8, 13–14). The finds were dated to the second half of the 14th century (7–8), 14th century (9), 14th–15th century (10–13), first half of the 15th century (14), 15th century (1, 15), second half of the 15th–first quarter of the 16th century (2), and 14th–16th century (3–6).

It should be noted, however, that in most cases, half of the preserved mark was enough to make a classification. It cannot be ruled out that if the full mark had been legible, it would have led to a different interpretation and assignment within the proposed groups or the separation of further types. However, based on the analysed material, it seems that these would not have been a common occurrence. The basic specified features can be legible even on an incomplete mark. Marks assigned to all of the aforementioned groups were found on the bottoms of barrels and other stave vessels from Elbląg, Gdańsk, and Puck dated to the period between the 14th and 16th centuries. The structure of the assemblage does not make it possible to statistically determine whether any of the mark types enjoyed greater popularity than the rest.

Assuming that the type of site (large or small city) has or does not have an influence on the occurrence of given groups, the correspondence analysis comparing finds from three sites showed that groups I and II are more frequent in Elbląg, group IV in Gdańsk and group V in Puck, and group III is present in Elbląg and Puck (23 illegible marks were not

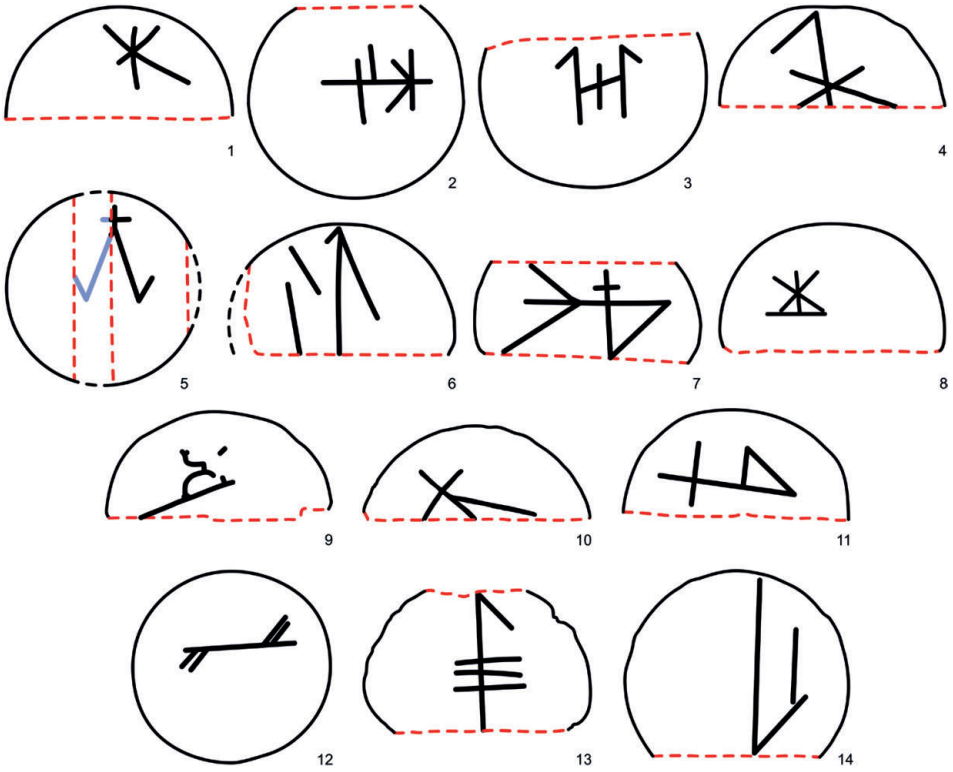

Fig. 8. Marks of group IV with compact composition from Elbląg (1–4, 7–9), Puck (5–6), and Gdańsk (10–14). The finds were dated to the first half of the 15th century (5), 15th century (1–4, 7–10), second half of the 15th century (6), and 14th–16th century (11–14).

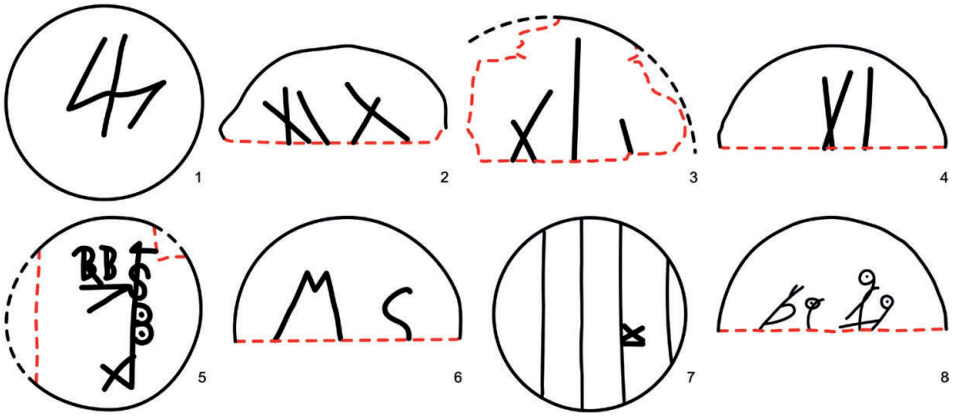

Fig. 9. Other marks found on stave-built vessels labelled as group V found in Elbląg (1–2, 5–6), Puck (3–4, 7), and Gdańsk (8). The finds were dated to the 14th century (1), 14th–15th century (2), late 14th–early 15th century (3), first half of the 15th century (4), 15th century (5–6), late 15th–first quarter of the 16th century (7), and 14th–16th century (8).

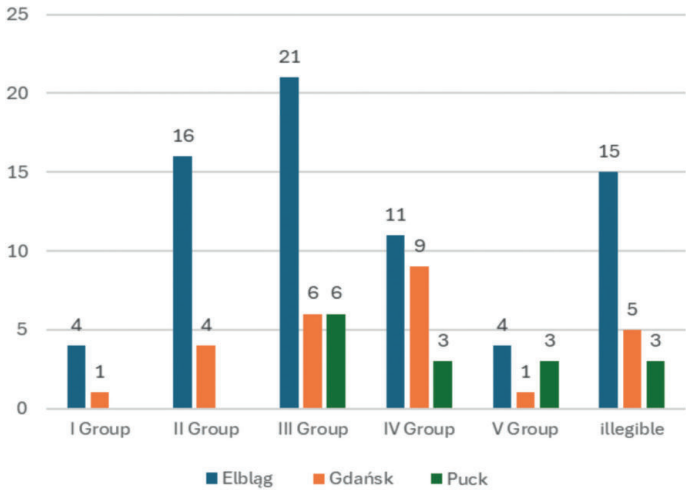

Fig. 10. Number of mark-bearing barrel fragments from each group, divided into analysed sites.

included) (*Fig. 11*). Such a great discrepancy between Gdańsk and Elbląg seems interesting and difficult to interpret. Nevertheless, the predominance of group IV in Gdańsk, as one of the most important trading cities on the Baltic Sea in this period, is not surprising. It should be noted, however, that with an assemblage of this size, the result is not statistically significant and with a larger number of finds, the proportions might show different trends. Still, even when the size of the assemblage is small, the correspondence analysis makes it possible to detect differences between frequencies and hints at possible relationships between mark groups which should be expanded upon in further research.

Among the 112 analysed marks, the majority are dated to various parts of the 15th century. However, with the data available today, none of the identified mark types seems characteristic of a particular time interval. Moreover, the marks are highly heterogeneous in form and almost never repeated. The only exceptions are a single symbol from Elbląg, which appeared twice (*Fig. 7*: 11–12), and one mark from Puck (*Fig. 8*: 5), found on four turned vessels from the same archaeological context (*Starski 2017*, 137, 147–149).

By compiling the available data on the barrel fragments found in Elbląg, it was determined that 67 out of 197 barrel bottoms bear marks (34%). The assemblages from Puck and Gdańsk were too small to serve as a statistically representative sample, but they still show a similar pattern. The presence of marks on approximately one-third of the finds may be taken to mean that barrels were routinely marked in the Late Middle Ages. As mentioned earlier, all of the many reasons for marking barrels can be linked to either mercantile or non-mercantile contexts.

Important sources for archaeological analyses of trade-related marks are wrecks of merchant ships preserved with their cargo. The shipwreck of *Miedziowiec* (‘Copper Ship’) from the Gdańsk Bay yielded several dozen barrels, or their fragments, whose bottoms and staves bore carved linear marks. The symbols showed considerable diversity, but it was still possible to distinguish a series of recurring patterns. Moreover, wainscot planks or single staves inserted in bundles of metal bars were also marked, and some of these marks matched those found on barrels (*Ossowski 2014*, 248, 260–280). This makes it possible to assess what part of the cargo belonged to the same owner – the barrels with multiple marks,

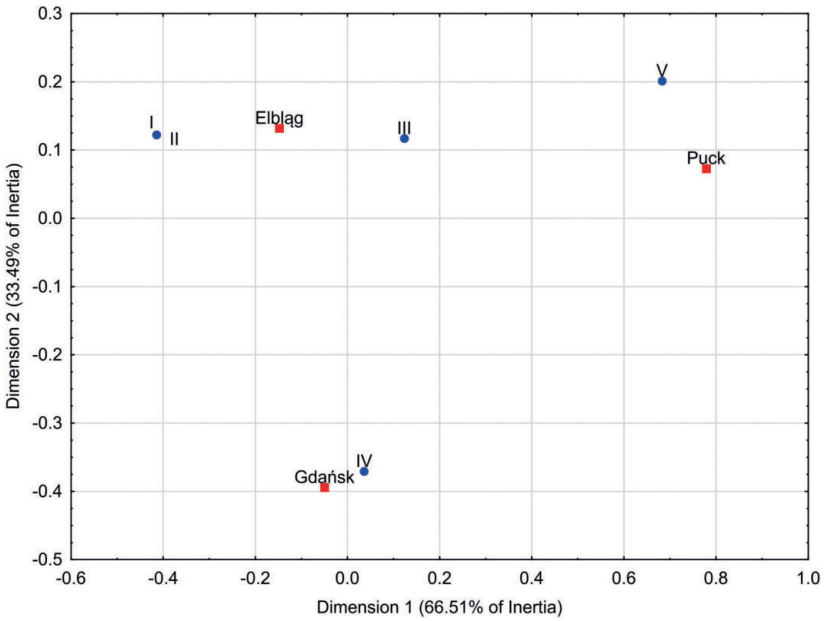

Fig. 11. A correspondence analysis for mark-bearing barrel findings from each group (chi-square=12.0, p=0.12). The number of finds from each city taken into account in the analysis: Elbląg – 56; Gdańsk – 21; Puck – 12.

however, remain problematic, as indicated earlier. Stylistically, the published marks from *Miedziowiec* should be assigned to group IV – regular and relatively simple symbols composed of several lines in compact arrangements.

The studies of marks found on wooden vessels benefit considerably from information supplied by written sources. The marks from the aforementioned *Miedziowiec* shipwreck, for example, revealed that one of the owners of the transported commodities was Johann Pilge, the *Großschäffer* of Königsberg. His family emblem showing a cross *pattée fitchée*, known from accounting books, can be found on some of the barrels from the shipwreck. Moreover, the year when the ship sank dates to the period of Johann Pilge's service as the *Großschäffer* (*Możejko 2014*, 67–68). Another example may be a letter sent in 1470 by a merchant from Riga to his partner from Lübeck. It mentions a mark used to sign mead barrels shipped to Lübeck (*Falk 2002*, 428–429). In both cases, the discussed marks show the distinctive features of group IV.

Another example is customs registers, such as the list of *Pfundzoll* (a type of tax in the Hanseatic League) payers preserved in the Municipal Archives of Toruń and published by Leon Koczy. Apart from information on the types of transported goods (mostly cloth from Western Europe) and the amount of payments, the manuscript names 27 Hanseatic merchants along with their marks (*Koczy 1935*, 275–331). Similarly, an analysis conducted by Marian Gumowski on wooden shields, coats-of-arms on gravestones, church epitaphs, portraits of town councillors, stained glass, houses and entablatures, rolls of arms, and genealogy books revealed 114 marks which could be associated with patricians of Toruń living between the end of the 14th and beginning of the 18th centuries (*Gumowski 1970*, tabs. XXXV–XXXIX). These also appear stylistically closest to group IV.

An interesting account mentioning barrel-marking is a list of errands of a Polish nobleman, Jacek Roztworowski, written in the mid-18th century and containing detailed instructions for a skipper responsible for purchasing required goods in Gdańsk. One entry is particularly relevant for the question of barrel-marking: '*Scottish Herring, but only fresh, from the Ships – buy Barrels no. 11 and mark them, so that they don't get lost on someone else's ship*' (translated by the author from Polish into English; *Roztworowski 1935*, 357). The form of the mentioned mark is of course unknown, but the account still clearly documents that marked barrels were not uncommon in trade-related contexts, even when the mark represented a private buyer rather than a merchant.

Conclusion

The examples quoted above demonstrate that at least the marks of group IV should be linked to mercantile contexts, in which barrels served as containers for various traded commodities, and that the role of a mark was to identify a specific person engaged in the exchange. It is possible that coopers' goods with similar marks found in Elbląg, Gdańsk, and Puck were used in the same manner. Analogous written sources could not be found for marks of groups II and III, although both are common in the discussed assemblage and among archaeological finds from other Baltic sites (*Scholkmann 1982*, 103; *Buchholz 1994*, 79; *Falk 2002*, 431). The marks of group III show much greater compositional coherence than those of group II and are considerably more sophisticated than group IV. In the literature on the subject, it is sometimes pointed out that barrels could be marked multiple times if they were reused (*Falk 2002*, 429; *Robben 2008*, 84; *Możejko 2014*, 72). Hence, it must be borne in mind that complex marks may in fact be several overlapping simpler ones. However, the repeated marking of reused barrels does not seem to be a rational practice, since a 'renewed' mark would likely become obliterated quickly. It is possible that a mark was intentionally changed when a barrel was no longer used as a container for traded goods. Nevertheless, at the current stage of research, this remains conjecture in need of future systematic verification.

Based on the available sources and the conducted analysis, it is difficult to either prove or refute that groups II and III contained marks related to trade. It should be recalled that the primary function of a barrel is to hold various commodities. At the same time, the connection of these marks to guilds, craftsmen, owners, or other yet unknown contexts remains an open question. In the case of the chaotic marks of group II, it should not be immediately ruled out that they were random symbols, devoid of any particular meaning. They could, however, just as well be applied deliberately, perhaps in a manner resembling carpenters' marks – quick and schematic indicators of specific quantitative or ordinal relations in a workshop or ship's hold. Meanwhile, the small number of marks of groups I and V precludes drawing any sort of conclusion.

The present analysis of 112 marks on barrel bottoms from Elbląg, Gdańsk, and Puck demonstrated the following: wooden goods were commonly marked, as approximately one-third of all finds bear marks. Those found on barrels tend to be very diverse and rather stylistically loose, which led to distinguishing five groups of symbols: group I, consisting of a small number of branded marks; group II, characterised with very complex, chaotic compositions; group III, with complex and multilinear, though more orderly and geometrised

patterns; group IV, comprising simple, easily-legible motifs; and group V, with marks of unspecified forms, usually somewhat resembling letters or Roman numerals. The widespread use of marks on wooden vessels also seems documented by the small number of repetitions despite the large sample size and rich corpus of analogies known from the literature. In light of the present evidence, the sporadic formal similarities between marks should be considered random occurrences. However, it is worth noting that these parallels and apparent repetitions are observed only in the marks of group IV, which is interpreted as related to trade.

The present analysis of archaeological and historical data does not provide a clearcut answer to the question stated at the beginning of the paper, but it contributes to further studies. Crucial for future research on late medieval marks on barrels will be expanding the source base, particularly through the publication of finds. A larger sample of artefacts will increase the chances of identifying analogies for the already known symbols and improving our understanding of the reasons behind barrel-marking. However, future research should not be limited to the standard archaeological description of morphological features, but rather include careful analysis of written sources, such as tax rolls, waybills, town registers, guild records, etc. Such an approach may reveal mentions of barrel marks in the historical documents and thus provide information on the persons and social realities in which these symbols were used. This, in turn, may provide new insights into late medieval craftsmanship and trade. Important contributions may also be made by experts in heraldry, palaeography, and sphragistics, who are well-equipped to develop coherent and transparent methods of description and classification.

Nonetheless, the primary function of the marks was undoubtedly related to trade – they linked persons to commodities transported in barrels. The kinds of person-barrel relations could vary, as demonstrated earlier, but they always remain adjacent to trade. In particular, the marks of group IV promise important insights in the future, potentially shedding additional light on the history of local as well as long-distance trade. This does not mean that marks from other groups should be excluded from this role, but in light of the current source base, this interpretation is not strong enough to be applied unequivocally. Therefore, it seems justified to postulate that research on barrel marks should prioritise archaeological assemblages retrieved from well-defined cultural contexts, such as the Hanseatic sphere of influence and the Baltic urban network, whose inhabitants were predominantly of German origin. Against this backdrop, an interesting research avenue could be comparative studies of large and small towns functioning within the model of centres and peripheries. This approach has already been explored, though more holistically, by historians of medieval European culture and economy (*Wallerstein 1974*; *Braudel 1992*; *Dygo 2006*, 122–123), suggesting that it can be fruitfully applied to archaeological analyses of barrel marks. However, this methodological move, as stressed before, would require a stronger source base, particularly larger samples of archaeological finds from Baltic urban centres of varying sizes and economic and cultural stature.

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MACIEJ MIŚCICKI, University of Warsaw, Faculty of Archaeology, Krakowskie Przedmieście 26/28, PL-00 927, Warsaw, Poland; mmiscicki@uw.edu.pl

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Mapping urban assemblages: Simulating material culture and social dynamics in a flea market context

Mapování městských souborů: Simulace materiální kultury a sociální dynamiky v kontextu blešího trhu

Jakub Sawicki – Jan Hasil

Although urban archaeological research yields a wealth of information, interpreting material culture in a complex context complicates the estimation of the artefact-space-human relationship. Drawing on the archaeological research on active (still operating) sites, this study presents a simulation of those dynamics using as an example a vibrant flea market, which is considered a space with a condensed assemblage of relationships between people and objects in a confined area. This approach allows for a better understanding of the dynamics of archaeological sites and social relations. We assume that multiple human activities, like trade, have their material reflection in waste and can be archeologically investigated. We surveyed a flea market (Cieplice, SW Poland), mapping finds of discarded or lost items and assigning them to different functional categories. The results show a partial correlation between the stalls and finds, varying on the object kind. However, the finds, given that as contemporary humans we understand the 'total' context, allow unobvious interpretations, opening a new perspective also for medieval and post-medieval urban archaeology.

medieval market – flea market – contemporary archaeology – medieval archaeology – material culture – active site – survey

Archeologický výzkum ve městech přináší řadu informací, avšak interpretace hmotné kultury v komplexním kontextu komplikuje odhad vztahu artefakt – prostor – člověk. Na základě archeologického výzkumu aktivních (stále fungujících) lokalit předkládá tato studie simulaci této dynamiky na příkladu živého blešího trhu, který je považován za prostor se zhuštěným souborem vztahů mezi lidmi a předměty na omezeném prostoru. Tento přístup umožňuje lépe pochopit dynamiku archeologických lokalit a sociálních vztahů. Předpokládáme, že mnohočetné lidské činnosti, jako je obchod, mají svůj materiální odraz v odpadu a mohou být archeologicky zkoumány. Provedli jsme průzkum blešího trhu (Cieplice, JZ Polsko) a evidované vyřazené a ztracené předměty přiřadili k různým funkčním kategoriím. Výsledky ukazují částečnou korelaci mezi stánky a nálezy, která se liší v závislosti na druhu předmětu. Nálezy však vzhledem k tomu, že jako současní lidé chápeme „celkový" kontext, umožňují ne-obvyklé interpretace, a otevírají tak novou perspektivu i pro středověkou a postmedievální městskou archeologii.

středověký trh – bleší trh – současná archeologie – středověká archeologie – hmotná kultura – aktivní lokalita – průzkum

Introduction

From the perspective of archaeological research, urban space presents a chaotic landscape. Frequently studied in small sections of the original plot, it is interspersed with numerous pits, walls, cesspits, with stratifications exceeding 5 metres in depth. This complexity makes interpretation challenging. Moreover, such studies present the researchers with huge quantities of artefacts, sometimes literally tonnes of them. Interpretation of this material

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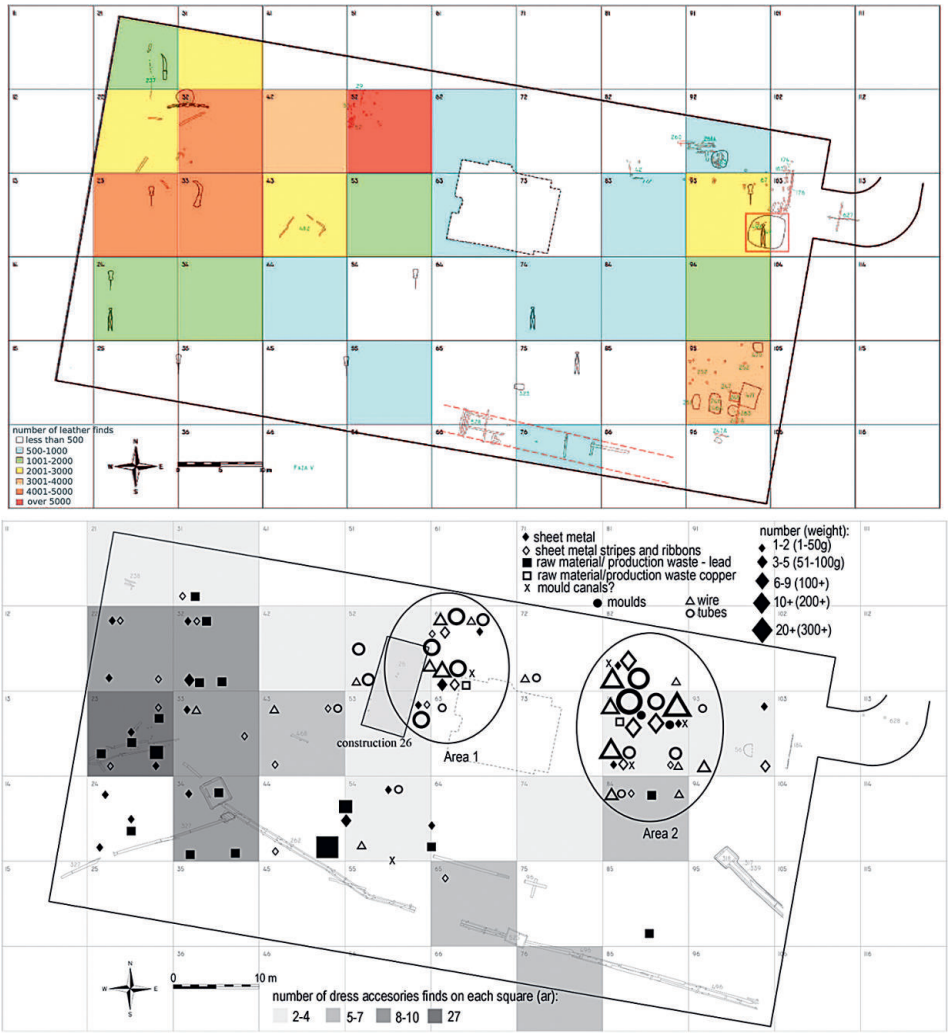


Fig. 1. The distribution of various finds on the medieval New Market Square in Wroclaw (after *Konczewska 2018; Sawicki 2018*).

culture on a macro scale is also difficult, as it consists mostly of settlement waste, accidentally lost, discarded rubbish, and rarely intentional deposits.

Field research in urban squares and marketplaces is less common. These parts of the city, of course, differ significantly from one another depending on their purpose, the type of ground surface (paved or not), the number of visitors, the types of stalls, etc. Nevertheless, their archaeological study, especially from the perspective of artefacts, raises numerous questions (*Buśko – Głowa 2017*; *Konczewska 2018*; *Piekalski – Wachowski 2018*; *Sawicki 2018*; *Tys 2020*). Can potential locations of trade and production be identified based solely on artefacts, as suggested by large concentrations of objects in certain areas? Did traders have specialisations, and are these reflected in the archaeological record?

Finally, a fundamental question for our discipline: what is the function of objects in relation to existing structures, such as buildings or stalls? Some observations on this topic have been made in studies conducted in Wrocław (*Konczewska 2018*; *Sawicki 2018*); however, these hypotheses have not yet been verified (*Fig. 1*).

Such open commercial marketplaces, similar in function and operational intensity, continue to exist today. Flea markets (French: marché aux puces, German: Flohmarkt, Polish: pchli targ, Czech: bleší trh) represent a global phenomenon, documented in a comparable form in medieval written sources, though their origins undoubtedly date back to much earlier periods. The flea market witnesses very intense entanglements (*Hodder 2012*; *2016*) between people and things, taking place over a short period of time (usually one day) and often recurring in the same place. It overwhelms with the accumulation of different actors: people and objects in one limited space, drawing images of the multiple social relations that take place between them – from the arrangement of the stalls to the trade itself (*Fig. 2*).

The aim of this study, however, is not to deal with the history of flea markets, but to reflect on them as an interpretative model of the dynamics between space and human entanglements based on material evidence, to test whether there is a correlation between different types of waste and the arrangement of stands in a highly dynamic and cyclically used structure. The recently developing field of Contemporary Archaeology (*Graves-Brown et al. 2013*) and projects referring to Garbology (*Graves-Brown et al. 2013*) provide inspiration to simulate an archaeological site with access to the 'total context' along with the simultaneous study of the material culture itself.

In this text, the term 'total context' refers to the current archaeological record, which we, as modern consumers of culture, should be able to understand easily (*Graves-Brown et al. 2013*). However, as this study will later demonstrate, this understanding is quite complex. We build here on the behavioural archaeology ideas discussed by Michael B. *Shiffer* (*2010*, p. 19) and an understanding of 'archaeological inferences' – which can be summarised as steps to understand human behaviour and cultural process on the basis of the archaeological record. Our aim was to alter ethnoarchaeological approaches to contemporary and historical archaeology, as we analysed the formation process by the application of middle-range theory as presented by Lewis Binford. Taking into account early comments on this approach by Mark Raab and Albert C. Goodyear (*Raab – Goodyear 1984*), we aimed to study the historical 'medieval marketplace' through an understanding of the recently advocated 'active' archaeological site.

This term was recently popularised by Carolyn *White* (*2020*) in her book on the Archaeology of the Burning Man festival, which provided a theoretical foundation for this type of research. Various types of studies in the field of contemporary archaeology (*Nativ – Lucas 2020*) have also been conducted at other music festivals (*Äikäs et al. 2016*), film sets (*Weller 2014*) and college campuses.[1] All of these studies focus on understanding human interaction with space on the basis of archaeological methods, reaching beyond traditionally explored sites that have already 'lapsed'.

Following the aforementioned approaches, the field research conducted in Cieplice was essentially an archaeological experiment in which the researcher-observer gains first-

[1] https://www.facebook.com/kampusjakostanowisko

Fig. 2. General views of the active site of the flea market. A – aerial view of the blue and red areas with surrounding parking places from southwest (photo by J. Hasil); B – terrestrial view of the blue area from west (photo by J. Sawicki).

hand, empirical knowledge that enhances their ability to develop and refine interpretive models (for more on archaeological experiments, see *Neustupný 2009*, especially p. 3–6). The uniqueness of this experiment lies in the scale of the studied structure and the number of participants involved (thousands of people and billions of artefacts), which could never have been simulated by other means. Similarly, it is worth mentioning that the context of all the finds from the site is heterotopic, as all of them were brought specifically for the flea market, and as such they are discussed from a cultural perspective of court durée.

Contemporary flea markets have not yet been archaeologically studied, apart from one survey conducted in Tübingen (*Porr 1998*). Medieval flea markets, however, have been the

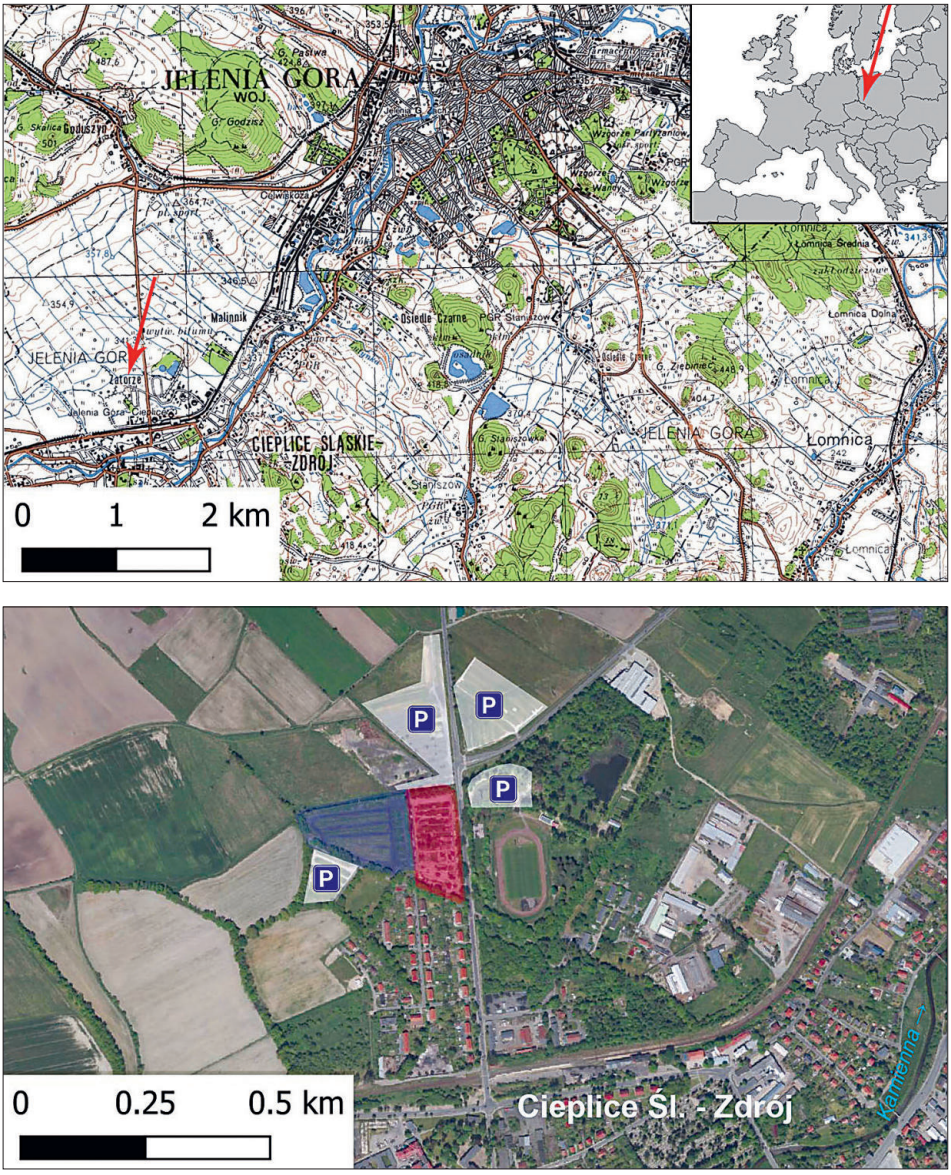


Fig. 3. Localisation of the site.

subject of scholarly debate (*Piekalski – Wachowski 2018*; *Oksanen – Lewis 2020*) concerning material culture, urban planning, micro and macro soil remains as well as commerce on a larger or smaller scale.

Their function and relationship with other actors are equally complex, creating an interpretative paradox: the archaeological situation is static, while the reconstructed reality is highly dynamic, changeable, and ambiguous.

Investigated site: Sunday flea market in Cieplice (SW Poland)

We carried out our research in Cieplice, Jelenia Góra District, Poland (*Fig. 3*), a town located close to the border with both the Czech Republic and Germany. The local flea market has been held on a weekly basis every Sunday since at least the turn of the century, but there is no official documentation of it. Trading takes place from early in the morning until around 2 p.m. The area in which the weekly market is located can be divided into several zones. The blue zone belongs to several private owners; the red zone, surrounded by a fence, is managed by the city hall. There are also multiple parking zones managed by individual entrepreneurs who determine the payment rates. The parking areas near both the blue and red zones also serve a minor commercial function, as they are occupied by local farmers selling their agricultural products.

For this experimental study, we chose to focus our survey on the largest blue zone, a decision influenced by several factors. This area served as the primary trade zone, featuring the highest number of traders from various specialisations and attracting the most customers. Additionally, its accessibility for fieldwork was a practical consideration.

The market area is unpaved (in contrast to the Tübingen case study, see *Porr 1998*), divided by dirt roads, and the stalls are set up on grass. The area is enclosed on two sides by a dike, and from north by a water channel. Trade is carried out in several ways: directly from the ground, from banana cartons serving as tables, portable tables, but also from the boots of cars. Some of the vendors are traders who make a living from this type of sale; however, a significant part are Sunday traders who set up with stalls as a 'hobby'. They treat this activity as an opportunity for additional income, but above all as a social event. Among the stalls, there are food trucks serving coffee and food to visitors. When the market day ends, traders as well as customers leave the area, which is then hastily cleaned by the ground owners. In addition, there are large waste bins at the two main entrances.

The marketplace area is open and unprotected during the week and therefore allows the simulation of an 'archaeological site', which is cyclically subject to various transformations – both human (cleaning of the area or further littering unrelated to commercial activity) and non-human (rain, snowfall, animals dispersing waste). The mere juxtaposition of the intensity of the individual items in relation to the site of the trade fair already yields interesting and unobvious results. In addition, this is supported by the analyses of individual finds, especially as their (almost) entire context is known.

Methods

Documentation of the dynamic structure – space

Typical archaeological research produces evidence of static (*Neustupný 2009*) and usually strongly transformed (*Schiffer 1987*) structures. Only in the case of an archaeological experiment do archaeologists document a diachronic process (*Schiffer 1987*), which is, however, pre-planned and carried out in a controlled manner and after necessary simplification. The study of material remains of the complex dynamic structure of the flea market creates the demand for a new quality of archaeological field documentation (*Gould – Schiffer 1981*). We carried out this work at a similar time as *Magnani et al.* (*2021*), independently developing similar field methods. However, we enriched the strictly archaeological documentation with observations with the active site questionnaire.

Fig. 4. Example of a deposit of intentionally discarded objects (photo by J. Hasil).

The surveyed blue area (*Fig. 3*) was divided into an irregular pattern of 45 sectors with an average area of 560 m², which was primarily oriented according to the structure of the internal roads. All the measurements were taken with dual GNSS instruments with real-time correction. These sectors were used to document 'static archaeological' relics as well as the living marketplace.

The day before the weekly market, non-invasive prospection was carried out in each sector, producing 45 individual finds assemblages considered to be mostly non-intentionally discarded artefacts, as 47 intentionally deposited artefacts or artefact assemblages were identified during the survey (*Fig. 4*). These finds were documented as partial documentation points. In the majority of cases, they were small-scale intentional deposits related to local consumption (e.g. container glass, disposable food packages and cutlery) or damaged goods (table glass and pottery). In other cases, objects were deliberately hidden for use at the next market day (mannequins for textile presentation), and in one case the purpose of the deposit could not be decided (a slightly damaged mirror hidden at the edge of the trade area). Across the market we also noted buried car tyres, which served as spatial structuring anchors distinguishing the stalls. Carpets had a similar function, but were localised only in one area, acting as the floor base of a stall. They were left on the surface, unprotected throughout the year. When older ones began deteriorating, they were covered with another, resulting in several layers of carpets. This also indicates the regular use of a certain stall by the same vendors.

Initial documentation of the finds was conducted on site. This was due to the repetitive presence of typed artefacts (e.g., packing glass), but also to the significant presence of low-durability finds (residues of fruits and vegetables) or finds posing a hygiene risk (disposable tableware, cigarette butts). The finds were therefore photographed on site (*Fig. 5*) and only a minority of the of finds were selected for laboratory processing and further evaluation.

Fig. 5. Example of unintentionally discarded objects from sector F4 (photo by J. Sawicki).

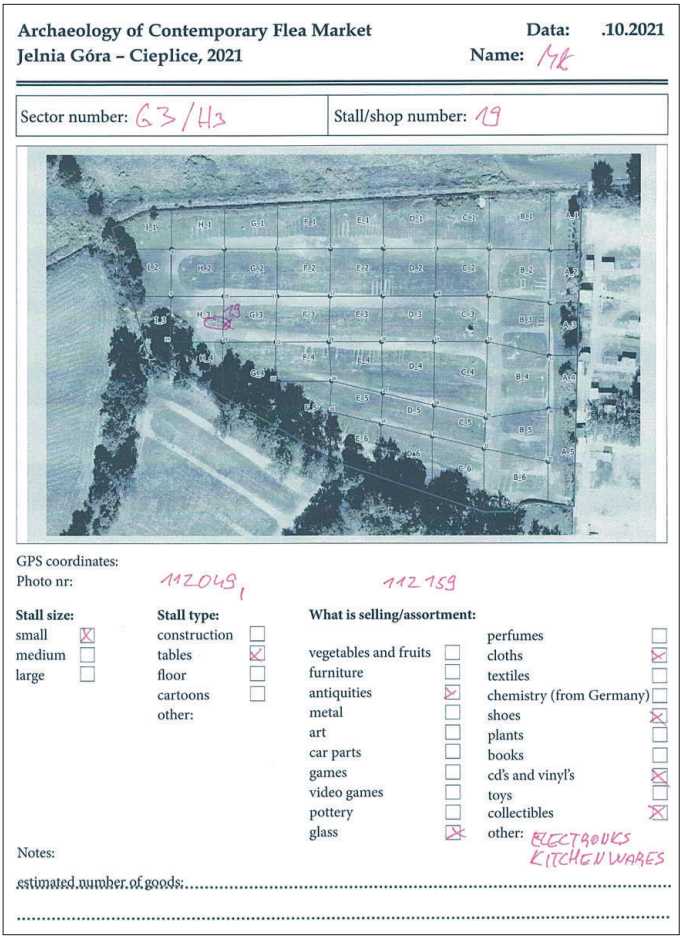
A questionnaire survey was chosen to record the live flea market. Groups of volunteers filled out a simple form with information on the construction of the stand, its general size, the goods sold and their estimated number. The location of the stalls in the existing sector structure was recorded (*Fig. 6*). Each stall was photographed (when owners gave their consent), and, independently, the entire market was documented by video recording. The outcomes were transferred to a GIS environment, providing data on the shape of the live market.

This method provided, for example, framework insight into the spatial distribution and typical combinations of goods sold, the intensity of the distribution of stalls in the market area, their relation to the communication axes, and the location of regular waste dumps. In effect, we created a 'static image' of the flea market. On the other hand, the chosen documentation procedure did not at all capture the processual dimension of the trading activity (assembly/disassembly of the stalls, cleaning of the area, removal of damaged goods, etc.), and as such only affects the results of the archaeological analysis of the surface-collected artefacts. Moreover, it shows that the sale of certain types of goods (e.g., car and bicycle parts, tools, taking orders for coal) does not appear at all at the level of non-intentionally or intentionally discarded items. The data obtained by both documentation processes can be compared with each other, but at the same time they can also be seen as complementary evidence.

Documentation of static structure – finds

During the study, a total of 2,251 artefacts were retrieved and assigned to four main categories, among which further groups and subgroups were distinguished according to their specific function/purpose in the marketplace (*Fig. 7*).

The first group consisted of consumables (367 specimens), i.e., food and drink leftovers such as coffee cups and lids, candy bar wrappers, bottles and cans of juices and sodas, including energy drinks. It is likely that these items were primarily consumed during the


Archaeology of Contemporary Flea Market
Jelnia Góra – Cieplice, 2021

Data: .10.2021
Name: MK

Sector number: G3/H3

Stall/shop number: 19

GPS coordinates:
Photo nr: 112049, 112159

Stall size:
small [X]
medium [ ]
large [ ]

Stall type:
construction [ ]
tables [X]
floor [ ]
cartoons [ ]
other:

What is selling/assortment:

vegetables and fruits	[ ]	perfumes	[ ]
furniture	[ ]	cloths	[X]
antiquities	[X]	textiles	[ ]
metal	[ ]	chemistry (from Germany)	[ ]
art	[ ]	shoes	[X]
car parts	[ ]	plants	[ ]
games	[ ]	books	[ ]
video games	[ ]	cd's and vinyl's	[X]
pottery	[ ]	toys	[ ]
glass	[X]	collectibles	[X]
		other:	ELECTRONICS KITCHEN WARES

Notes:

estimated number of goods:.....

.....

Fig. 6. An example of the stall form developed for a description of the active site (design by N. Sawicka).

market day rather than acting as commodities, and if so, they were consumed immediately after purchase (see *Kopytoff 2013*).

A separate category of consumption leftovers was stimulants (88 items). These included alcohol bottles as well as cigarette packages. These items are also traces of consumption rather than trade. There was no (official) trade of stimulants in the entire market area.

As a specific type of stimulants, we distinguished used medicine packs (14 cases). A significant share of these are individual tablets scissor-cut from whole blisters. Most of them were hypertension drugs.

The second main group is commodities (745 examples), items that were traded at the market, or most often their fragments that were broken, lost, or discarded. Among them are toys (Lego blocks, doll parts, game pieces, etc.), ceramic and glass vessels, etc. This is the most diverse category of finds, as the range of products traded in the marketplace is almost limitless (*Fig. 7*), which is highlighted by the find of an Elvis Presley vinyl record. Unlike sites from earlier periods, pottery (or even glass) is not the dominant material. Only 204 table pottery fragments were counted, and 269 table glass fragments (*Hasil et al. 2020*,

Fig. 7. Different categories of trash (photo by I. Hrušková).

here also on pottery documentation); however, they do not entail evidence of a settlement discard as in most other archaeological contexts.

The third category included trade utensils. This substantial category (233 items) contained various utility tools, like clothes hangers (mostly fragments), tags, bubble wrap, string bags, business cards as well as simple information cards with prices written on them. Rubber gloves were also included here, as were banana cartons used for storing and displaying goods.

The fourth category was rubbish. Although technically all the above-mentioned items could be categorised here, this group, however, identifies unspecified items that are difficult to classify in the other basic groups. These are mostly deformed pieces of plastic, unspecified scraps of paper, etc. (tissues and newspapers were separated). A further division was based on their raw material – paper, plastic, and metal.

Each item was further described with its function and, where possible, the brand and/or country of origin. This more detailed subdivision included 133 types of specific objects. However, the biographies of things can be complicated, and we cannot always clarify whether an item functioned as a commodity at a particular time and place, or, for example, was a trade utensil.

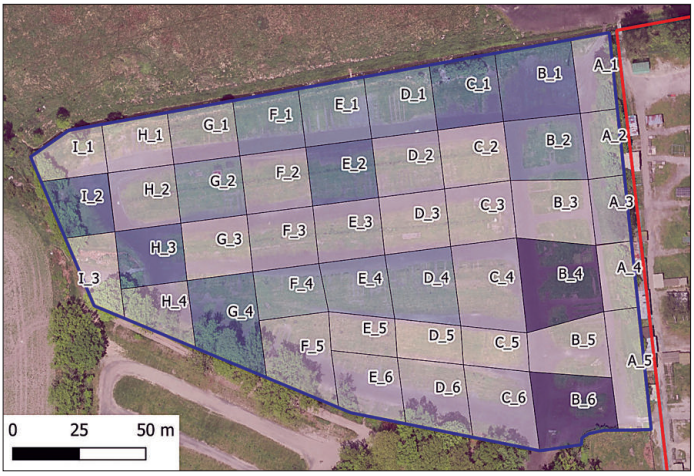


Fig. 8. Total number of finds, expressed in 5 Jenks intervals.

Fig. 9. Finds of toys (expressed in quintiles) and stalls providing toys.

Fig. 10. Finds of coffee accessories (expressed in quintiles) and stalls providing coffee.

Dynamic vs static

The main part of the study tested the correlation of specific object types from sectors and deposit points against the localisation of certain stalls.

The first comparison we made was to check the overall intensity of the objects in the study area (*Fig. 8*). This is the most general picture, but it reveals some patterns necessary for further, more in-depth analyses.

The highest concentration was in sectors B6, B4, C1 and B1. The entrances to the area are in sectors B1, B6 and B4 (A4); the alley in row B is the main traffic axis. These two areas are the most crowded. In addition, rubbish bins were located at the entrances (B1 and B6). The high volume of finds is also not surprisingly in the vicinity of sector I2, and across alley 1 (A1–G1). These sectors are next to the ridge of the marketplace, next to tall bushes and a boundary ditch. The general intensity of all items therefore appears to be primarily related to the deposition and discarding habits of items. We believe that this spread of objects primarily evidences accessibility to the rubbish bins (the entrance to the market) or places where one can safely discard rubbish unseen by other customers. Places at the boundary of the market (bushes, ditch) are also where the cleaners of the market (private owners, not the cleaning service) are reluctant to go, as this space is not visible to market customers at first sight.

As a specific, precise group, we chose toys. Their sale was noted at 37 stalls spread out in different areas of the market, with the highest concentration around sector C4 and in alley 2 (sectors D2–I2, *Fig. 9*). Although the intensity of lost/destroyed/discarded toys is evident near the sectors where the stalls were located (especially in sector E1, where many toys occurred at the stall), the accumulation coincides with that general intensity of finds (cf. *Figs. 8* and *9*). Again, the key here seems to be the location of available rubbish containers as well as unethical but convenient (ditch, bushes behind a hill) places of disposal. This group, however, shows the connection between the stalls with the goods in question and the finds themselves. It is not a very high correlation apart from the very distinctive point of the stalls in sector E1. The distribution of items seems to be of greater importance due to paths and the availability of rubbish bins.

A very interesting result was obtained by juxtaposing consumable waste associated with coffee (spoons, cups, lids) with the localisation of coffee selling points in sectors G4, C6 and D3 (*Fig. 10*). A certain regularity can be seen here. The ‘materiality of coffee drinking’ is not discovered directly next to the stalls themselves, but at a distance of a few dozen metres from them (offset by a sector or two). This seems to indicate that people walk around with the coffee they have bought and, if they do not find bins, they often deliberately discard them or lose some of their elements (lids, spoons, bags of sugar). Coffee is also consumed by traders who leave their cups at the stalls in deposits or bushes. Furthermore, coffee cups, are quite rare finds in the sectors with rubbish containers, especially in the usually intense sector B6. We believe that this is, paradoxically, due to the clean-up of the site. Large coffee containers (cups, lids, etc.) easily clog up the bins by filling the rubbish bags, while smaller rubbish is discarded at the market square.

The selected examples show several regularities as well as the difficulty of interpreting this material, even in the case of a (theoretically) well-understood context and the laws that occur in the marketplace, as observed during the trading day. This argues for remaining cautious during material culture analyses of such dynamic sites, and suggests, in addition to the spatial analysis, looking for the context of finds (rubbish) in isolation from the stalls, and searching for their broader social-cultural interpretation.

Biographies of things in the total context

The study of a contemporary site theoretically offers the 'total context' – complete understanding of cultural and social entanglements of all the finds. After all, it concerns us directly, the people living at the same time as the material from the study. However, it is not always explicitly possible to interpret the dynamic structure and the specificity of these finds. Here, we will present selected observations that complement the spatial analysis of the site. These observations focus more on the cultural and social context by analysing objects from the perspective of their biographies (*Kopytoff 2013*).

'Monkeys' and 'Cows'

According to the statistical office, the most consumed alcohol in Poland is beer – an average of 97 litres per person per year (for statistical purposes including infants). These numbers are reflected in the quantities of cans and beer bottles found at the market, which by far dominate the spirits category.

While the second most frequently consumed alcohol is vodka, there are certain specific consumer behaviours. In Poland, this refers mainly to so-called 'monkeys' (Polish: małpki, sg. małpka) – bottles of vodka or sweet liquor with a volume of 100 or 200 ml. Statistical data shows a decline in the consumption of this type of alcohol in 2022, but as it was estimated three years earlier that three million people were reaching for them every day! In an interview with Andrzej Nyk, the founder of Addiction Treatment Clinic 'Monar' in Warsaw (*Mazurek 2019*), we read that there are three sales waves: in the morning, afternoon and evening. They are bought on the way to work, from work and in the evening, by all social groups, men and women. Among other things, their popularity is based on their low price. After all, their small amount of alcohol gives a false sense of control. We were expecting them at the marketplace (for more regarding cultural drinking behaviour and garbology, see: *Sosna – Brunclíková 2019*).

Vodka bottles were present at the market, but predominantly those with a volume of 0.5 and 0.7 litres; later popularly known as 'cows' (Polish: krówki, sg. krówka). Fourteen pieces of these were found (including one with a label written in Cyrillic, possibly illegally traded), while only four 'monkeys' were found, quite clearly indicative of recent fads. We believe that this is the evidence of 'stall consumption', most likely carried out by traders rather than visitors. When trade lasts all day, there is no need to stock up on 'monkeys' when one can bring a 'cow'. A significant share of the bottles (50% of the 'monkeys' and 16% of the larger bottles) come from deposits rather than from the market area, i.e. from local mini dumps.

Cigarettes

Analyses of the social and economic situation of the market visitors can also be based on cigarette brands (*Volk et al. 1996*; *Brink et al. 2018*). Price seems to be of decisive importance, but there are also other cultural factors. Certain brands are preferred because of the message they carry, e.g. they are considered exclusive or allude to values associated with adventure or a sense of freedom. In Poland, but also in countries behind the Iron Curtain before and just after the 1989 transformation, the type of cigarette one smoked was an important indicator of position and social status. This was reflected in pop culture. On a somewhat mocking album released in 1984, *King Bruce Lee Karate Mistrz*, Franek

Kimono (actor Piotr Fronczewski) in the song 'Disc Jockey' (Polish: Dysk Dżokej) observes: 'When the speakers get the jitters/ And on the dance floor madness and frenzy/ She's not dancing, she's on the loose/ She's smoking "Pewex" and is showing off'. Pewex (the name comes from the only type of shop where it was legal to buy foreign goods in communist Poland) meant imported, foreign cigarettes. This motif was also present in the cinema, where characters who were supposed to be modern, fashionable and cosmopolitan (regardless of their good or bad intentions) smoked foreign cigarettes in addition to wearing imported clothes (e.g. *Hydrozagadka*, 1970, by A. Kondratiuk and *Psy*, 1991, by W. Pasikowski). Despite the widespread access to most cigarette brands, the cultural context of cigarettes should not be underestimated even in most contemporary contexts (*Galiniki – Akrivopoulou 2020*).

A total of 24 cigarette packs were found at the market, including one pack of cigarette warmers (Heets). The most popular brands appear to be from the lower and medium price group (Camel, LM, Winston). Only one pack could be considered more exclusive (Davidoff). The almost complete absence of one of the most recognisable, but also more expensive brands (Marlboro, one pack) is notable. This seems to indicate a preference among consumers for more affordable cigarettes. In addition, no pack smuggled from Ukraine (label in Cyrillic) were found (they are significantly cheaper than goods from domestic distribution). Similarly, there are no packs from the Czech Republic or Germany (both priced higher than in Poland). Electric cigarettes and cigarette warmers, on the other hand, do not appear to be as popular as seen in urban areas and among younger people.

Covid-19 masks

The small number (5 specimens) of Covid masks is noteworthy (*Angelo et al. 2021*; *Magnani et al. 2022*) and can be linked to several different factors. First, the field survey was conducted at the end of the main wave of the pandemic (autumn 2021) and, at that time, regulations in Poland did not mandate the wearing of masks in open spaces, even during 'mass events'. In fact, in this period, the wearing of masks even in enclosed places was no longer respected in Poland. Hence, they were only worn by people who felt threatened. In addition, discarded masks are clearly visible in the landscape (light blue against green grass or black road), so they are easy to sort by cleaners. Moreover, masks, if worn, are usually not taken off until their wearers return to home, so we can expect them to be discarded mostly in the private space.

Coins

Another visible regularity is the complete lack of coins across the market square. In Poland, the currency is the zloty. The basic coin denomination is 1 'zloty' (c. 0.22 euros), and there are also 2- and 5-zloty coins. The 1 'zloty' is made up of 100 'grosze', existing in denominations of 1, 2, 5, 10, 20 and 50. All of them currently have a very low value. It is noteworthy that almost all trade at the market is conducted in cash, with only the food trucks using payment terminals. This may indirectly indicate a kind of crisis, since even the smallest denominations were collected from the ground on a regular basis. On the other hand, the site was not examined with the use of metal detectors. Apart from the roads, the rest of the site has a grassy surface, which makes it difficult to spot lost coins. In addition, there is also a popular folk custom of collecting coins from the ground 'for luck' as an apotropaic activity, which may also impact the number of finds.

Discussion

The research at the marketplace did not yield clear-cut results, but provided many valuable observations about the artefacts, the spatial relationships between the finds and the stalls as well as about consumption patterns. A general socio-cultural interpretation of the finds seems to provide more interesting results than the spatial analysis. We have demonstrated the immense possibility of reading a wider context based on pop culture as well as on available statistical data of different types of finds. A full understanding of the cultural and social context obviously facilitates interpretations, but also allows for nonobvious observations about local communities. Interpreting contemporary material culture (e.g. based on biographies of things) as an 'archaeology of the everyday' or an 'archaeology of us' provides an often-unobvious point of view on the present, but also on applying similar methods to other archaeological sites from the past.

The spatial analysis shows some regularities. The correlation between stalls and finds is not always obvious. The most relevant factor seems to be the distribution of the skips and their availability. The 'natural' rubbish bins (ditch, bushes behind a hill, car tyre deposits) and the location of the main paths are also important factors, as most finds seems to come from the most crowded areas. However, 'the material culture of coffee' example shows that other factors should also be considered, such as the fact that people may walk around with the items purchased at the market and discard them elsewhere after finishing their consumption.

The intensity of specific item types is confirmed by the clear correlation between the stall and the toy finds (example of sector E1), but in other cases it is not so obvious. The attempt at a macro-scale study as presented here also has its shortcomings. A further analysis of the material especially focused on a more in-depth study of individual finds, their specific juxtapositions and, considering their biographies, might yield better results in terms of correlation and spatial organisation, but is nevertheless difficult to carry out. Our research should also be repeated under similar conditions elsewhere, to test the results both on a macro scale – interpretative correlation – and on a micro scale – the biographies of selected objects or groups of objects.

These observations have direct implications for understanding analogous findings from medieval marketplaces (see *Sawicki 2018*). The significant clustering of objects appears to be primarily associated with areas frequented by larger numbers of people on a cyclical basis. Consequently, if the objects are not deliberate deposits, their abundance merely reflects the heightened mobility of individuals, leading to a greater accumulation of tangible items. While this conclusion may seem obvious, it warrants restatement.

This clustering pattern suggests that certain areas within medieval marketplaces were particularly dynamic, attracting more visitors and consequently more objects. The correlation between object density and human activity provides valuable insights into the social and economic dynamics of these historical sites. By recognising that the presence of numerous artefacts in specific zones is likely due to the repeated and intensive use of these spaces by large groups of people, we can better interpret the archaeological record. For instance, this can possibly make it possible to trace paths and roads taken by customers at the markets even if they are not visible through other archaeological records.

Moreover, this understanding highlights the importance of considering the broader context of object deposition. It reminds us that not all concentrations of artefacts indicate

intentional deposits; instead, they may simply result from the natural byproduct of daily activities and human movement. Reiterating this point helps prevent the misinterpretation of archaeological evidence and underscores the need for a careful analysis of artefact distribution in relation to historical patterns of human behaviour.

Moreover, understanding socio-cultural dynamics and spatial distributions in contemporary settings can provide analogies for interpreting archaeological sites from the past. The approach of integrating artefact biographies and broader cultural interpretations can offer nuanced insights into the daily lives and social structures of medieval urban communities, enhancing our understanding of the past through the lens of modern analogues. These studies demonstrate the complexity of the relationships between humans, things, and space within the active site of the flea market, and only signal further research challenges, arguing for a need to often look for less obvious interpretations.

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JAKUB SAWICKI, Institute of Archaeology of the CAS, Prague, Letenská 4, CZ-118 00 Praha 1, Czech Republic
sawicki@arup.cas.cz
JAN HASIL, Institute of Archaeology of the CAS, Prague, Letenská 4, CZ-118 00 Praha 1, Czech Republic
hasil@arup.cas.cz

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

What does the waste say about the medieval town of Banská Bystrica (Central Slovakia) and its environment

Co vypovídá odpad o středověké Banské Bystrici (střední Slovensko) a jejím přírodním prostředí

Martin Miňo – Barbora Styková – Ivan Jarolímek – Jozef Šibík – Mária Šibíková – Mojmír Choma – Katarína Šimunková – Michaela Látková – Ivo Světlík – Kateřina Pachnerová Brabcová – Markéta Petrová – Peter Ďurica – Peter Barta – Pavol Midula – Janka Ševčíková

The historical town hall of Banská Bystrica was rebuilt in the second half of the 16th century from a medieval town mansion that had traditionally been owned by the town's high-ranking citizens. As the building was an important structure, there is an extraordinary record of written sources depicting its history. However, there is almost no information before the year 1500 due to the fire that destroyed the town archives. Just as the fire obliterated the written record, modern construction activities severely damaged the archaeological record. The archaeological survey at the historical town hall of Banská Bystrica conducted between 2008 and 2009 could be considered a prime example of a rescue event. The small assemblage of artefacts dated shortly before and after the great fire was complemented by animal bones, water-preserved wooden planks, and archaeobotanical material. These finds underwent dendrochronological and radiocarbon dating, providing clues for assessing settlement continuity from the pre-colonisation period. By applying an interdisciplinary approach, which included the analysis of pottery, chemical analysis, DNA sampling, archaeobotanical and archaeozoological analysis, it became possible to reconstruct certain aspects of everyday life as well as the environment in the town and its surroundings.

absolute dating – interdisciplinary research – archaeobotany – environment – geochemistry – Middle Ages – reverse 3D modelling

Historická radnice v Banské Bystrici byla přestavěna v druhé polovině 16. století ze středověkého městského sídla, které tradičně patřilo vysoce postaveným osobám ve městě. Protože se jednalo o významnou stavbu, dochovaly se k ní mimořádné písemné prameny zachycující její historii. Pro období před rokem 1500 se však nedochovaly téměř žádné informace kvůli požáru, který zničil městský archiv. Stejně jako požár smazal písemné záznamy, novodobá stavební činnost vážně poškodila archeologické záznamy. Archeologický průzkum historické radnice v Banské Bystrici, který proběhl v letech 2008 a 2009, lze považovat za ukázkový příklad záchranné akce. Skrovný soubor artefaktů, datovaný krátce před a po velkém požáru, doplnily zvířecí kosti, dřevěná prkna zachovaná v zamokřeném prostředí a archeobotanický materiál. Tyto nálezy byly podrobeny dendrochronologickému a radiokarbonovému datování, což poskytlo vodítka pro posouzení kontinuity osídlení z předkolonizačního období. Uplatněním interdisciplinárního přístupu, který zahrnoval analýzu keramiky, chemickou analýzu, odběr vzorků DNA, archeobotanickou a archeozoologickou analýzu, bylo možné rekonstruovat některé aspekty každodenního života i prostředí ve městě a jeho okolí.

absolutní datování – interdisciplinární výzkum – archeobotanika – přírodní prostředí – geochemie – středověk – reverzní 3D modelování

https://doi.org/10.35686/AR.2025.251

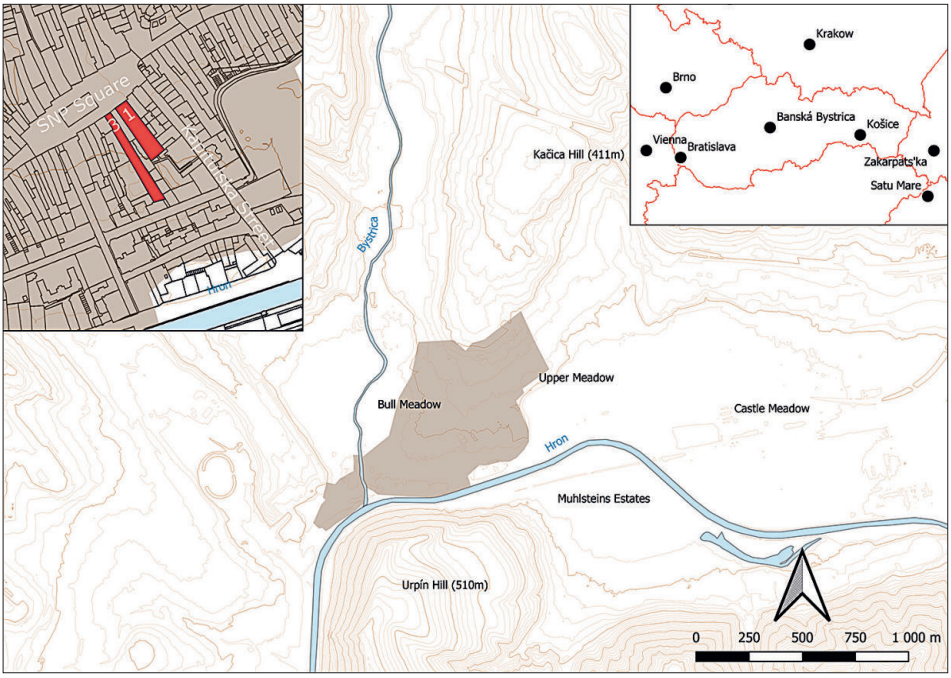

Fig. 1. Localisation of the surveyed site.

Introduction

The town of Banská Bystrica was founded before the year 1255 AD, when the town charter, the first known written source concerning the town, was issued. The town's name is mentioned as *nova villa bystriciensis*, which is usually interpreted as proof of an older medieval settlement at the site (e.g. *Baláž 2002*, 7). This is partially supported by archaeological evidence for settlement phases dated to the 9th century AD (*Mácelová 2013*, 74–75). The medieval town, which was part of the Hungarian Kingdom and now of Central Slovakia, was located on an outcrop of Kačica Hill pointing into the confluence of the Bystrica, a mountain river, and the region's major water course, the Hron River (*Fig. 1*). The earliest known representation of the urbanistic structure of the town is depicted in the 16th-century Ferrari map produced while the town walls were being planned (*Sura 1982*, 12–13).

In this paper, we focus on a plot in the older southeastern part of the town situated very close to the street leading to the Hron River crossing, where the medieval town hall was built in the second half of the 16th century at the site of a medieval town mansion. This study aims to present and interpret the comprehensive results of the excavation campaign and the analyses performed, which contribute to an understanding of town development in Central Europe.

According to previous research in the field of the history of architecture, the town hall building was originally a town manor that evolved from merging two separate three-room houses into a single house of the thoroughfare type (*Fig. 2*; *Sura 1982*, 110–113; *Staníková 1990*; *Sura et al. 1996*). This evolutionary scheme is traditionally applied to most of

Fig. 2. Evaluation of the finds on the plot of Square SNP 4: A – Town hall development model from two different medieval houses; B – analysis of archaeologically or historically dated features.

the buildings in the medieval town centre (*Sura 1982*). Later archaeological and historical building surveys elaborate further on this model. They point to an earlier phase most likely based on a timber frame construction combined with wattle and daub walls, while only the storage room was constructed in masonry (*Šimkovic – Žuffová 2021*, 116–117). Destruction layers of wattle and daub walls were documented, for example, at Horná Street 2–4 by *Zachar* and *Mácelová* (*2008*) and *Kvietok* (*2016*), and this phase seems to be documented on the plot of the later town hall as well. A burned clay layer was found in the cellar (*Sura et al. 1996*, fig. 7), which lies under the base of the oldest recorded masonry walls. A similar layer was recorded under the base of one of the pillars supporting the backyard façade (*Fig. 3*) and spread across the plain of the backyard (*Miňo et al. 2008*, layer K006, fig. 28).

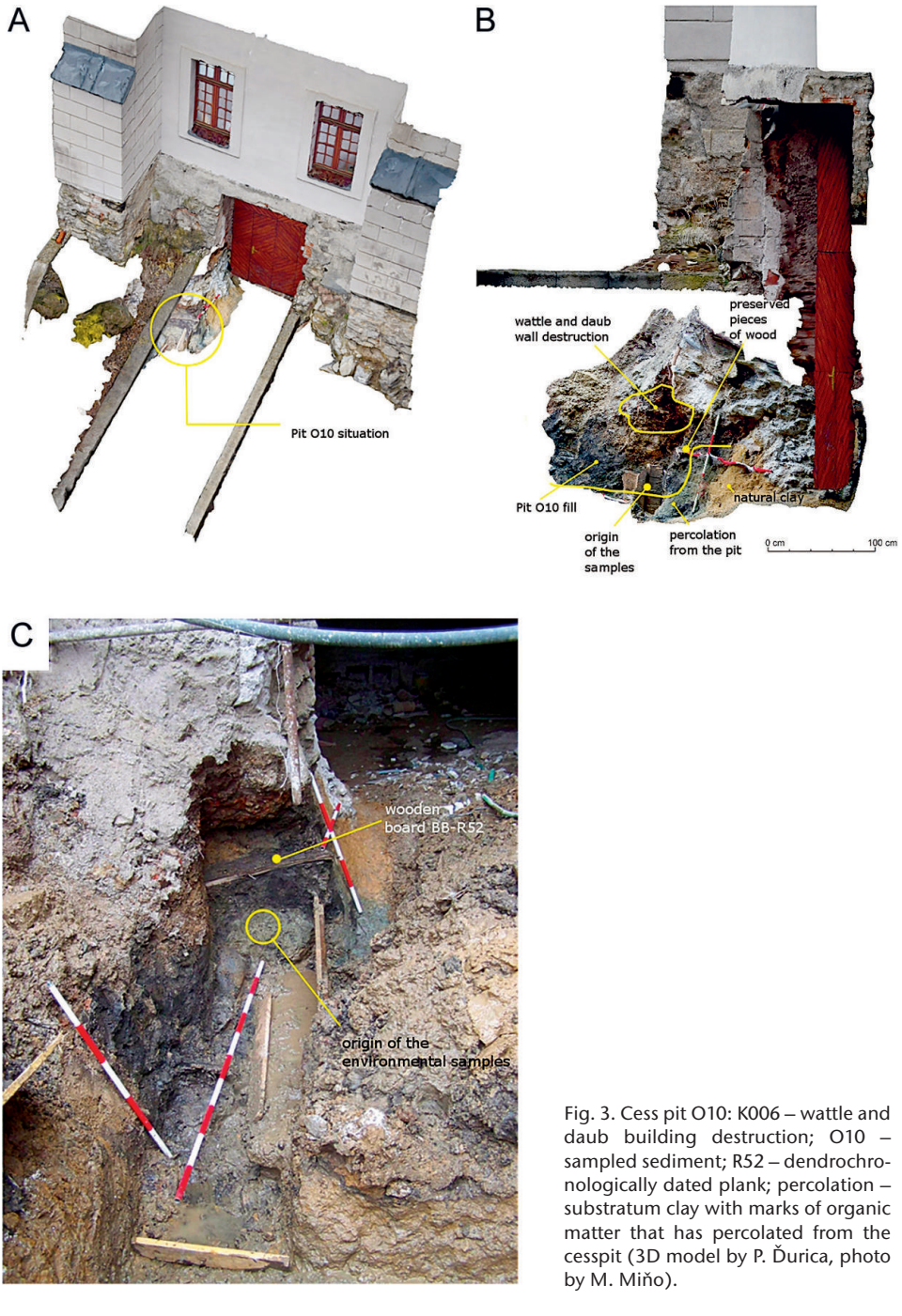

Fig. 3. Cess pit O10: K006 – wattle and daub building destruction; O10 – sampled sediment; R52 – dendrochronologically dated plank; percolation – substratum clay with marks of organic matter that has percolated from the cesspit (3D model by P. Ďurica, photo by M. Miňo).

Due to the great fire of Banská Bystrica in 1500, which destroyed most of the town's archives, we know more about the owners than the house itself. During this phase, the house was owned by Stephan Jung, the owner of a copper mine and town mayor in 1450 and 1454. After his two sons died suddenly in 1465, he sold the house to the Buda citizens Johan Ernst and Veit Mühlstein for 6,200 ducats (*Staníková 1990*; *Sura 1982*; *Sura et al. 1996*). Veit Mühlstein came to town, probably with King Matthias Corvinus. He served as the vice-count and later as the count of Zvolen County. He also held the office of the count of the mining chamber in Kremnica. He was the owner of a green paint mine in Špania Dolina – Piesky (Sandberg; see *Lacko 2024*) and was also elected mayor of the town. He founded one of the chapels in the parish church and one of the towers in the walls of the town castle. During his ownership of the house, the last medieval building phase, prompted by the great fire of 1500, began. However, Mühlstein died in 1501, so it is highly probable that the building activities were not completed and were continued by his heirs. In this phase, the front part of the house was rebuilt in stone. The two-story house had a three-room layout. A vaulted cellar was built under parts of the house (*Staníková 1990*; *Sura et al. 1996*). The interiors were heated with tiled stoves featuring figural motives, likely made in a famous workshop in Banská Bystrica (*Mácelová 2005*). There seems to be more than one Late Gothic building phase, as is evident from the historical building survey. This might be a result of the inheritance following Mühlstein's death. Though the two different surveys were conducted only a few years apart, they produced different results. The ground plan of the house provided in this paper (*Fig. 2*) is a combination of the results of both surveys that did not contradict each other (*Staníková 1990*; *Sura et al. 1996*). However, it should be noted that the dating of several constructions attributed in both surveys to Gothic phases was later than the 16th century according to the archaeological stratigraphy (mainly the yard wing of the house; compare to *Miňo et al. 2008*). After Veit Mühlstein passed away, the house was inherited by his daughter-in-law's third husband, Henrich Kindlinger, who was the last private owner of the property (*Staníková 1990*; *Sura 1982*; *Sura et al. 1996*).

After his death in 1539, Emperor Ferdinand I granted the property to the municipality, which used it for the town hall. The town rebuilt the house in 1546, when a vault was constructed on the ground floor (perhaps over the original yard between the two medieval houses), the roof was changed, a new staircase was built in the back part of the building, the wastewater was directed into a stone outlet, the entire building was plastered, and the town bakery was built in the yard. The construction was supervised by Master Linhard. The change to the roof might be linked to the Renaissance-style attic that was added to the main building in the 16th century.

The first record referring to the town hall's internal organisation is from the year 1555. Only a single room on the second floor was used for this purpose, while other rooms were rented out. The records indicate that in addition to the main masonry, there were other structures on the property: the house at the well, an old brewery, a barn converted into brick storage, and a garden stretching down to the riverside. The 'house at the well' would most likely correspond to some or all of the walls 1, 2, and 8 documented in the yard near the well (O6), which were dated to the 16th century by stratigraphy (*Fig. 2*).

In 1566, the building activities were led by Master Pankratz, who built a vault over the cellar, some interior walls and a wall around the property. Since 1570, the town scribe lived in the town hall, and the second scribe also moved there in 1579. Beginning in 1586, the town-watch commander resided here, and in 1591 and 1662, there are records of an

organist living in the building. The first reconstruction of the main façade was carried out by Jacob II di Pauli in 1632. He painted it an aquamarine colour, which he created by mixing indigo with the local copper-based green paint. The town sign was painted gold. In 1654, Master Martin Mezifický covered the corridor, which had once been the yard between the two original medieval houses, with a vault. In 1660, a new staircase was added in the central part of the building. In 1761, another fire broke out in Banská Bystrica, damaging the town hall and other buildings in the town. After the fire, the Renaissance attic was removed, new Prussian-style vaults were built in multiple rooms, and a new façade was added. This work was overseen by Master Georg Friedrich. The last significant historic reconstruction took place in 1904, but it mainly concerned the yard wing (*Güntherová et al. 1967*, 47; *Sura 1982*, 110–113). The interior of the building has not yet been archaeologically surveyed, except for irregular investigations in part of the cellars and the fills of the vaults, notable for finds of impressive Late Gothic figural stove tiles analysed by *Mácelová* (*2005*). The backyard of the plot was surveyed in a single rescue trench by *Mácelová* (*1998*) and during excavations conducted in 2008–2009.

This archaeological survey was associated with the reconstruction of the current town hall. Although the contractor claimed no plans for digging during his work, many trenches were recorded by monitoring the construction. Their unplanned schedule prevented the implementation of any sophisticated excavation strategy, and under these circumstances, the decision to sample the excavated deposits for future research proved to be most significant. These deposits were analysed from 2008 to 2023 using approaches from various scientific disciplines to obtain specific data. There were additional reasons to investigate the deposits further, such as the lack of archaeo-environmental data in the region, the good preservation of organic materials, and the prominence of the site itself in the context of the town. The original aim was to acquire as much data from different perspectives as possible in order to establish a final alignment of the results as a starting point for further research. The data acquisition was also aimed at providing a foundation for a future environmental database of the region.

Methods

Archaeological excavation and documentation

During the fieldwork, multiple features were recorded (pits and walls labelled as ‘O’, layers labelled as ‘K’). Three pits were noted directly on the plot and targeted sampling was conducted in two of them. In pit O4, the focus was on the burned charcoal layer, while in pit O10, it was the damp deposit containing organic matter. A smaller sample volume (0.5 l) was extracted from pit O4, since the main aim was to retrieve material for radiocarbon dating. The sample from pit O10 was larger (1.0 l in total); the mass of the uncontaminated damp layer on the bottom was meant to be dug away, so a larger amount was taken. Most of the sample was used for flotation, while 0.3 l was saved for other types of analyses.

Pit O10 was of significant importance in this regard. As the feature was so rich in informational value, a novel approach to reverse documentation was attempted. The situation was photographed in 2008 with only eight digital snapshots, some aimed at details,

	Species	Species (lat.)	NISP	MNI	weight (g)
Domestic mammals	domestic cattle	*Bos taurus*	34	1	1912.60
Domestic mammals	domestic sheep	*Ovis aries*	1	1	33.83
Domestic mammals	sheep/goat	*Ovis/Capra*	4	1	45.85
Domestic mammals	domestic pig	*Sus domesticus*	6	1	71.0
medium mammal		–	4	–	35.75
big mammal		–	4	–	23.01
unident. Fish		–	1	1	
unident.		–	5	–	31.82
Total			**59**	**5**	**2153.86**

Tab. 1. Quantification of animal species representation. NISP – Number of Identified Specimens, MNI – Minimum Number of Individuals.

some represented parts of the section, and a few provided an overall view from different angles. Due to the aforementioned constraints, it was impossible to accurately locate the spatial situation during the fieldwork. The documentation was made only via an orthogonal method in reference to the building ground plan, which lacked absolute coordinates. As this method was considered insufficient given the importance of the data acquired, we reconstructed the situation by means of 3D-based modelling using artificial intelligence (AI; see details in *Online Supplementary Material 1*). The model was used to generate orthographic ground and section plans (*Fig. 3*) and can be utilised anytime as a source for any type of metric figures and absolute coordinates. The finished model is used as an interpretive tool of the site for the lay public, as it is published on the Sketchfab platform (*Online Supplementary Material 2*) and as an Augmented Reality application.

Archaeozoology

An assemblage of animal bones retrieved from medieval-dated contexts K001, O4, O9, and O10 was analysed (*Tab. 1*). Anatomical and taxonomical analyses were based on available publications from veterinarians, anatomists, and archaeozoologists (*Kolda 1951*; *Schmid 1972*; *Popesko 2007*; *Adams – Crabtree 2008*; *Bocheński – Tomek 2009a*; *2009b*; *France 2009*) and comparative data provided by K. Šimunková. Fragments that could not be reliably assigned to a species were categorised using auxiliary classifications commonly found in archaeozoological literature: big mammal (the size of a horse, a bovid, or a deer) and medium mammal (the size of sheep/goat, pig, roebuck, or larger dog) based on the size, weight, and structure of the bone fragment. The group of small ruminants selected as *Ovis/Capra* includes both species of the *Caprinae* subfamily – domestic sheep and goat. The differentiation of these related species was carried out following the methodologies of *Boessneck* (*1969*), *Payne* (*1973*), *Halstead* and *Collins* (*1995*), *Halstead et al.* (*2002*), and *Adams* and *Crabtree* (*2008*). *Von den Driesch*'s (*1976*) style of measurement and methodology was used. Furthermore, the analysed features on bones included cultural and taphonomic modifications, pathologies on bones (cutting, deformation of bone, etc.), preservation grade of the bone tissue after *Behrensmeyer* (*1978*), and heat marks (*Shipman et al. 1984*; *Thurzo – Beňuš 2005*). Both methods were used for the approximation

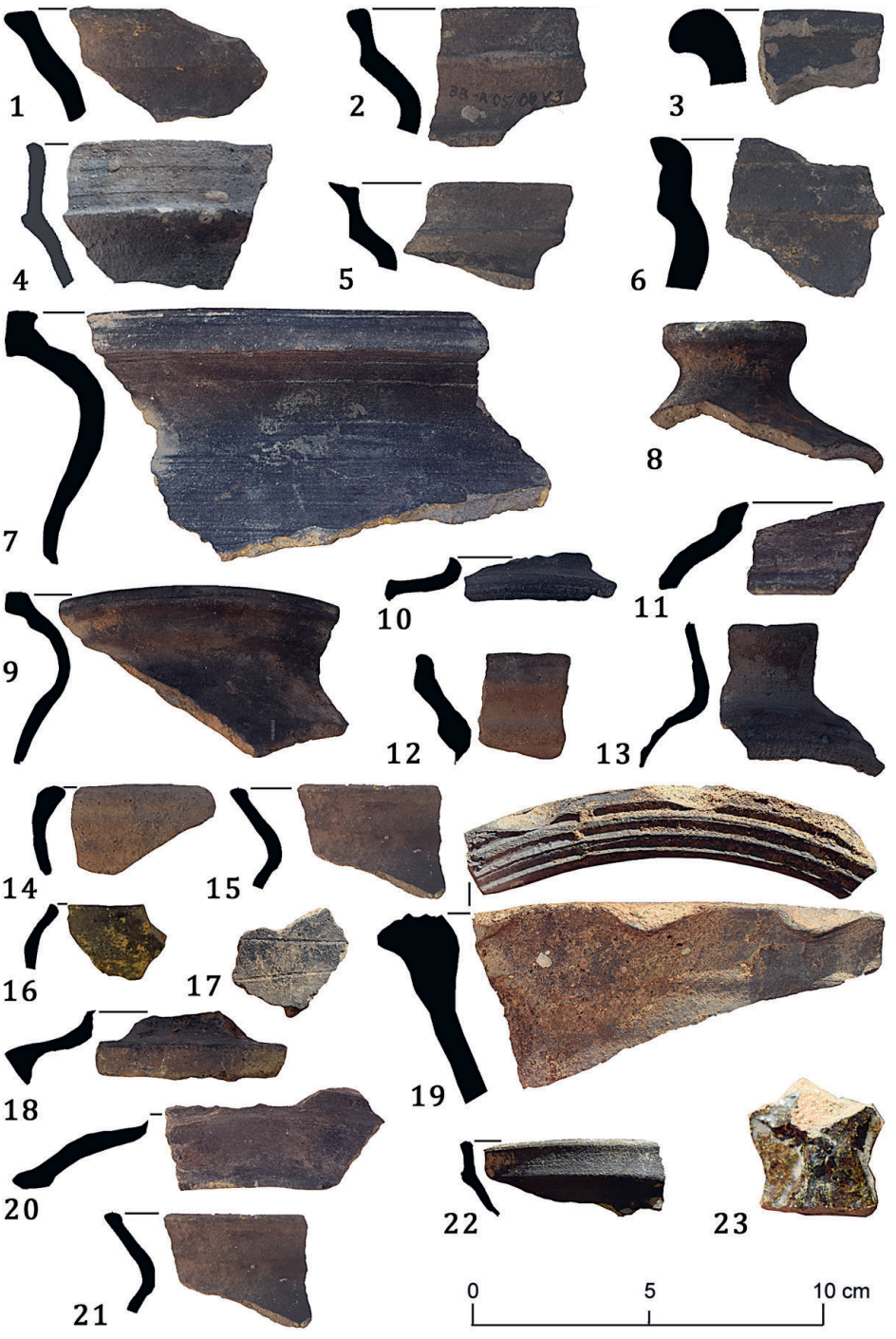

Fig. 4. Typologically sensitive finds from the plot. 1–6 – pit O4; 7–14 – pit O10; 14–20, 22, 23 – layer K001; 21 – layer K003 (photo by M. Miňo).

of animal age: epiphyseal fusion (*Zoetis et al. 2003*; *Reitz – Wing 2008*) and eruption and wear of teeth (*Payne 1973*; *1987*; *Grant 1982*; *Hillson 2005*).

Pottery

The pottery was analysed based on typologies by *Hoššo* (*1983*; *1996*) and *Ruttkay* (*1995*) and categorised into morphological and chronological groups, which were used for the relative chronology (*Fig. 4*).

Archaeobotany

The bulk sample coming from the deposit in pit O10 was analysed. Thus, the strategy for archaeobotany sampling on the site was not intense. Analysed samples were taken using a judgement sampling strategy (*Jones 1991*). The volume of the sample taken from the stratified context was standard for a permanently wet layer. To separate the archaeobotanical material from the sediment, we used a flotation tank washing combined with the wash-over method. Light ecofacts and artefacts (floating and capillary rising in the water column) were captured by a 0.25 mm sieve. Two samples of anthropogenic sediments were analysed: BB-R53/08 with a volume of 0.3 l and BB-B46/08 with a volume of 0.4 l (*Tab. 2*). The nomenclature of vascular plant taxa follows *Marhold* and *Hindák* (*1998*).

DNA

A portion of the deposit from the pit O10 was used to attempt to isolate historic human sedimentary DNA, as the feature was assumed to contain human biological material and was interpreted as a cesspit. Six samples were retrieved from the deposit: two high-volume and four low-volume samples. The size of the samples was adjusted to fit the isolation kits. Three different methods of isolation were used: (1) phenol-isolation – two samples with a higher amount of analysed material (approximately 10 g); (2) chelex-isolation – two samples with a lower amount of analysed material (approximately 0.5 g); and (3) isolation via paramagnetic particles – two samples with a lower amount of analysed material (approximately 0.5 g).

Dendrochronology

Pit O10 was the only archaeological feature that contained timber samples preserved well enough to be dated by dendrochronology. Four samples were analysed using the VIAS TimeTable measurement with the PAST 5 software interface (*Tab. 3*). The acquired curve was detrended and compared using a ‘window smoothing’ algorithm and to a standard chronology developed by T. Kyncl.

Radiocarbon dating

Seven samples were selected for radiocarbon dating (*Tab. 4*; *Tab. 5*). All can be identified as a part of the terrestrial biosphere, and their ages have different relationships to the dated archaeological events.

Category		Taxon (species)	Sample BB-R53/08	Sample BB-R46/08	Sum
cultivated plants	fruit	*Vitis vinifera*	–	3	3
cultivated plants	vegetable	*Daucus carota*	1	7	8
cultivated plants	oil or fiber-plant	*Linum usitatissimum*	–	2	2
wild species		*Agrostemma githago*	1	4	5
wild species		cf. *Anthemis* sp.	2	1	3
wild species		*Asteraceae*	–	1	1
wild species		*Avena/Bromus*	–	1	1
wild species		*Barbarea vulgaris*	–	1	1
wild species		*Bupleurum rotundifolium*	2	2	4
wild species		*Capsella bursa-pastoris*	–	1	1
wild species		*Carex/Scirpus*	4	5	10
wild species		*Cornus mas*	–	1	1
wild species		*Crepis* sp.	–	3	3
wild species		*Fallopia convolvulus*	–	3	3
wild species		*Fragaria vesca*	–	1	1
wild species		*Glechoma hederacea*	–	–	1
wild species		*Humulus lupulus*	–	2	2
wild species		*Chenopodium album* agg.	7	18	30
wild species		*Lithospermum arvense*	–	1	1
wild species		*Papaver rhoeas*	–	1	1
wild species		*Polycnemum arvense*	–	–	1
wild species		*Polygonum lapathifolium*	2	1	3
wild species		*Potentilla argentea*	1	3	4
wild species		*Potentilla recta*	3	–	3
wild species		*Potentilla reptans*	–	2	2
wild species		*Potentilla supina*	–	1	1
wild species		*Prunus/Cerasus*	–	1	1
wild species			–	2	2
wild species		*Ranunculus acris/repens*	2	–	2
wild species		*Ranunculus repens*	–	1	1
wild species		*Rubus fruticosus*	–	2	2
wild species		*Rubus idaeus*	2	5	7
wild species		*Rumex acetosella*	–	1	1
wild species		*Rumex crispus/obtusifolius*	–	1	1
wild species		*Rumex* sp.	1		1
wild species		*Setaria viridis/verticillata*	2	11	14
wild species		*Silene vulgaris*	–	1	1
wild species		*Silene* sp.	–	1	1
wild species		*Solanum dulcamara*	–	1	1
wild species		*Solanum nigrum*	–	2	2
wild species		*Stachys arvensis*	1	1	2
wild species		*Stachys/Ballota*	–	2	2
wild species		*Tanacetum vulgare*	6	1	7
wild species		*Veronica hederifolia*	–	–	1
wild species		*Vicia tetrasperma/hirsuta*	–	–	1
wild species		*Quercus* sp. (cover)	–	4	4
wild species		indet.	6	64	71
Total			**43**	**166**	**221**

Tab. 2. Identified plant taxa.

ID	Species	Tree ring count	Date od falling	Remark	Figure
R43/08	*Abies alba*	27	summer 1813	low tree ring count for reliable dating, best position TBP 4, 63; THO 4,49; GL 83,3% ABNCAR15 (T. Kyncl)	*8:B*
R44/08	*Larix*	109	winter 1131/1132	low reaction for standard chronologies and surrounding samples, identified after AMS date was known	*8:A*
R52/08_1	*Quercus* sp.	64	after 1336	lower correlation, TBP 2,46; THO 3,31; GL 72,7% morges2010det (T. Kyncl)	*8:C*
R52/08_2	*Abies alba*	122	after 1346	TBP 6,71; THO 8,3; GL 73,8% ABNCAR15 (T. Kyncl)	*8:D*

Tab. 3. Results of dendrochronological dating.

Lab code	Material	Species	Stratigraphic unit (SU)	Stratigraphic phase	Archaeological event
CRL22_0835	animal tooth	*Bos taurus*	O4	1. 13–15th century	formation of the oldest settlement
CRL22_0829	charcoals	–	K001.1	4. 15/16th century	fire and site 'cleaning'
CRL22_0830	wood	*Larix*	O10	4. 15/16th century	fire and site 'cleaning'
CRL23_0171	wood	*Larix*	O10	4. 15/16th century	fire and site 'cleaning'
CRL23_0172	wood	*Larix*	O10	4. 15/16th century	fire and site 'cleaning'
CRL22_1458m	seed	*Vitis vinifera*	O10	4. 15/16th century	fire and site 'cleaning'
CRL22_1459	seed	*Cornus mas*	O10	4. 15/16th century	fire and site 'cleaning'

Tab. 4. Samples used for radiocarbon dating and their interpretation.

Lab code	Conventional ^{14}C age BP	Calibrated unmodelled interval (2σ), yrs cal AD	Calibrated modelled interval (2σ), yrs cal AD	Agreement index
CRL22_0835	688±14	1278–1302 (82.4%)	1279–1302 (59.6%)	79.8%
		1369–1378 (13.1%)	1366–1382 (35.8%)	
CRL22_0829	551±14	1326–1348 (16.5%)	1326–1348 (16.0%)	97.6%
		1394–1423 (78.9%)	1394–1423 (79.4%)	
CRL22_0830	1031±15	993–1026 (95.4%)	–	–
CRL22_1458m	306±17	1510–1593 (74.6%)	1518–1592 (78.5%)	102.1%
		1618–1645 (20.9%)	1620–1644 (17.0%)	
CRL22_1459	1217±17	709–716 (1.7%)	–	–
		772–882 (93.8%)		
CRL23_0171	947±16	1035–1054 (14.9%)	–	–
		1062–1158 (80.6%)		
CRL23_0172	906±16	1046–1085 (42.7%)	–	–
		1095–1103 (1.5%)		–
		1124–1213 (51.2%)		

Tab. 5. Radiocarbon data of individual samples and their modelled intervals with a 95.4% probability.

Sample / Element	O10	O4
P	3218.00	8863.00
S	2327.00	544.00
Mg	2708.15	4490.55
Al	12245.70	13482.90
Cr	153.60	106.40
Mn	420.70	718.20
Fe	14045.00	16044.70
Co	11.50	10.85
Ni	90.05	66.65
Cu	47.55	149.95
Zn	77.75	168.25
Pb	156.50	133.80

Tab. 6. Concentrations of selected elements in soil samples. The values are in mg/kg and represent the mean concentrations of composite three-fold sample measurements. LOQ = 10 mg/kg.

Archaeobotanical samples were inspected and mechanically cleaned. They were then repeatedly washed with 0.5 M HCl, 0.1 M NaOH, and 0.01 M HCl, with distilled water wash steps in between (*Gupta – Polach 1985*; *Jull et al. 2006*). The bone sample was cleaned, ground to a fraction of 0.5–1 mm and finally washed under the same conditions as the other samples. The isolated collagen was gelatinised at 90°C, filtered, and dried at 60°C to reach a constant weight. The yield of bone collagen was 19.3 mg/g. All samples, with a small amount of CuO, were torch-sealed under a dynamic vacuum into a quartz glass tube and combusted at 900°C. The resulting carbon dioxide was purified and graphitised (*Orsovszki – Rinyu 2015*).

All samples were measured using the Multi-Isotope Low-Energy AMS System (MILEA) in the Nuclear Physics Institute of the Czech Academy of Sciences (*Kučera et al. 2022*). The resulting ^{14}C activities were calibrated using OxCal v4.4 software and the calibration curve IntCal20 (*Bronk Ramsey 2009*; *2017*; *Reimer et al. 2020*).

To identify the true calendar age of the analysed timber, we decided to employ a high-resolution ^{14}C wiggle-matching method (*Pearson 1986*; *Bronk Ramsey et al. 2001*). Individual tree rings (more than 120) were identified in cross-section, and three of them were sampled in the middle part using the known gaps between the sampled tree rings. The last retained ring was extrapolated by knowing the gap (63 years) since the last sample (CRL22_0172). Also, sequential phases combining radiocarbon and calendar data were generated through Bayesian modelling (*Bronk Ramsey 2009*).

Total concentrations of selected elements in sampled soils

The dry homogenised soil samples were ground to a fine powder. A subsample of 100 mg of the investigated material was used for microwave digestion (Mars) with nitric and hydrochloric acid in a solution ratio of 1:3. The concentration of phosphorous and sulphur was measured by optical emission spectroscopy with inductively coupled plasma – ICP-OES (Perkin Elmer, The Optima 8000) by 3-point individual calibration. The concentrations of Mg, Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, and Pb were determined by mass spectrometry with

inductively coupled plasma (ICP-MS) using 5-point individual calibration. To obtain a higher accuracy of the results, the final value was calculated as the mean concentration of three individually analysed subsamples (*Tab. 6*).

Results

Relative chronology

The stratigraphic situation of the plot was determined and visualised by a Harris Matrix (*Harris 1989*; Harris Matrix software; *Fig. 5*). A medieval deposit was documented (K001), bordered on its surface by a charcoal horizon (K001.1; *Fig. 6*). The deposit contained medieval pottery dated typologically to the period from the 14th to the turn of the 16th century AD. The pottery included one fragment of a glazed stove tile with figural relief (*Fig. 4*: 23). The figure on the relief could not be linked to any known published scene, but it corresponds stylistically to an older phase of figural stove tiles dated to the mid-15th century (*Mácelová 2005*; *Kvietok – Mácelová 2013*). The charcoal horizon is thus dated based on the artefacts to the late part of the 15th century or the early 16th century. It may be related to the great fire of 1500 AD (*Baláž 2002*, 10).

Apart from this deposit, only three other features could be identified as medieval based on the finds they contained. All three were excavated in sunken features. Feature O4 was a prolonged pit surveyed only in a narrow cross-sectional trench. The pit could be dated by pottery to the 13th–15th century. The pit was covered by the medieval deposit (K001). Feature O9 was a small, probably round waste pit. It contained only a single late medieval potsherd in the upper part of the fill (K007). The pit was disturbed by wall O8, which was dated by stratigraphy to the 16th century at the earliest. Based on this fact, the medieval age of this pit was assumed. The last medieval feature was a large pit situated between the pillars supporting the backyard façade of the town hall (O10). This pit had already been disturbed earlier by the 20th-century entrance to the basement. The pit was partially covered by the supporting pillars and a burned clay deposit, which might represent the destruction of the medieval wattle and daub phase of the building (K006; *Fig. 3*). The pit contained multiple pottery fragments and organic material, including larger pieces of timber that were retrieved (R43/08, R44/08, R52/08-1, R52/08-2). Two samples of the deposit were taken from the pit fill (BB-R53/08, BB-B46/08). The pottery from the pit dated the feature to the turn of 16th century. Since the pit was located under the oriel window toilet, it was interpreted as a cesspit (*Fig. 3*). The burned deposit over the cesspit (K006) did not contain any finds, so it was only considered to be younger than the pit (early 16th century or later). All the sunken features shared one common trait – a buffer of up to 40 cm-thick substratum clay that was soaked with organic matter from the pit fill (*Fig. 3*).

The medieval stratigraphy was covered by four Early Modern period deposits dated to the 16th–17th century (K002-K005). This part of the stratigraphic sequence includes stone walls O1, O2, and O8, which form a two-room layout oriented rectangularly to the axis of the plot. Walls O1 and O2 seem to continue northeast to the neighbouring plot on Kapitulská Street. Wall O2 is in line with the border between the two plots on Kapitulská Street.

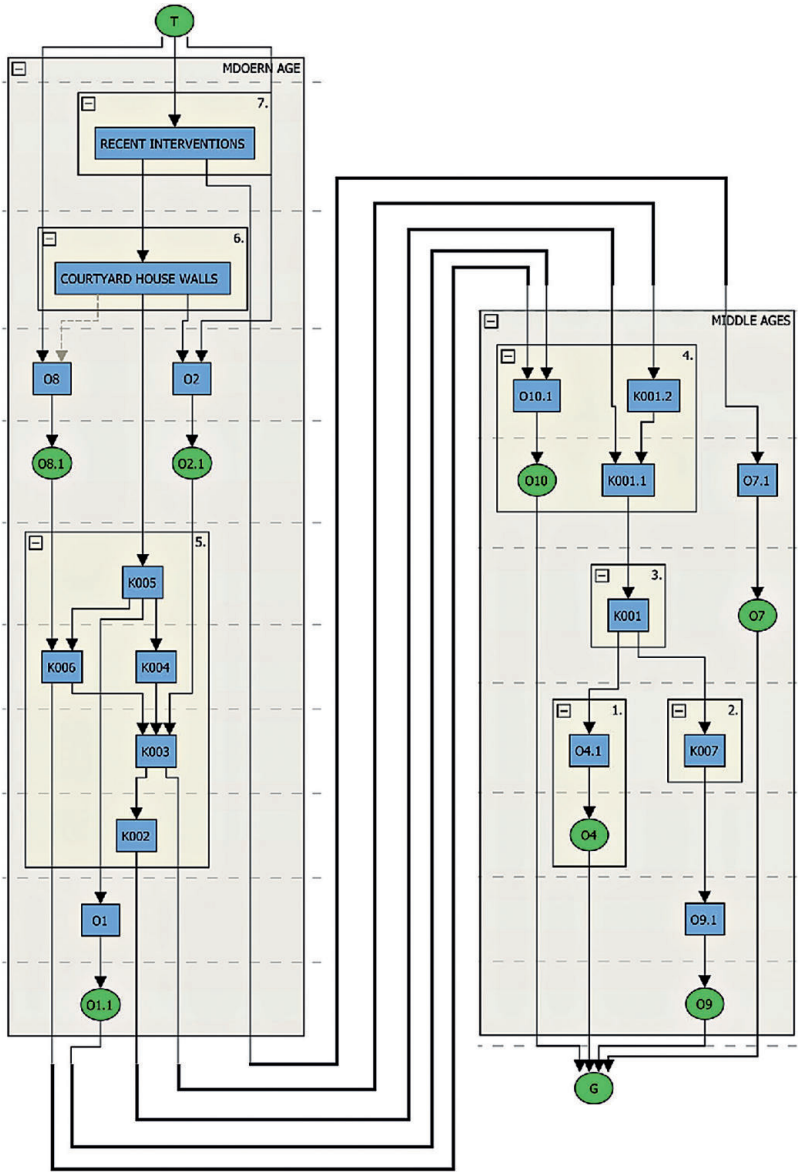

Fig. 5. Archaeological stratigraphy recorded by the Harris matrix diagram. Middle Ages: 1 – 13th–15th century; 2 – 14th–15th century; 3 – 14th–15/16th century; 4 – 15th/16th century. Modern period: 5 – 16th–17th century; 6 – 17th–19th century; 7 – 21st century. Stratigraphic units (SU) – deposits (blue) and surfaces (green): G – geology; K001 – grey viscous deposit; K001.1 – charcoal horizon; K001.2 – slag; K002 – brown deposit; K003 – thin yellow deposit; K004 – grey cultural layer; K005 – brown-yellow deposit from modifying terrain; K006 – deposit with burnt lumps of clay; K007 – top deposit of pit O9 backfill; O1 – quarry stone masonry; O1.1 – excavation for masonry O1; O2 – quarry stone masonry; O2.1 – excavation for masonry O2; O4 – excavation for waste pit; O4.1 – waste pit fill; O7 – quarry stone masonry; O7.1 – excavation for masonry O7; O8 – stone masonry; O8.1 – excavation of stone masonry O8; O9 – excavation of a small shallow waste pit; O9.1 – grey wet deposit with organic residues; O10 – excavation of a sunken cesspit; O10.1 – fill with a high content of organic residues; T – top surface.

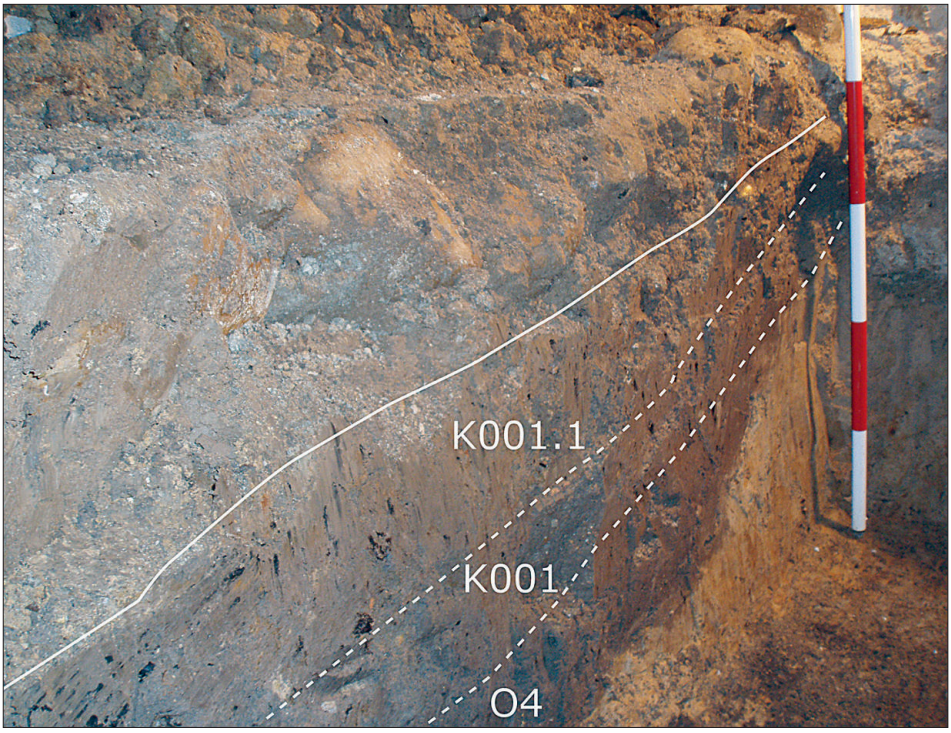

Fig. 6. Documented pit O4 containing medieval deposits – fill (K001) and charcoal horizon (K001.1) (photo by M. Miňo).

Inside the northeast room of this layout, the top part of a stone-lined well (O6)[1] was documented. Another undated feature was wall O7, which was parallel to walls O1 and O2 but lies deeper in the back of the plot.

The pottery assemblage found on the premises of the town hall is represented mostly by so-called grey ware (*Fig. 4*). The oldest identified vessel is a 13th-century pot with an everted rim (*Fig. 4*: 1). The pottery assemblage consists predominantly of rounded pots with collared rims occurring in all stratigraphic contexts. This form is the most common vessel type throughout the medieval period in the area, being used from the 14th century up to the Early Modern period. The only exception is the shouldered bowl with an everted, thickened, and hooked rim (*Fig. 4*: 3). A collared rim is also typical for both examples of jugs with looped rod handles. Other (less numerous) shapes include lids, mainly collared lids with an integrated clubbed knob. The profile of the lids, together with marks from cutting the vessel off the wheel with a string, links them chronologically with the set of collared bowls. The identified vessel forms included an undecorated Late Gothic waisted

[1] Even though the bottom of pit O10, interpreted as a cesspit, was at the level of the groundwater, we do not expect its contamination. The cesspit has a small visible amount of contaminated subsoil and its distance from the well is c. 13 m. Notably, the well and the cesspit belonged to two separate plots in the Middle Ages.

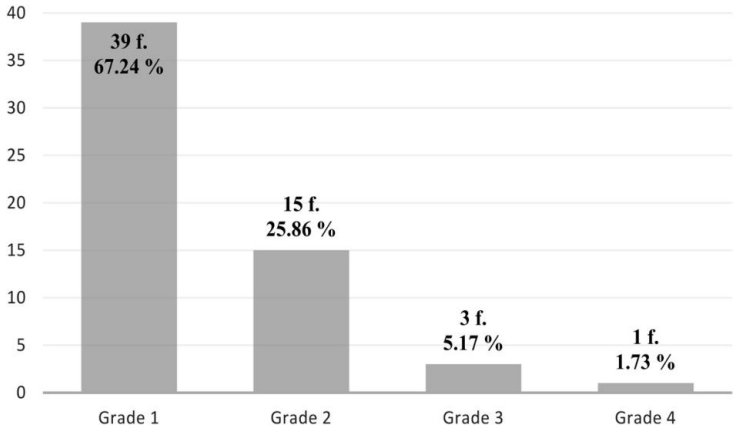

Fig. 7. Ratio of bone preservation under the criteria of *Behresmayer* (*1978*).

beaker with a collared rim and an unusually high neck. This Bratislava type beaker – phase II according to *Hoššo* (*1996*) – can be dated to the mid-15th century (*Fig. 4*: 22). It is interesting that there is no single example of oxidised glazed waisted beakers with an inverted rim from the turn of the 16th century known from the town castle (*Ušiak 1997*; *1999*). However, their unglazed predecessors were identified (*Fig. 4*: 14, 16). Decorated pottery is scarce in the assemblage, which is typical for the region and time. The documented decorative patterns are typical as well. They consist of roulette and running incised wave line. In a single instance, a finger-pressed decoration on the pot mouth and a band of incised lines was documented (*Fig. 4*: 19). Most of the assemblage is dated to a single time frame from the mid-15th to the early 16th century. The assemblage is quite uniform in terms of technology and local provenance. Only one piece of white clay pottery from a different region (likely Kremnica or Hont County) was recorded.

Absolute chronology

Well-preserved organic material in cesspit O10, dated by stratigraphic relations into the 15th/16th century, allowed the use of dendrochronological analysis as well as radiocarbon dating. First, four samples of timber (*Tab. 3*) were analysed by dendrochronology. All of them showed traces of carpentry work (*Fig. 8*), so they can be considered relevant for dating human activity on the plot. Two of the samples were identified as *Abies alba*, one as *Quercus sp.*, and one as *Larix*. Only two samples, *Abies* (R43/08) and *Larix* (R44/08), preserved the last outermost tree ring. The other two samples could be determined only as *terminus post quem.* The *Abies alba* sample (R43/08) was a carpenter's splinter and thus provided only a *terminus post quem* date with a low scale of precision. The *Quercus* (R52/08_1) and *Abies alba* (R52/08_2) samples were sections of boards, so the last outermost tree ring was not present in either sample. The most problematic was the *Larix* sample (R44/08; *Fig. 8*). It represented a section of a half-pole, with one end roughly cut into a pointy shape by an axe; burn marks were found at the opposite end. The pole was made from the entire width of the tree trunk, including the outermost tree ring. The circumference of the trunk in its broadest part was only 38 cm, but 109 tree rings in total were identified. This would suggest a much broader trunk. Another important observation was that the tree rings

Fig. 8. Analysed timber samples: A – *Larix* (R44/08) as a section of a half-pole with traces of burning and carpentry work, B – *Abies alba* (R43/08); C – *Quercus sp.* (R52/08_1); D – *Abies alba* (R52/08_2) (photo by B. Styková).

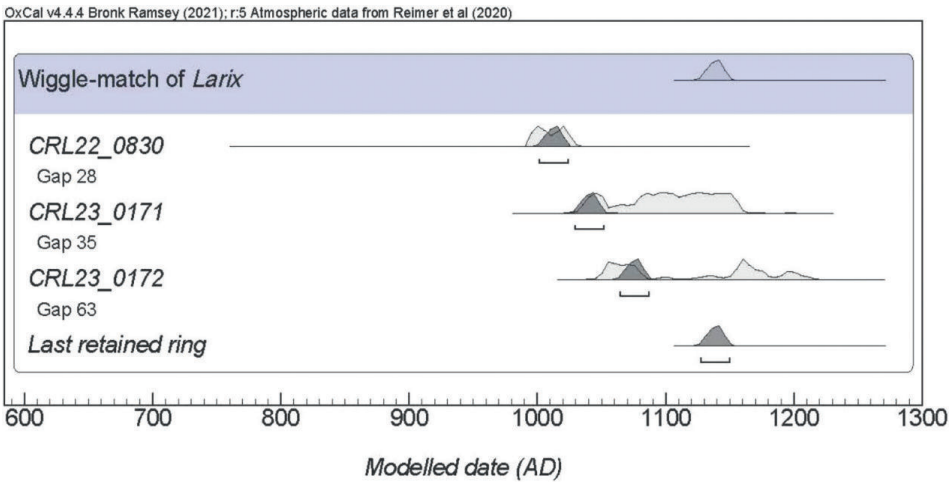

Fig. 9. Wiggle-match result using extrapolation of the last preserved ring.

were not uniform around the whole circumference (some might be too subtle for identification in certain parts). This indicates that the tree had to grow in a specific location, which is why the sample initially could not be dated by the dendrochronology method.

Separately, the same *Larix* timber was radiocarbon dated. Three individual tree rings were sampled (CRL22_0830, CRL23_0171, and CRL23_0172) and used for the wiggle-matching method. With knowledge of the 63-year gap between them, his approach allows the model to estimate the age of the last retained ring within the range of *1127–1150 cal AD* with a 95.4% probability (*Fig. 9*). This wiggle-match has good overall agreement (A_{comb} = 83.7%, A_n = 40.8%, n = 3).

After the radiocarbon dating, the matching sequence in dendrochronology was identified (*Fig. 10*), which narrowed the window for a possible match. The obtained interval of *1127–1150 cal AD* showed the highest correlation with statistical data for a cut date in the winter of 1131/1132 AD (statistical probability values: TBP 3.93; THO 2.24; CC 0.25; Gl 59.7; OLP 108). This is the most probable date for the felling of the tree under the circumstances. The reliability of this date needs to be further verified in the case that more samples of the same species for the date are collected. There is not much comparable data available, so the value of the source data is lower.

For the absolute chronology of the site, more samples were analysed using the radiocarbon dating method. Two seeds of annual plants (C3 plants; CRL22_1458 and CRL22_1459) from pit O10 were sampled, as this type of material contains a C^{14} signal from the year of the plant's death. Furthermore, one animal tooth obtained from waste pit O4, which is older (13th–15th century) than cesspit O10 according to stratigraphy (*Fig. 5*), was also sampled. Using archaeozoological methods, the tooth was identified as a lower M1/2 tooth (first or second lower molar) from *Bos taurus*. The estimated age of the tooth approaches the time of animal death.

Banská Bystrica's great fire, mentioned in 1500 AD, and its identification on the site was the next target of the radiocarbon analysis. Stratigraphy and the arrangements of the charcoals in deposit K001.1 suggest deposition in a short time interval, such as during a fire

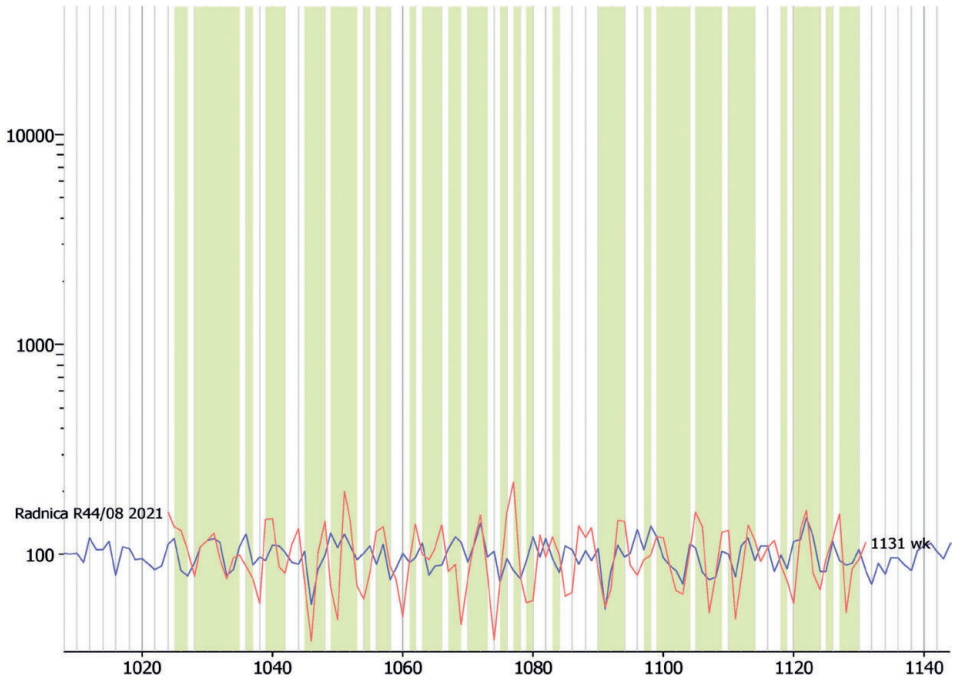

Fig. 10. Dendrogram of *Larix* timber (R44/08) from pit O10.

event. The charcoals (CRL22_0829) from this deposit, which is contemporary with cesspit O10 and later than waste pit O4 and deposit K001, were dated. Unfortunately, the species and part of the wood cannot be identified and, therefore, the sample represents only the *terminus post quem* for when the fire may have occurred (*Tab. 5*).

Three radiocarbon and three calendar dates (dendrodates: *Quercus* – R52/08_1, *Abies alba* – R52/08_2, and the known town fire in 1500 AD) were used for sequential phases labelled Sequence 1–3 (*Fig. 11*), generated by Bayesian modelling. These dates were arranged according to their character (accurate data or *terminus post quem*) and the archaeological phases based on stratigraphy. *Cornus mas* and the wiggle-matching result from the *Larix* do not reflect the use phase of the archaeological feature that we wish to date, and therefore we did not include them in the model. *Cornus mas* (CRL22_1459) belongs to the latest feature (O10), in the stratigraphy dated to the 15th/16th century, but its unmodelled interval is 709–882 cal AD (95.4% probability). Usually, the archaeobotanical remains of annual plants allow for the dating of the archaeological objects in which they were stored or their deposition. In this case, seeds of *Vitis vinifera* (CRL22_1458m) and *Cornus mas* (CRL22_1459) fall into two distinctly different time ranges (*Tab. 5*). This discrepancy is further addressed in the discussion. Using radiocarbon and dendrochronological dating, the *Larix* (R44/08) was most probably felled and used to build a wooden construction (I) in winter 1131/1132 AD. This provides evidence of previous settlement of the plot or its nearby area, which dates back to the 11th or 12th century AD, before the first archaeological phase according to a Harris matrix diagram. Its deposition in later feature O10 clearly documents the reuse of wood.

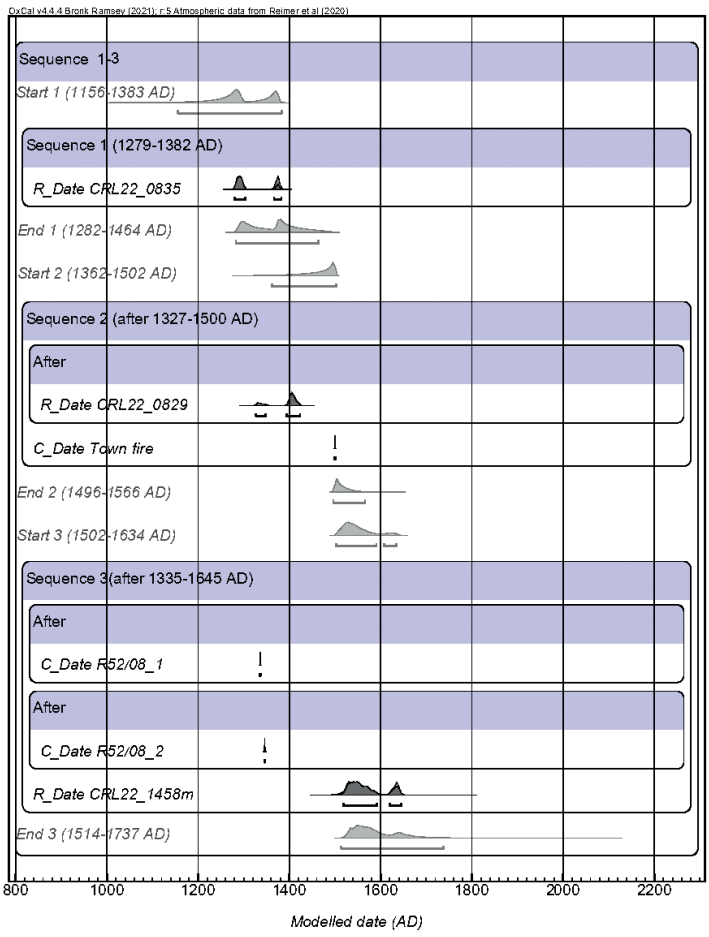

Fig. 11. Final sequence model based on Bayesian stratigraphic analysis performed in OxCal v4.4. software (*Bronk Ramsey 2009*; *2017*) using the IntCal20 calibration curve (*Reimer et al. 2020*).

The first sequence of the Bayesian model (*Fig. 11*) with the *Bos taurus* tooth sample (CRL22_0835) allows for dating waste pit O4 as well as the first archaeological phase. The modelled interval is in the range of *1279–1382 cal AD* (95.4% probability), which indicates ordinary activity at the site.

Even though the charcoal samples (CRL22_0829) are related to the town fire in 1500 AD, they represent the period before that. These dates were incorporated into the second sequence using the After function. The modelled interval after *1335–1500 cal AD* (95.4% probability) represents the time the tree was felled and used for a wooden construction (II), which subsequently burned down, most likely during the town fire in 1500 AD.

Lastly, the third sequence contains two dendrodates (R52/08_1, R52/08_2) and a *Vitis vinifera* seed sample (CRL22_1458m) dated 1518–1644 cal AD (95.4% probability). In this case, we used the After function again. Based on the archaeological dating of feature O10 to the 15th–16th century AD, we can lean towards attributing a younger age to this seed. It represents the activity of the settlement just before the establishment of the historic town hall in the second half of the 16th century.

Environmental analysis

Archaeozoology

The osteological material consisted of 58 bone fragments with a total weight of approximately 2.2 kg, of which only 13 bones (90.58 g) could not be categorised. The preserved condition of the bones was relatively good, assessed as grade 1–4 under the criteria of *Behrensmeyer* (*1978*; see *Fig. 7*).

Thus, the bones were not significantly affected by abiotic factors of decomposition (erosion, effect of soil pH, etc.). The sedimentation of the bone fragments was finished 3–6 years after the death of the animal. From the analysed collection of bones, domestic cattle (*Bos taurus*), domestic pig (*Sus domesticus*), domestic sheep (*Ovis aries*), and a group of small ruminants, likely sheep/goat (*Ovis*/*Capra*), were identified. Based on bite marks on the bone of a domestic pig (R51/18_5), we can assume the presence of a domestic dog (*Canis familiaris*) at the site. Fish bones were acquired from the sediment flotation of pit O10, but were not examined.

The domestic cow (*Bos taurus*) was represented by at least one individual. The age was estimated to be 42 months, and the sex was identified as female. It was not possible to calculate the withers height. Unevenly ground molars were documented on the mandible. Cut marks were documented on the left forehead (*Fig. 12*: A, B). The same marks were found on a lumbar vertebra, a radius and a talus. Some bone fragments showed changes of colour to brown (assessed temperature 285–525°C) and black (525–645°C) due to heat exposure.

Domestic sheep were represented by at least one individual, but butchering age, sex, and withers height could not be determined. The group of small ruminants (*Ovis*/*Capra*) was represented by at least one individual. Butchering age was estimated at 23 to 42 months. Sex and height could not be determined. One bone showed changes in colour to brown-black (assessed temperature 285–525°C).

The domestic pig was represented by at least one individual. The withers height of the individual was derived from the total length of the metatarsus, which measured 732 mm (*Teichert 1969*). Butchering age and sex could not be determined. Cut marks were detected on a vertebra and a rib (*Fig. 12*: C) and dog bite marks were found on a second vertebra. Some of the bones exhibited changes in colour to brown (assessed temperature 285–525°C).

Archaeobotany

From the total volume (3.7 l), 221 plant macroremains (only plant seeds) were extracted. In general, it could be stated that the average density of finds per litre of sediment in almost all of the samples was high, within the interval of 4–415 f/l. There are two reasons for this high density: the context allowed for the long duration of plant material accumulation, and the material is conserved by water, as constantly wet contexts usually hold more organic matter. The largest part of the collection consisted of wild species, with 208 finds representing 38 identified taxa (*Tab. 2*). According to their ecological demands, they can be divided into five main categories: 1. a mixture of meadow species (*Avena*/*Bromus*), 2. weeds (*Agrostemma githago*, *Papaver rhoeas*, *Stachys arvensis*, *Solanum nigrum*, *Tanacetum vulgare*, *Capsella bursa-pastoris*), 3. moisture-loving species (*Carex*/*Scirpus*, *Potentilla reptans*, *Ranunculus repens*, *Solanum dulcamara*), 4. species common in riparian vegetation

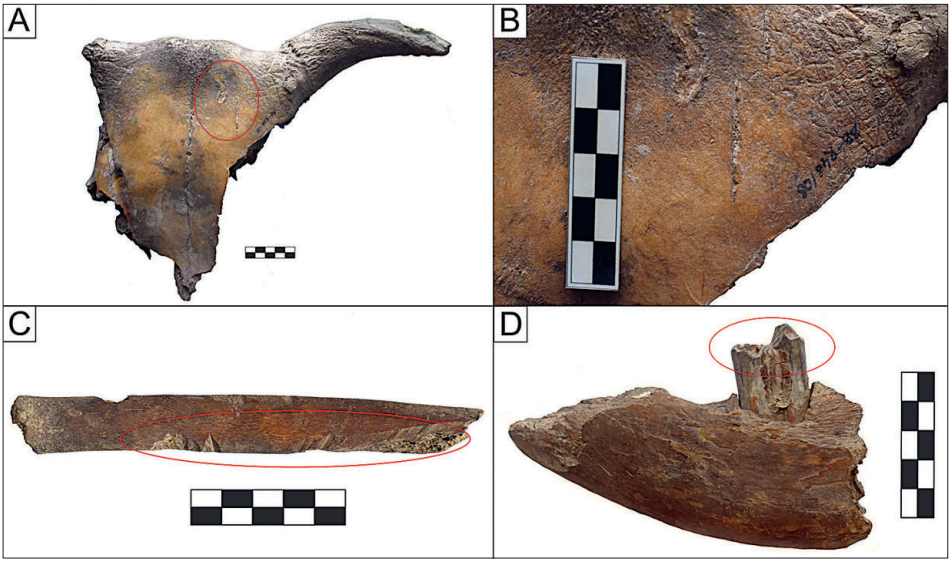

Fig. 12. Analysed bones with documented marks: A – left forehead of domestic cattle (*Bos taurus*) with cut marks; B – detail of cut marks; C – rib of domestic pig (*Sus domesticus*) with cut marks; D – mandible of domestic cattle (*Bos taurus*) with unevenly ground molar (photo by K. Šimunková).

(*Glechoma hederacea*, *Humulus lupulus*), 5. species typical for therophyte communities on cultivated soils and freshly disturbed ruderal habitats (*Barbarea vulgaris*, *Chenopodium album*, *Fallopia convolvulus*, *Setaria viridis*, *Silene vulgaris*),

The second documented group, with 13 finds, consisted of cultivated plants. They were represented only by categories of fruits, fibre-plants, and vegetables. Three taxa were specified – grapevine (*Vitis vinifera*, 3 finds), common flax (*Linum usitatissimum*, 2 finds), and carrot (*Daucus carota*, 8 finds). Common finds of plants as cereal grains or their chaffs and grain legumes are missing from the assemblage.

Total concentrations of selected elements in sampled soils

The results of ICP-MS and ICP-OES analyses (*Tab. 6*) reveal that the concentration of sulphur in the sample from the charcoal layer over pit O4 is 544 mg/kg, whereas in the sample from the bottom of pit O10 reaches 2327 mg/kg. The content of phosphorus also shows a considerable difference: 8863 mg/kg for feature O4, and 3218 mg/kg for feature O10.

DNA

The quantification analysis did not identify traces of human biological material in any of the samples. In samples isolated by the phenol and Chelex method, PCR inhibition of quantification analysis was recorded. However, in samples processed with paramagnetic particles, PCR inhibition of quantification analysis did not occur. Subsequent DNA analysis via STR systems did not confirm the occurrence of any biological material of human origin.

Discussion

Chronology and interpretation

The acquired chronological dates can be contextualised spatially and chronologically based on typological dating, which is still quite scarce. An early medieval layer dated to the 9th century was documented on a nearby plot at SNP Square 3. Early Medieval pottery was also documented further down the slope on Cikkerova Street. The site consisted of a thick layer that continually accumulated until the Early Modern period. The layer might be interpreted as a trash dump site by the riverside or as an accumulation of layers eroded from the higher parts of the slope. The list of pre-charter (1255) finds from the historical centre of Banská Bystrica could be supplemented with the single find of a 12th-century pot bottom found on Štefan Moyzes Square and a coin hoard from the 11th–12th century, which is localised only broadly within the town centre (*Hrašková et al. 2009*; *Mácelová 2013*, 74–75). All of these finds are dated only by means of typology, and the dating of at least some of them might be controversial. However, they provide a hint of the continuity of the settlement. More precise dating methods need to be applied for further conclusions. The find of an 8th/9th century *Cornus mas* in a pit is surprising but not necessarily problematic. A contemporary layer was found nearby (SNP Square 3, *Mácelová 2013*, 74–75). Therefore, it might have entered accidentally or been brought into the pit with other material (e.g. a collapsed wattle and daub wall, which might include parts of older finds in the clay, or intentional fill as part of cleaning, etc.).

The find of a *Larix* pole dated to the first half of the 12th century might play an important role in understanding the continuity of settlement. Due to cut marks on one end, the pole might indicate that it was originally used as part of an unknown building structure on the plot. The fact that it was found in a pit with artefacts dated to the mid-14th (wood boards) to early 16th century (pottery) suggests a continuous use of the plot from the 12th century to the modern age. Several potsherds from the same pit, originating from a vessel made using archaic technology, might support this theory; however, any typologically relevant part of the vessel is missing. Thus, there remains the possibility that the pole was brought from a different plot in the town. In that case, it is still an important find indicating the continuity of settlement activities in the town since the 12th century. The burned end might indicate the discard event of the pole. Considering the homogenous pottery assemblage from the turn of the 16th century found in the pit, we assume the discard time to be around the time of the great fire in 1500 AD (thus the burned end?). The association of the burn marks with anti-decay measures is less likely due to the overall short length of the pole, which suggests that a significant part of its original size might have burned off. Until around the time of the great fire event, the plot was probably used as part of a building erected on the site and might have eventually been reused during any rebuild events. Another explanation is the continuous use of the waste pit or cesspit, perhaps with periodical cleaning since the 12th or even the 9th century. The latest absolute date in this feature comes from a dendrochronologically dated 19th-century wood splinter. The presence of this artefact in the collection is surprising. However, the possibility of intrusion during the construction of a secondary entrance to the cellars might offer an explanation. After all, cesspits could have a very long lifespan, especially if maintained well (*Smith 2020*, 454). Typically, only the middle part of the cesspit was emptied, allowing older waste

sediments to remain on the edges as later ones accumulated in the centre. Nonetheless, with the long lifespan of cesspits, a specific type of form and construction can be expected (according to *Smith 2020*, 447–454). Hay was commonly used as a sanitary layer to mitigate odours (*Bain – King 2011*; *Smith 2020*) and as an accelerator for the breakdown of organic materials (*Atta et al. 2013*). This usage is supported by archaeobotanical finds of grass seeds (according to *Smith 2013*, 539), as was the case in pit O10.

Carbon, nitrogen, sodium, and phosphorus are among the most important chemical elements indicating human activity, while potassium, magnesium, sulphur, copper, and zinc are less significant (*Holliday – Gartner 2007*). For the detection of soils affected by settlement activities, phosphorus is a particularly suitable marker since soil chemical assessments assume that during the time a certain place was inhabited, there was an increase in the surface deposition of organic material, which, among other fractions, contains the organic form of phosphorus (*Schlezinger – Howes 2000*). Similar activities include the removal of household waste and faeces (*Terry et al. 2000*). In both analysed cases, phosphorus reached higher concentrations (O10 – 2327 mg/kg, O4 – 8863 mg/kg) than the average for soils, indicating that both places represent soils affected by anthropic activities. In the case of top layer K001.1 filling pit O4, the concentration reaches considerably higher values. The high concentration of phosphorus could refer to a fire event, as it is present in wood ash in higher concentrated forms. According to the dating of the charcoals, this could possibly be linked to the town fire of 1500 AD. The sulphur content in feature O4 could also serve as a marker of anthropic activity, indicating the presence of a site used as a cesspit, since both phosphorus and sulphur are contained in human faeces. This statement, however, should be supported by multiple sampling of the site.

Another attempt to confirm the interpretation of feature O10 as a cesspit was the DNA analysis, based on the assumption that human faeces and urine are indicators of this interpretation. The presence of these biological materials might result in increased traces of sedimental DNA. Analysis of the retrieved samples did not prove any occurrence of biological material of human origin. In four of the six samples, the quantification DNA analysis was inhibited. Generally, there is a need to use a more appropriate isolation method aimed at higher input quantity and the removal of PCR reaction inhibitors when assuming that the presented deposit contained some human DNA in a detectable quantity and quality. In at least two samples, no evidence of preserved biological material was detected. This leads to the conclusion that the preservation of biological material, particularly human DNA in this case, is highly influenced by physical, chemical, and microbiological conditions, as well as the input amount, character, and quality of the biological material. However, another possible conclusion is that the deposit did not contain any human biological material, and the interpretation of feature O10 as a cesspit might not be correct. This is also supported by the absence of bran in the archaeobotanical sample, as bran indicates excremental waste (*De Cupere et al. 2022*). There is still a chance to validate the interpretation through the identification of coprolites by micromorphological analysis of the remaining part of the sample deposit. The dimensions of pit O10 (4.4 m × min. 2.8 m) suggest it could have originally been the underground part of a temporary dugout dwelling used during the construction of the main house, which eventually ended up as a waste and cesspit. Although temporary dugout shelters are rarely preserved or recognised archaeological features, there are some examples, the most well-known being the Selepcheny house in Trnava (*Hoššo 2007*; *Žuffová 2009*, 55).

The historical analysis of architecture pointed out the evolution of the building from two different houses (*Sura 1982*, 110–113; *Staníková 1990*; *Sura et al. 1996*), and the spatial analysis of the plot seems to confirm this hypothesis. The plot width is 22 metres, which is double the size of an average historical plot in the town centre (11±0.5 m). Despite this, it could be said that analysed pit O10 originally belonged to a different house than pits O4, O9, and stone-lined well O6. The boundary between these plots might be preserved in wall O8, the archaeological date of which might possibly correlate with the written record of master Pankratz's 1555/1556 reconstruction of the town hall, which included the construction of walls around the yard (*Sura et al. 1996*, 29). According to a record from 1556, two individual houses had already been merged into one two-storey thoroughfare type mansion. The town hall was located upstairs, while other rooms were rented out. Various structures, such as a building by the well, an old brewery, a barn converted into a warehouse for brick, and a garden extending to the Hron River, were situated behind the main building (*Güntherová et al. 1967*, 47). The relationship between the mentioned building by the well and the archaeological record of the stone-lined well (O6) and surrounding walls (O1, O2, O8) is questionable.

The position of wall O2 and its proposed continuity to the northeast, in correlation with the axis of the plot boundary on Kapitulská Street, might suggest that part of the plot could have belonged to Kapitulská Street for some time. This scenario could only have occurred during the period between the year 1600, as depicted by the Ferrari map, and the mid-19th century, but this scenario seems unlikely. However, building activities extending across different plots in the town are already known (e.g. the Thurzo mansion).

Diet

The analysis of osteological material identified only domestic animals. The most numerous were cow bones. Even though the osteological material was not plentiful, it provided interesting information concerning the butchering age of animals. Only mature animals were detected (sheep aged 23–36 months, cows older than 42 months), which may indicate a primary focus on dairy products rather than meat. A later 18th-century written record suggests that even poorer citizens of the town typically raised 1–3 cows per family (*Jurkovič 2005*, 205). An interesting find was the mandible of a cow, which probably had tooth problems due to unevenly ground molars. Cut marks were found on the left forehead of this animal and they were also recorded on other species, specifically on their ribs, vertebrae, and long bones, indicating butchering and kitchen preparation of meat. The presence of heat marks on 11% of all bones indicates that these bones were related to baking waste. The assumed temperature that caused these marks were too low for the burning of the waste bones, which was common for the period. The animal bones reflect, on one hand, the dietary practices of the town's high society, and, on the other hand, they indirectly confirm the presence of one species unrecorded in osteological material – the dog. Although its bones were not found in the assemblage, bite marks on the bones of other animals (R51/08) indicate its presence. The absence of dog bones could be explained by the custom of the disposal of dog and horse carcasses outside the town, often around the gallows (*Boriová 2019*, 123). A late medieval horse burial at the Hron riverside excavated in what is now Cikkerova Street in Banská Bystrica might contribute to this as well. The burial was broadly dated by the presence of a late medieval horseshoe and atypical pottery. The pit in which the

horse was buried was dug in the area covered by a thick organic layer with artefacts from a broad time span between Early Middle Ages to the Modern Age (*Hrašková et al. 2009*). The context most likely represents a waste disposal site. The find of fish bones is not surprising, as the last private owner, Mühlstein, left an estate that included a fishpond on the left bank of the Hron River (*Jurkovič 2005*, 205).

Archaeobotanical finds of cultivated plants did not yield much new information. However, they raise the question of why there are no cereals or legumes in the record. This absence might be attributed to various reasons, but cereals are present in the only other existing archaeobotanical assemblage from the town (*Hajnalová – Mihályová 1998*, 62). Of interest is the presence of grapevine (*Vitis vinifera*) in the 16th–17th century, which can ripen at this location today, although its quality is not particularly high. Due to the historical context of the wine trade in the region, which was disrupted by Ottoman expansion, the domestic source of the grapes could have been limited mainly to the area around Krupina or the Malé Karpaty (*Baďurík 1990*; *Miňo 2021*), and they might also have been imported in the form of raisins. On the other hand, the hops (*Humulus lupulus*) recorded in archaeobotanical samples could be related to beer brewing. Two preserved seeds of this taxon indicate that hops grew on the plot or on the adjacent estates. It is uncertain whether these hops were collected or intentionally cultivated. Naturally, wild hop plants grow in wet fen carrs as well as in river or stream bottoms (*Delyser – Kasper 1994*, 166). The first mentions of hop cultivation come from the year 736 AD in the area of Hallertau in Central Bavaria (*Bradáč 2008*, 38) and 768 AD in a letter of Pepin the Short. In the Slavic regions, written records mention hops from the 10th and 11th centuries (*Beranová 2005*, 122–124). and later archaeological records are also known (*Schneiderwinklová et al. 2008*, 191; *Široký et al. 2008*, 289; *Orna – Dudková 2018*). Wild hops were used in breweries alongside cultivated hops for a long time (*Beranová 2005*, 122–124). The final interpretation of this find is highly difficult because it cannot be determined whether it is a component of the natural vegetation growing on the plot or not. However, according to historical sources from 1556, the old brewery in the backyard of the main tract is documented (*Sura 1982*, 116) based on the brewing rights granted by Louis II of Hungary in 1524 for every house in Banská Bystrica (*Jurkovič 2005*, 184).

Environment and ecology

The finds of wild plants seem to be more interesting. They allow for a certain reconstruction of the species composition of the local flora and vegetation in the surrounding landscape (forests, meadows, fields) and provide insight into the climate of the time. Oak is currently found very sparsely around Banská Bystrica, i.e. in the northern part of Zvolenská kotlina Basin (e.g. *Šuvada 2023*, 266). It occurs commonly only further south of the Lukavica – Veľká Lúka – Badín line, due to local environmental influences and changes in management. The relatively high occurrence of oak in the samples may indicate its frequent presence as a result of specific landscape use in the Middle Ages, associated with targeted cultivation for economic timber and traditional management practices such as forest grazing, coppice management, or the collection of leaf litter. These practices helped keep the stands well-lit and increased the competitive abilities of *Quercus* species (*Roleček 2010*).

The presence of flax (*Linum usitatissimum*) testifies to the use of this crop. Weeds, such as *Agrostemma githago* recorded in the assemblage, commonly grew in the fields

in the past. Nonetheless, this species is currently rare and listed as critically endangered (*Eliáš et al. 2015*) due to more efficient seed cleaning and the intensification of land use. This find is linked to crop use or farming, although cereal crops were not identified in the archaeobotanical record.

The other species composition shows a mixture of meadow plants (*Avena/Bromus*), weeds (*Agrostemma githago*, *Papaver rhoeas*, *Stachys arvensis*, *Solanum nigrum*, *Tanacetum vulgare*, *Capsella bursa-pastoris*), moisture-loving species (*Carex/Scirpus*, *Potentilla reptans*, *Ranunculus repens*, *Solanum dulcamara*), and species common in riparian vegetation (*Glechoma hederacea*, *Humulus lupulus*). The species typical for therophyte communities on cultivated soils and freshly disturbed ruderal habitats are the most common (*Barbarea vulgaris*, *Chenopodium album*, *Fallopia comvolvulus*, *Setaria viridis*, *Silene vulgaris*), which were naturally the most prevalent components of the medieval flora around dwellings and communities. From this list, it is possible to form an image of a medieval landscape near a river or stream, which consisted of a mosaic of the aforementioned types of habitats. This landscape does not differ much from some parts of today's landscape with low-intensity economic use and those not marked by collectivisation, such as the neighbourhood of the town of Krupina. Here, we find similar landscape elements and structures formed by natural, semi-natural and ruderal, and nitrophilous communities and their species in the vicinity of dwellings.

From the agricultural perspective, the historical cadastre of Banská Bystrica was not particularly valuable. Records from 1720 explain that two-thirds of the fields had poor yields, while the remaining one-third had only an average yield. As a result, the town greatly depended on grain imports (*Jurkovič 2005*, 205). However, the demand for protein-rich food by the mining communities, which were the backbone of the town's economy, boosted livestock production (e.g. *Skladaný 2010*, 43). The archaeobotanical finds from the cesspit, together with historical records and ecological research, provide clues about livestock management and the associated landscape use strategy. These findings suggest the existence of woodland pastures in the vicinity of the surveyed site and may indicate a pastoral strategy for raising domestic ruminants at least seasonally. Woodland pastures are known from written records in the eastern parts of the Štiavnické Vrchy Mountains, indirectly mentioned in 1367, and specifically described in the context of pig pastoralism in 1543 (*Maliniak 2019*, 73). Remains of woodland pastures in the Štiavnické Vrchy range, including rock-built enclosures for animals, were recorded in the Svätý Anton – Banský Studenec area. The pastures existed, according to remaining *Quercus* individuals, until the 19th century, but their origins are still unknown (*Miňo et al. 2020*, 54–55).

The distribution of wood pastures in Slovakia was analysed by *Wiezik et al.* (*2018*) based on the aerial map from 1950. One of the oldest recorded sites is Dobrá Niva – Gavurky, where the majority of standing trees are, on average, 250 years old, but individuals over 400 years are still present (*Fig. 13*). Thus, oak-based wood pasture seems to be an important part of the late medieval environment in the region. Not all of the woodland pastures proposed by *Wiezik et al.* (*2018*) need to be oak-based, as the discovery of pollarded *Fagus sp.* individuals in the woodland pasture of Uľanka suggests. However, today's typical *Quercus sp.* habitat appears to be constricted by mountain-affected climate, extending only about 10 km south of the historical cadastre of Bánská Bystrica. Yet, occasional enclaves of *Quercus sp.* relics along the right bank of the low terraces of the Hron River might indicate that this was not always the case. The written record from the early

Fig. 13. Example of woodland pasture relic at Dobrá Niva (photo by M. Miňo).

16th century (*Maliniak 2011*, 131) regarding *Quercus sp.* trees or growths, together with the preserved toponymy (after *ZBGIS*), indicates a more common distribution of *Quercus sp.* in the lower parts of the Banská Bystrica cadastre in the past (*Fig. 14*). The acorns from the current research were not dated, and their context extends from the 8th/9th century to the 16th (or possibly 19th?) centuries. The written records come mostly from the 16th century, as most of the earlier ones were lost to the fire in 1500.

Therefore, determining the time frame for the *Quercus sp.* occurrence in the Banská Bystrica area is challenging. However, there are hints of a longer tradition of pastoral land use in the surroundings, which may be connected to the sustenance of postglacial steppe relics through pastoral activities since the Neolithic, resulting in open park landscapes that survived at least until the 16th century AD. This correlates with the model by *Ložek* (*2011*, 71). The *Quercus sp.* and *Cornus mas* charcoal find from Netopierska Cave (4th/5th century AD), the 8th/9th-century and likely the 15th-century *Cornus mas* from the Banská Bystrica town centre[2] (*Hajnalová – Mihályová 1998*, 61–62) might suggest this scenario, as do the most recent yet unpublished finds of multiple sites with chipped stone industry

[2] The find is dated solely based on stratigraphy and pottery, but comes from a context that might be a 9th-century deposit disturbed by a 15th-century water pipe trench.

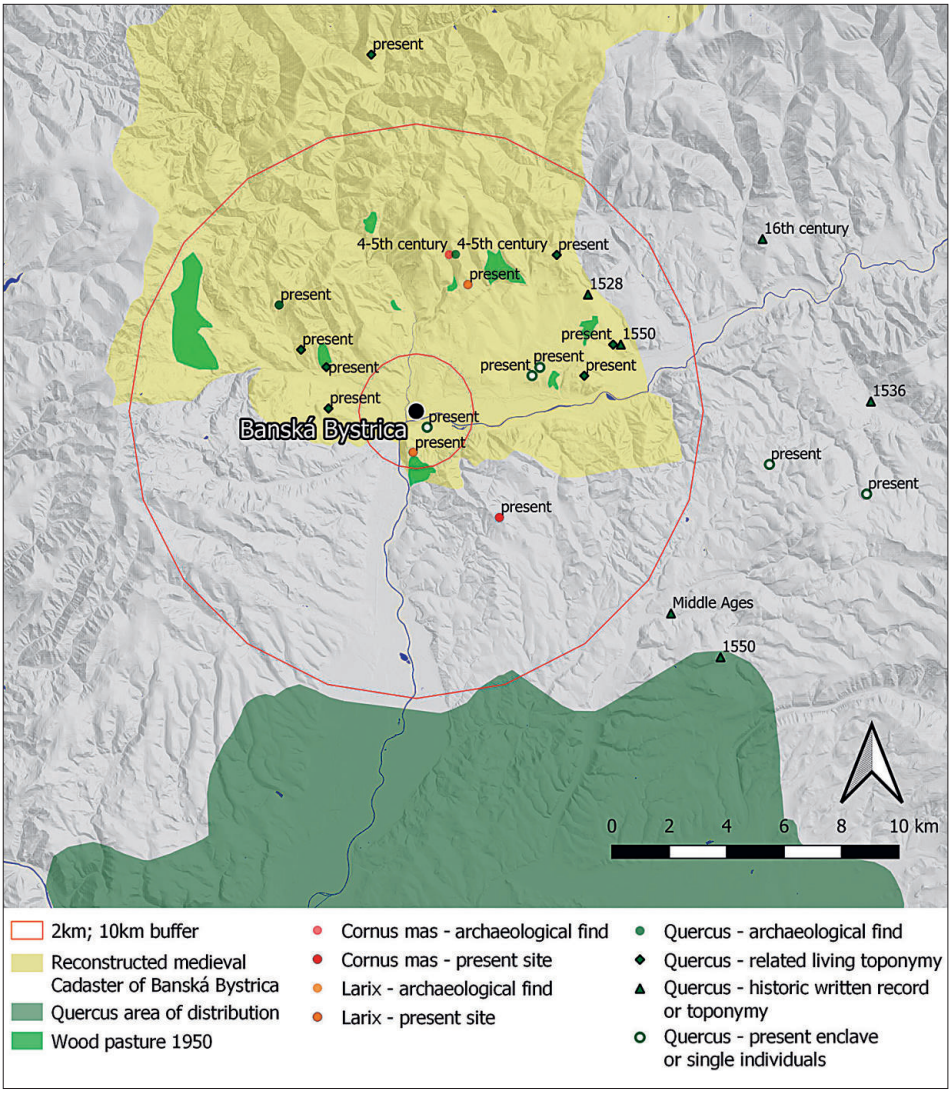

Fig. 14. Plan of past and recent oak (*Quercus*) growth distribution.

(presumably Copper Age and Bronze Age) in the region, correlating with recent or historical shepherds' cabin locations. One of them is located in the area of a historical *Quercus sp.* growth relict in Banská Bystrica – Senica. The presumably Late Iron Age shepherd gear from Selce might contribute to this, too. Notably, *Cornus mas* was present in all of the archaeobotanically examined deposits in Banská Bystrica, even though this taxon is very scarce at the location today. As *Swida sanguinea* may be common mainly in the highlands southeast of the town, the only site of *Cornus mas* was recorded on the southern slopes of Kozlinec Hill, some 10 km to the south of the town, but it is now typically found only as far south as the Krupina Plain.

Pastoral activities are also documented in 16th-century written records around the outskirts of the town (*Fig. 14*). The Castle Meadow extends from the town edge along the right bank terraces towards Senica and continues upriver as Chervartovsky Meadow (*Jurkovič 2005*, 206). Both properties contain *Quercus sp.* growth relics. The church-owned Bull Meadow was situated on the right bank of the Bystrica River, where today's Town Park is located, and the Upper Meadow was located in the backyards of Horná Street. Linked to the finds in the researched plot is the important Mühlstein estate, which was located on the left bank of the Hron River and consisted of a fishpond, a field, and a meadow (*Jurkovič 2005*, 205–207).

Importantly, young individuals of *Quercus sp.* were recently discovered at the edge of this property, appearing in the current natural succession, but they were not recorded here before. The estate lies in close proximity to the excavated site, and could thus be the source of acorns and twigs, as well as the hay containing meadow, wetland, and riparian taxa. The estate lies beneath Urpín Hill, which is the closest home of a *Larix* stand around Banská Bystrica and includes rocky stands or coulees that might be the original stand of the recorded find based on its overall properties. One of past woodland pastures proposed by *Wiezik et al.* (*2018*) is located in this area as the Urpín Wood Steppe protected natural reserve. It is important to note that *Quercus sp.* woods, exploited by pollarding the trees in wooded pastures, might have been a relevant source of charcoal for local silver and copper smelting facilities. These facilities were not only an important part of the town's economy but also influenced the ecology. A pertinent example is the historical record from Matthias Bel, who described the malevolent winds carrying copper fumes from Banská Bystrica to the Lower Manor in the neighbouring town of Radvaň (*Bel 2017*, 314–315).

According to the results of our ICP-MS and ICP-OES analyses, the contents of selected metals relatively correlate with average values of non-contaminated soils. Since Banská Bystrica was affected by the copper mining and processing, the presence of lead, which was used for separating silver from copper, may be related to smelting activity (*Irabien et al. 2012*). The results of the presented samples should be compared with the range of elements found in soils from the wider environment of the studied region. Additionally, various influences of the geological substrate and supporting evidence of the structural behaviour at the site (from excavation, geophysics, surface survey, or even field names) should be compared accordingly. This should lead to meaningful conclusions, because as the review by *Bintliff* and *Degryse* (*2022*) shows, elementary analysis alone can lead to misleading results. However, if more analysed samples yield comparable results, this would confirm flue ash contamination of the soil in the inhabited part of the town prior the great fire in the year 1500.

Conclusion

The paper presents the possibilities for the reconstruction of original situations based on traditional documentation techniques such as photography and drawing. The method described in this paper proved feasible for recreating a three-dimensional image of the archaeological situation based on a small number of photographs, using depth maps as the main tool.

The other line of results consists of interdisciplinary findings that provide a comprehensive view of life in Banská Bystrica. Specifically, it offers information on the economy and land use of the inhabitants of two town plots, where the town hall was later built. The archaeological and historical records suggest that the economy was primarily focused on livestock breeding, for both dairy and meat production. This significantly affected a large part of the landscape around the Hron River, as open land had to be maintained for both summer pasture and hay production. The livestock-focused economy was particularly important in an agriculturally unfavourable environment for basic sustenance, not only for the citizens but also for the miners working in the mining fields deeper in the mountains. This land use strategy helped to preserve ancient open ecological environments, which disappeared due to collectivisation in the 20th century.

We also addressed the issue of dating. Cesspit O10 is perhaps the most precisely dated archaeological feature in the region, since we employed multiple exact dates provided by radiocarbon dating and dendrochronology. However, the results are confusing. Although the pottery from this pit is, except for a single older pot, uniformly dated to a short period and seems to provide a clear dating, the exact dates range across a whole millennium, which is a very broad range in the context of historical archaeology. On one hand, the dates relate to a prolonged continuity of settlement, even to the continuity of the plot and its function. On the other hand, it raises a warning about the constraints of possibilities for standard archaeological dating based on typology. All of the organic finds would be attributed to the same period as the pottery, which would be correct when considering the process of deposition, but not in terms of their origin. Thus, with the typological method, the sense of the prolonged life of some artefacts and its implications for the overall interpretation would be much more constrained. Another important outcome is the realisation that omitting the sampling of deposits while conducting rescue archaeology might result in the loss of information that is often more crucial than that retrieved from material culture. This is important because most sites where rescue archaeology applies are condemned to physical destruction.

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MARTIN MIŇO, Regional Monuments Board of Banská Bystrica, Lazovná 239/8, SK-974 01 Banská Bystrica, Slovakia; martin.mino@pamiatky.gov.sk
BARBORA STYKOVÁ, Nuclear Physics Institute of the Czech Academy of Sciences, Na Truhlářce 39/64, CZ-180 86 Praha 8, Czech Republic; barbora.stykova@gmail.com
IVAN JAROLÍMEK, Department of Biodiversity and Ecology, Institute of Botany, Plant Science and Biodiversity Center, Slovak Academy of Sciences, Dúbravská cesta 9, SK-845 23 Bratislava, Slovakia ivan.jarolimek@savba.sk
JOZEF ŠIBÍK, Department of Biodiversity and Ecology, Institute of Botany, Plant Science and Biodiversity Center, Slovak Academy of Sciences, Dúbravská cesta 9, SK-845 23 Bratislava, Slovakia; jozef.sibik@savba.sk
MÁRIA ŠIBÍKOVÁ, Department of Biodiversity and Ecology, Institute of Botany, Plant Science and Biodiversity Center, Slovak Academy of Sciences, Dúbravská cesta 9, SK-845 23 Bratislava, Slovakia maria.sibikova@savba.sk
MOJMÍR CHOMA, ADendro, A. Dubčeka 14, SK-921 01 Piešťany, Slovakia; mojmirch@gmail.com
KATARÍNA ŠIMUNKOVÁ, Department of Archaeology, Constantine the Philosopher University in Nitra, Hodžova 1, SK-949 01 Nitra, Slovakia; ksimunkova@ukf.sk
MICHAELA LÁTKOVÁ, Institute of Archaeology Czech Academy of Science, Brno – Research base Mikulčice, Mikulčice 736, CZ-696 19 Mikulčice, Czech Republic; latkova@arub.cz
IVO SVĚTLÍK, Nuclear Physics Institute of the Czech Academy of Sciences, Na Truhlářce 39/64, CZ-180 86 Praha 8, Czech Republic; svetlik@ujf.cas.cz
KATEŘINA PACHNEROVÁ BRABCOVÁ, Nuclear Physics Institute of the Czech Academy of Sciences, Na Truhlářce 39/64, CZ-180 86 Praha 8, Czech Republic; brabcova@ujf.cas.cz
MARKÉTA PETROVÁ, Nuclear Physics Institute of the Czech Academy of Sciences, Na Truhlářce 39/64, CZ-180 86 PRAHA 8, Czech Republic; Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Břehová 7, CZ-115 19 Praha, Czech Republic; petrova@ujf.cas.cz
PETER ĎURICA, archaeologist of the municipality of Letanovce, Slovakia; peter.durica@letanovce.sk
PETER BARTA, Bratislava City Museum, Radničná 1, SK-815 18 Bratislava, Slovakia; Nuclear Physics Institute of the Czech Academy of Sciences, Na Truhlarce 39/64, CZ-180 86 Praha 8, Czech Republic peter.barta@mmb.sk
PAVOL MIDULA, Faculty of Environment, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 1, CZ-400 01 Ústí nad Labem, Czech Republic; pavol.midula@gmail.com
JANKA ŠEVČÍKOVÁ, Faculty of Natural Sciences, Matej Bel University in Banská Bystrica, Tajovského 40, SK-974 01 Banská Bystrica, Slovakia; janka.sevcikova@umb.sk